

Evaluation of the  
national COVID-19  
testing programme  
in England between  
October 2020 and  
March 2022

EY-Oxford Health  
Analytics Consortium  
April 2023



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# Acknowledgements

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## Acknowledgements

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- ▶ Prof Sheila M Bird
- ▶ Prof Greg Fell
- ▶ Prof Iain Buchan
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Please note, the report does not necessarily reflect the views of the Scientific Advisory Group.

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## Disclaimers

The views and opinions expressed in this report represent those of the EY-Oxford Health Analytics Consortium (referred to as the 'evaluation consortium' throughout the report) and do not reflect those of the individuals and organisations named above.

Advice provided by those listed was considered and, where deemed relevant, actioned by the evaluation consortium.



# List of abbreviations

<b>ACT</b>	acute trust	<b>ISARIC</b>	International Severe Acute Respiratory and Emerging Infection Consortium
<b>Ag-RDT</b>	antigen RDT	<b>JBC</b>	Joint Biosecurity Centre
<b>AIC</b>	Akaike information criterion	<b>LA</b>	local authority
<b>AMT</b>	ambulance trust	<b>LAMP</b>	loop-mediated isothermal amplification
<b>ATS</b>	asymptomatic testing site	<b>LFD</b>	lateral flow device
<b>BAME</b>	Black, Asian and minority ethnic	<b>LFT</b>	lateral flow test
<b>BJT</b>	business justification template	<b>LIMS</b>	laboratory information management system
<b>CMT</b>	community trust	<b>LSOA</b>	lower-layer super-output area
<b>COMF</b>	Contain Outbreak Management Fund	<b>LTLA</b>	lower-tier local authority
<b>COVID-19</b>	novel coronavirus disease 2019	<b>M&amp;E</b>	monitoring and evaluation
<b>CQC</b>	Care Quality Commission	<b>MHRA</b>	Medicines and Healthcare products Regulatory Agency
<b>DfE</b>	Department for Education	<b>MHU</b>	mental health trust
<b>DHSC</b>	Department of Health and Social Care	<b>MI</b>	management information
<b>DPIA</b>	data protection impact assessment	<b>NHS</b>	National Health Service
<b>DTCC</b>	daily testing for contacts of covid	<b>NHSE</b>	NHS England
<b>EDGE</b>	Environment for Data Gathering & Engineering	<b>NICE</b>	National Institute for Health and Care Excellence
<b>FCDO</b>	Foreign, Commonwealth and Development Office	<b>NPI</b>	non-pharmaceutical intervention
<b>FSM</b>	free school meals	<b>ONS</b>	Office for National Statistics
<b>FTE</b>	full-time equivalent	<b>OR</b>	odds ratio
<b>FY</b>	financial year	<b>PCR</b>	polymerase chain reaction
<b>GDPR</b>	General Data Protection Regulation	<b>PCSE</b>	Primary Care Support England
<b>HES</b>	Hospital Episode Statistics	<b>PHCO</b>	Public Health Clinical Oversight Team
<b>HFR</b>	hospitalisation fatality ratio	<b>PHE</b>	Public Health England
<b>HPT</b>	health protection team	<b>POC</b>	point of care
<b>ICTF</b>	Infection Control and Testing Fund	<b>PPE</b>	personal protective equipment
<b>IDACI</b>	Income Deprivation Affecting Children Indices	<b>PPV</b>	positive predictive value
<b>IFR</b>	infection fatality ratio	<b>QA</b>	quality assurance
<b>IMD</b>	Index of Multiple Deprivation	<b>QALY</b>	quality-adjusted life-year
<b>IPC</b>	infection prevention and control	<b>QMS</b>	quality management system

# List of abbreviations

<b>RCT</b>	randomised controlled trial
<b>RDT</b>	rapid diagnostic test
<b>REACT</b>	Real-time Assessment of Community Transmission
<b>RR</b>	relative risk
<b>SARS-CoV-2</b>	severe acute respiratory syndrome coronavirus 2
<b>SDCS</b>	Strategic Data Collection Service
<b>SEND</b>	special educational needs and disabilities
<b>SOP</b>	standard operating procedure
<b>SSP</b>	Statutory Sick Pay
<b>TIEB</b>	Testing Initiatives Evaluation Board
<b>UI</b>	uncertainty interval
<b>UKHSA</b>	UK Health Security Agency
<b>UON</b>	Unique Organisation Number
<b>UTLA</b>	upper-tier local authority
<b>VoC</b>	variant of concern
<b>WHO</b>	World Health Organization

# Contents



# Executive summary



# Executive summary

## Context and introduction

In December 2019, the disease now known as novel coronavirus disease 2019 (COVID-19) was discovered and quickly spread around the world, resulting in a pandemic unprecedented in recent times. In response to the pandemic, the UK government committed to mass testing, commencing in March 2020. In May 2020, the National Health Service Test and Trace (NHSTT) was formally established, as an Executive Agency of the Department for Health and Social Care (DHSC) to lead an 'at scale' national testing, tracing and isolating service. The United Kingdom Health Security Agency (UKHSA) was established, also as an executive agency of the DHSC, on 1 April 2021 and was operational on 1 October 2021. UKHSA combines the health protection, clinical and scientific functions formerly carried out by Public Health England (PHE) with the functions of NHSTT and the Joint Biosecurity Centre (JBC).

In August 2022, UKHSA appointed a team comprising relevant experts in their respective fields from Ernst and Young LLP in partnership with Oxford University Innovation Limited (hereafter referred to as 'the evaluation consortium') to undertake a six-month (September 2022 – February 2023), independent evaluation of the testing capability delivered in England from October 2020 to March 2022 (hereafter referred to as 'the evaluation'), with a focus on public health outcomes. This evaluation built on previous evaluation work conducted by UKHSA and legacy organisations and sought to capture key learnings from the rollout of testing services to various target populations, offered as part of the national testing programme during this period.

## Methods

During the scoping phase, three key hypotheses were developed:

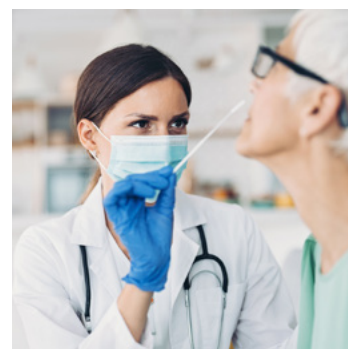
**Hypothesis 1:** Testing services aimed at protecting high-risk groups (e.g., care home residents and healthcare workers) led to a reduction in hospitalisations and deaths in these risk groups.

**Hypothesis 2:** Testing services aimed at high-contact groups (e.g., schools) led to a reduction in hospitalisations and deaths in the general population.

**Hypothesis 3:** Testing services aimed at increasing access to and eligibility for testing and targeting disproportionately impacted groups (universal testing service) led to increased testing uptake in these populations.

Based on these hypotheses, the evaluation sought to answer the following research questions:

1. How was the national COVID-19 testing programme delivered and what factors affected this?
2. What were the barriers and facilitators to access, use and deliver the programme?
3. What were the costs and the cost-effectiveness of the programme?
4. For the universal testing service:
  - a. Did the diversity of those reporting test results increase?
  - b. Did the barriers and facilitators for testing, reporting and acting on a result change?
5. For each priority service:
  - a. Did the service achieve the UKHSA intended aims and purposes of the service?
  - b. Was the service cost-effective?
  - c. If testing were to be implemented again, what are the barriers and facilitators to increase access, use and delivery of tests?



The overall success and effectiveness of any testing programme implemented during a pandemic situation is dependent on multiple contextual factors, shaped by the particular features of the pandemic itself, such as the availability of tests, the efficacy of available tests and the evolving epidemiological context. The testing programme comprised a variety of testing service settings. The combined impacts of these testing services in these settings include their public health impact, their cost-effectiveness and the population's behavioural responses. This retrospective evaluation considered each of these contextual factors against the epidemiological and policymaking backdrop of the pandemic.

Any retrospective evaluation, by its nature, looks back to look forward. As a key premise of this evaluation, this enabled learnings to be made based on the experiences of the past, which could then be applied to current or future ways of working, in a way that was empathetic to the challenges faced. Thus, this retrospective evaluation helped to define what was intended through the implementation of the national testing programme, to evaluate the outcomes and to understand how the findings of the evaluation have been shaped by the nature of this particular pandemic. This enabled us to suggest ways in which approaches to testing could be adapted if these conditions were to differ in any future pandemic.

This retrospective evaluation drew on a mixed-methods, Magenta Book-aligned approach and utilised existing frameworks that have previously been applied when evaluating complex interventions. A Theory of Change (ToC) framework was used to understand the causal pathways and intended and unintended outcomes of each testing service, in addition to exploring the effect of context on each individual service setting's intended outcomes. The evaluation comprised process, outcome, impact and cost-effectiveness components and involved a variety of techniques. These included quantitative approaches, such as health economic modelling and statistical analyses, and qualitative approaches, including a rapid scoping review of internal UKHSA and legacy organisation documents and relevant publicly available documents, as well as stakeholder interviews, to understand behavioural and operational insights gleaned during the course of the evaluation period. The qualitative approach also included international research, which aimed to provide parallel strategy and policy comparators.

The evaluation consortium undertook a rapid assessment of the entire testing programme and, due to limitations explored in the introduction chapter, chose to conduct a detailed evaluation covering the national testing programme with a focused 'deep dive' into the schools, healthcare workers and adult social care testing services.

## Results and key findings

The English national COVID-19 testing programme was a complex programme with multiple, interlinked services that sought to address varied aims from a range of stakeholders. It was rolled out at speed and ramped up to high levels of testing capacity with a total of 2 billion lateral flow devices (LFDs) distributed and 158 million polymerase chain reaction (PCR) tests registered in England, accounting for 84.6% and 89%, respectively, of the total in the UK. Of the total number of LFD tests distributed, 15.7% were reported during the evaluation period in England. This equates to an average of two tests per person per month, at a cost of GBP 25 per person per month. Testing throughout was free of charge at the point of access; from April 2021 onwards, asymptomatic testing was made available to the entire population, as and when individuals felt the need to test.

This evaluation of the national testing programme demonstrated that, overall, the national COVID-19 testing programme in England mostly achieved its intended aims, objectives and purposes (highlighted within the testing service chapters 3, 4 and 5), despite the considerable uncertainty due to the evolving pandemic threat. The results also highlighted the trade-offs between the rollout of a generic testing strategy to achieve coverage of the general population versus a more targeted approach for underrepresented and high-risk populations. We summarise our findings with respect to the evaluation hypotheses and research questions below.

## Protecting high-risk groups

Our analysis shows that testing appears to have been an effective public health intervention for protecting those in high-risk settings, such as adult social care home residents and healthcare workers. Our analysis further suggests a relationship between testing and reduced deaths in two key COVID-19 risk settings, adult social care home residents (see chapter 5 for further details) and hospital patients (see chapter 4 for further details). We did not have access to data at the granularity required to infer a relationship between testing and hospitalisations in these risk groups. The healthcare worker testing service and testing in adult social care homes were both predicted to be cost-effective and well tolerated by the public at the intensities delivered, and there was some evidence to suggest that higher testing intensities could have led to greater impacts. Our analysis of the healthcare worker testing service in particular showed that healthcare worker testing was associated with a 16% reduction in nosocomial infections and that increases in LFD test coverage were associated with decreases in full-time equivalent (FTE) days lost due to COVID-19, except during the periods when the Delta and Omicron variants were predominant.

## Testing high-contact, low-risk groups

School-aged young people represented a high-contact but low-risk group during the COVID-19 pandemic. Our analysis shows that testing in this group instilled confidence to resume activities such as face to face teaching and supported the identification of asymptomatic cases within school settings. Limitations in the data available meant that it was not possible draw conclusions about whether testing in high-contact groups led to wider reductions in community transmission. However, we conclude that these benefits may have been achieved with a lower intensity testing regimen, as opposed to the increased testing intensity required for transmission reduction. The decision about the level of testing intensity for future pandemics would need to be balanced against the uncertainty of the severity of the disease, transmission dynamics and the evidence available at the time, as well as the appetite for risk from a policy and public health perspective. While the evaluation consortium also endeavoured to determine the impact of testing on school absenteeism and carer days lost, this was not possible due to the required data not being available at the time of the evaluation.

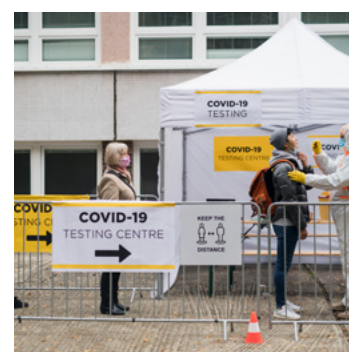
## Increasing access to and eligibility for testing and targeting disproportionately impacted groups

Testing detected an increasing proportion of all COVID-19 cases, between 26% and 40% of all possible symptomatic and asymptomatic cases, providing an accurate reflection of the unfolding pandemic that could be used to inform policymaking. The evaluation of the national testing programme found that it was successful in its aim of increasing the uptake of testing in disproportionately impacted groups and partially successful in improving equity. More-deprived areas consistently reported lower numbers of tests taken per person, with an increase in reporting seen following the rollout of universal testing. However, this increase in uptake was still more pronounced in less-deprived groups, leading to continued inequities.

Many people viewed testing as being important and for the greater good of society. However, some people may have been reluctant to test given the financial implications of having to self-isolate, if financial support was not made available. The testing programme was likely to have been cost-effective at averting hospitalisations, deaths and economic burden; it could thus be viewed as an effective insurance policy against the costs that would have been incurred had hospitalisations, deaths and economic burden continued to increase.

## Considerations

A range of considerations are made in the service chapters, which aim to play back the operational insights gleaned from the analysis. They are framed to support service implementers of the future with actionable operational insights that may aid with future service development. They can be briefly summarised as the impacts of a targeted versus service-specific versus general testing regimen, data capture and availability linked to real-time decision making, confusion experienced by users due to frequent guidance changes and differences within their sectors, and confusion relating to reporting of results. Further details can be found within each of the service deep dive chapters.



## Recommendations

A series of programme-level recommendations are made in chapter 6. The key learning from this evaluation is that testing, and in particular asymptomatic testing, in any future pandemic should be streamlined from the start, utilising a Theory of Change approach (or equivalent), with clear and measurable aims from the outset that are easy to communicate to the public.

In the future there should be three approaches to testing. First, testing intensity should be highest in high-risk groups and their contacts. During the COVID-19 pandemic, this involved care home residents and staff and healthcare workers. Second, a lower testing intensity should be employed in the future among low-risk but high-contact groups. During the COVID-19 pandemic, this group comprised school-aged young people. Third, a universal testing service should aim to maximise the accessibility and equity of testing. Testing should therefore be made available to anyone wishing to take a test, but further efforts should be made to increase testing uptake among disproportionately impacted groups. During the COVID-19 pandemic, for example, this would have involved more targeted strategies and awareness-raising of testing and its importance among ethnic minority groups and people living in more-deprived areas, akin to the targeted community testing (TCT) programme, which was rolled out during the later stages of the pandemic, in July 2021. It is crucial to note that the groups identified here as being at 'high' or 'low' risk may comprise different subsections of the population in any future pandemic dependent on the virus and its transmission dynamics, although these general principles would still apply.

### **The evaluation identified three enabling functions to focus on:**

The first is centred around data. Appropriate mechanisms must be in place to ensure data can be accessed, collected and analysed in real-time, with an understanding of the critical public health datasets that are required and a plan to identify, capture and measure these in the future. Efforts must therefore begin immediately to establish the foundations necessary to initiate and implement a national testing and surveillance programme, rapidly and at scale, along with the necessary underlying digital infrastructure to support this, in the event of any future pandemics that may once again threaten the health of the nation.

The second relates to live impact and outcome evaluation. Ideally, an evaluation should be performed alongside a testing programme itself and carried out in real-time. However, this has considerable implications for the human resources and the organisational infrastructure required and may be challenging to achieve during the early stages of an unprecedented pandemic. There is also an ethical consideration, where this approach to implementation may be perceived to give access to testing to some segments of the population ahead of others. This could be mitigated by developing pre-prepared procedures for a range of future pandemic scenarios that incorporate learnings from the COVID-19 pandemic, such as the learnings associated with testing gained through this evaluation. A ToC or similar approach, employed from the outset, could help to ensure a programme's aims are not in conflict with one another.

The third is to support closer working among the groups within UKHSA, commercial functions and their external partners (e.g., DHSC and NHS England) to deliver the above with regards to pandemic preparedness as a part of business as usual.





# 1

# Introduction

# Overview of the English National Testing Programme for COVID-19

This chapter, focusing on key features of the English national COVID-19 testing programme, including the universal testing service, will cover the following:

# Introduction

## 1.1 Background

In December 2019, the emergence in China of a novel coronavirus resulted in one of the greatest challenges to global public health in recent history. This virus was named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the disease it causes, novel coronavirus disease 2019 (COVID-19) [1]. On 11 March 2020, the World Health Organization (WHO) declared COVID-19 a pandemic, urging member states to 'test, test, test' [2]. To date, the pandemic has led to almost 14.83 million deaths globally [3, 4].

At the beginning of the pandemic, there was no widespread means of testing for COVID-19, no vaccine existed and there was considerable uncertainty around the epidemiology of SARS-CoV-2. The only public health measures available to control the spread of the epidemic were non-pharmaceutical interventions (NPIs), including social distancing, wearing face masks and, most stringent of all, periods of national lockdown. In England, periods of national 'lockdown' involved the closure of all 'non-essential' businesses, and people were urged to stay at home [5]. Only 'essential' services were allowed to remain open, including pharmacies, supermarkets, banks and parks [6]. In the absence of pharmaceutical interventions or a vaccine, testing was seen as a key means to reopen society.

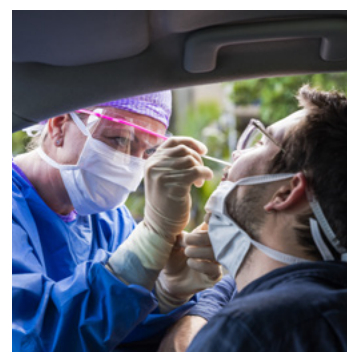
The UK government's COVID-19 response strategy was therefore deployed in the context of mitigating the impact of the pandemic and the measures employed to control it on key areas of society, such as education, protection of livelihoods and preventative and mental health [7].

## 1.2 The NHS Test and Trace Programme

In response to the COVID-19 pandemic, the UK government committed to mass testing, with initial testing commencing in March 2020 [8]. NHS Test and Trace (NHSTT) was then formally established in May 2020, as an Executive Agency of the Department of Health and Social Care (DHSC) to lead an 'at scale' national testing and tracing service [9]. The UK Health Security Agency (UKHSA) was established, also as an Executive Agency of DHSC, on 1 April 2021 and was operational on 1 October 2021 [10]. UKHSA combines the health protection, clinical and scientific functions formerly carried out by Public Health England (PHE) with the functions of NHSTT and the Joint Biosecurity Centre (JBC) [11].

NHSTT was tasked with providing mass-scale testing and tracing systems to rapidly identify individuals with COVID-19 and their close contacts, thereby minimising the spread of the disease [12]. The NHSTT programme had four main stated objectives: 1) to increase the speed and availability of testing, 2) to identify close contacts of positive cases and require them to isolate, 3) to contain local outbreaks via a coordinated response, and 4) to enable the government to learn more about the virus and explore ways to ease infection control measures as the science developed [9]. The programme, at its scale, was the first of its kind in the UK and was created and delivered at pace during a period of unprecedented uncertainty and evolved over time.

The testing programme component of NHSTT played an integral role through its various testing services. The testing programme sought to work in partnership with national and local public health bodies, local authorities, the NHS, and commercial and academic providers. Testing was first rolled-out through a population-specific



service delivery model followed by a population-wide universal testing service. The testing strategy and resultant policies were frequently adapted and revised in response to the changing epidemiological context of the pandemic, such as the emergence of new variants of concern (e.g., the Delta and Omicron variants), updated scientific evidence and the rollout of vaccines.

The delivery of testing for each of these target populations was multi-modal, through combinations of in-person testing (e.g., public regional testing sites, mobile testing units), pharmacies and home direct self-test kit deliveries, and driven in part by the technology available at the time (e.g., accredited self-sample collection was originally not an option, so physical sites were required). The delivery of testing was initially focused on regional testing sites, followed by service-specific testing sites, then home testing was rolled out as evidence accrued that this was a viable approach. These approaches to testing were subject to ongoing revision by policymakers throughout the pandemic, dependent on factors such as changing epidemiological prevalence, emerging scientific evidence, and vaccination rollout. However, the UK testing programme was generally carried out through the following four routes [13]:

- ▶ **Pillar 1:** Swab testing for the virus in UKHSA laboratories and NHS hospitals for those with a clinical need and for health and care workers
- ▶ **Pillar 2:** Swab testing for the virus in the wider population, through commercial partnerships, either processed in a laboratory or more rapidly via lateral flow device (LFD) tests
- ▶ **Pillar 3:** Serology testing to show if people had antibodies from having had COVID-19
- ▶ **Pillar 4:** Blood and swab testing for national surveillance supported by UKHSA; the Office for National Statistics (ONS); and research, academic and scientific partners, to learn more about the prevalence and spread of the virus and for other testing research purposes

Tests for COVID-19 include those that detect the presence of the SARS-CoV-2 virus and those that detect the presence of antibodies to the virus [14]. Tests for the virus, such as polymerase chain reaction (PCR) and loop-mediated isothermal amplification (LAMP), detect viral nucleic acid and are usually performed in a laboratory. These tests can appear positive beyond the period of infectiousness. LFD tests, which detect SARS-CoV-2 viral protein (antigen), are a quicker approach to testing. They can also be used for self-testing, although they are less sensitive than nucleic acid-based tests [15] and tend only to appear positive during the period of maximal viral shedding [16]. At the start of the pandemic, only PCR tests were available for testing swabs from suspected COVID-19 cases; however, LFD tests for COVID-19 were rapidly developed and being evaluated for use by the middle of 2020 [17]. LFD tests were initially rolled out for asymptomatic testing, followed by a confirmatory PCR test in the case of a positive LFD result.

A full policy timeline can be found in appendix 1.1; this outlines key policy announcements and changes in guidelines that took place throughout the evaluation period (October 2020 to March 2022).





## 1.3 Evaluation of the national COVID-19 testing programme

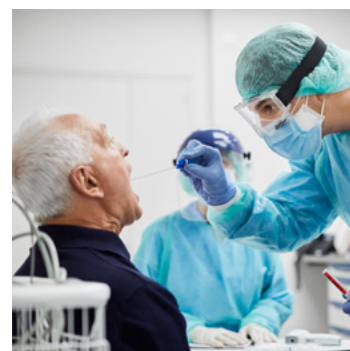
The overall success and effectiveness of any national testing programme during a pandemic is influenced by multiple contextual factors and the combined impacts of the various testing services. Together, these result in a complex balance of interconnected impacts on transmission of the disease, hospitalisations and mortality due to the disease, societal productivity, and costs to the economy. To assess these various factors and impacts, articulate lessons learned and develop an evidence base to support future decision-making, a detailed, independent and carefully constructed evaluation is required.

To this end, UKHSA conducted an open tender process and appointed a team comprising relevant experts in their respective fields from Ernst and Young LLP in partnership with Oxford University Innovation Limited. This team (hereafter referred to as 'the evaluation consortium') built on previous evaluation work conducted by UKHSA and undertook a six-month (September 2022 - February 2023) independent evaluation of the testing capabilities delivered by the national COVID-19 testing programme in England from October 2020 to March 2022 (hereafter referred to as 'the evaluation'), with a focus on public health outcomes. This evaluation sought to capture key learnings from the rollout of testing to the various target populations via the different testing services during this period. The insights gained informed the formulation of key considerations and recommendations for future pandemic preparedness.

To support the evaluation consortium, UKHSA established the Pan Evaluation Secretariat (hereafter referred to as 'the secretariat') to facilitate access to data, both internally from UKHSA as well as externally from other government departments, and to facilitate stakeholder engagement where required. A Pan Evaluation Liaison Board was also set up, comprising key senior stakeholders across UKHSA, the Department for Health and Social Care (DHSC), the Department for Education (DfE), NHS England, the Treasury and the Cabinet Office, with the purpose of overseeing delivery of the evaluation. In addition, a Pan Evaluation Scientific Advisory Group was established, comprising senior academics, with the purpose of providing challenge and critique to support the execution of a robust evaluation as well as providing any reflections from their experience that might be pertinent to the evaluation.

A national testing programme represents a complex public health intervention, due to the intricacy of the intervention plan, the actions that occur as a consequence of a test result, and the context within which it is implemented [18]. Any evaluation must take each of these factors into consideration. Therefore, this retrospective evaluation drew on a mixed-methods approach, utilising existing frameworks that have previously been applied to the evaluation of complex interventions and which can be broadly divided into process, outcome and impact evaluation, as well as cost-effectiveness evaluation components [19-22]. Various techniques were employed, including quantitative and qualitative approaches. The quantitative approaches included health economic modelling and statistical analyses. The qualitative approaches included a rapid scoping review of relevant literature. Stakeholder interviews were conducted to obtain additional behavioural and operational insights. Further evidence was accrued via a more extensive literature review (that included internal UKHSA materials, additional documentation received from the secretariat and a full scan of publicly available documents) and from numerous, iterative stakeholder interviews conducted throughout the course of the evaluation.

Effective evaluation requires an understanding both of an intervention itself and how the intervention can achieve the expected outcomes. The ToC approach [23, 24] – a theory of how, whether and to what extent an initiative works – was used to map causal pathways for each of the testing service settings, as this approach lends itself to understanding complex interventions with multiple causal pathways [25]. The ToC framework was used to understand the causal pathways and intended and unintended outcomes of each testing service, in addition to exploring the effect of context on each individual service setting's intended outcomes. These separate insights were subsequently used to define outcome and process indicators, to determine whether and how the combined aims of the testing programme were achieved. The ToC was



developed in a participatory manner with UKHSA stakeholders and Liaison Board members who, as the evaluation progressed, were regularly consulted to discuss evolving causal assumptions and hypotheses. In addition, a series of indicators was created to measure process, outcome and impact against the ToC for each service setting, explained in section 1.6 of the introduction.

The evaluation thus comprised the following phases:

- A scoping phase, to determine which service settings to focus on and to develop a ToC, a series of hypotheses and key research questions
- A design phase, to agree evaluation approaches, methods, and process and outcome indicators
- A conduct phase, to collect, review and synthesise data

The English national COVID-19 testing programme incorporated within it a variety of testing services, including adult social care, healthcare workers, events, schools, universities and universal testing. For this evaluation, the overall testing programme and the universal testing service, which was a major component of the national testing programme and was delivered via various channels, with rollout to the general public from 9 April 2021 [26], were explored in detail (chapter 2). In addition, of the various testing services within the overall testing programme, three services were selected for 'deep dive' evaluations. These were the schools, adult social care (specifically the testing in care homes) and healthcare worker testing services. The rationale for this selection was that care homes and healthcare workers represented high-risk groups and their contacts, while schools represented a low-risk, high-contact group. Further detail on this rationale for prioritisation is given in section 1.4.

To gather insights from other countries and shed light on possible alternative approaches for future consideration, a Google search was conducted to explore how other countries approached their testing programmes, specifically concerning testing in schools, healthcare and adult social care, as well as their approach to universal/mass testing. Relevant articles were analysed and are reflected on in case studies we have included throughout the report. However, it should be noted that these case studies are for illustrative purposes only and must be considered in terms of the respective countries' demographic and cultural differences. We did not conduct impact analyses comparable to those we conducted for this evaluation.

This is the first national-scale evaluation of the testing response to COVID-19 in England to incorporate most service settings. One of the strengths of this mixed-methods evaluation was its use of theory-based, complex evaluation approaches and iterative, participatory engagement with the stakeholder (UKHSA). The approach we took could be applied to the evaluation of pandemic responses in other contexts or to other types of interventions.



Ideally, complex interventions should be accompanied by a prospective evaluation design, initiated at the time of the intervention or earlier. However, due to the pace of testing delivery, during a period of unprecedented uncertainty, prospective evaluation was not prioritised. Therefore, a limitation of our approach is that this study comprises a retrospective evaluation and was limited by the quality of existing UKHSA-led research and data available to the evaluation consortium at the time of conducting the evaluation and within the time constraints of the evaluation period. Furthermore, the retrospective nature of the evaluation posed a challenge for isolating the impacts of interventions. These constraints and the paucity of previous relevant research into COVID-19 testing responses, both in England and in appropriate international comparators, warranted the mixed-methods evaluation approach adopted.

## 1.4 Rationale for testing service prioritisation and descope within the evaluation

Initially, nine testing services aimed at specific population subgroups were considered (see appendix 1.2 for a full list of testing services considered). However, due to the complexity and scale of the English COVID-19 testing programme, emerging data availability limitations and the need to conduct a rigorous evaluation within a short time, it was necessary to prioritise some services to be evaluated while other services were descope.

A key first step within the scoping phase was the development of a prioritisation matrix to aid in deciding which testing services to focus on, based on the following parameters: (1) availability and completeness of previous evaluations, (2) availability of sufficient data for the evaluation consortium to evaluate, (3) testing volume of the service by person hours, (4) proximity of the service to risk groups, and (5) spend on testing. This prioritisation matrix can be found in appendix 1.2.

A decision was then made by the evaluation consortium to conduct an overarching evaluation of the national COVID-19 testing programme in England, assessing the combined impact of the asymptomatic and symptomatic testing services, as well as an evaluation of the universal testing service. This was complemented by 'deep dive' evaluations of three priority testing services, including both asymptomatic and symptomatic testing:

- Schools (secondary school pupils aged 11 to 18 years)
- Healthcare workers
- Adult social care (staff and residents in care homes)

These three service settings were identified to ensure a broad spectrum of testing populations were being evaluated, e.g., high volumes (universal testing), high-contact groups (schools) and high-risk groups (care homes and healthcare workers), to best reflect the challenges faced during the pandemic and to balance the findings and recommendations for future pandemics.

## 1.5 Our evaluation followed a hypothesis-led approach

During the scoping phase, three key hypotheses were developed:

**Hypothesis 1:** Testing services aimed at protecting high-risk groups (e.g., care homes and healthcare workers) led to a reduction in hospitalisations and deaths in these risk groups.

**Hypothesis 2:** Testing services aimed at high-contact groups (e.g., schools) led to a reduction in hospitalisations and deaths in the general population.

**Hypothesis 3:** Testing services aimed at increasing access to and eligibility for testing and targeting disproportionately impacted groups (e.g., universal testing service) led to increased testing uptake in these populations.



Based on these hypotheses, the evaluation sought to answer the following research questions:

1. How was the national COVID-19 testing programme delivered and what factors affected this?
2. What were the barriers and facilitators to access, use and deliver the programme?
3. What were the costs and the cost-effectiveness of the programme?
4. For the universal testing service:
  - a. Did the diversity of those reporting test results increase?
  - b. Did the barriers and facilitators for testing, reporting and acting on a result change?
5. For each priority service:
  - a. Did the service achieve the UKHSA intended aims and purposes of the service?
  - b. Was the service cost-effective?
  - c. If testing were to be implemented again, what are the barriers and facilitators to increase access, use and delivery of tests?

These research questions and their results are covered in more detail in the subsequent chapters.

## **1.6 We used a series of evaluation indicators to measure process, outcome and impact**

Given the rapid deployment of testing via various service settings during the pandemic, trade-offs were made between the need to expand testing coverage in a timely manner and having adequate management information (MI) reporting and monitoring and evaluation (M&E) frameworks. Much of the information and data that would be collected under normal circumstances for public health evaluation purposes were either missing or too broad for this retrospective evaluation. Therefore, in consultation with UKHSA stakeholders and Liaison Board members, the evaluation team started by developing a ToC to understand causal pathways for each of the priority services; we also synthesised information contained within existing standard operating procedures (SOPs) and other operational documents for each testing service. Following this exercise, service-specific indicators were developed to guide the evaluation of each service, address the research questions and determine how well each service met its objectives and intended purpose(s). Based on data availability and granularity, these indicators were further refined based on what was achievable within the evaluation timeframe.

The indicators were categorised as follows:

- Process and output indicators: how did the delivery and uptake of the service compare with what was planned over time, and what factors affected this?
- Outcome indicators: what was the effectiveness of each service in terms of intended outcomes?
- Impact indicators: what were the broader economic and societal impacts? What were the overall impacts on minimising transmission while limiting harm?

Complete lists of the indicators assessed can be found in the appendices of the relevant chapters.

The evaluation consortium reviewed a wide range of data sources, covering publicly available documents to internal UKHSA materials and other documentation received from the secretariat to evidence these indicators. In addition, the evaluation consortium accessed datasets from cross-government sources to support the evaluation. There were, however, three key data sources that were not obtained within the timeframe, impacting the ability of the evaluation consortium to measure impact and outcomes in totality. These were:

- Targeted community testing data, which due to the way the data were collected and coded, could not be distinguished from the general testing data
- COVID-19-related absenteeism by school, by week
- Hospitalisation by care home, by week



See appendix 1.3 for further information with regards to datasets requested and accessed.

## 1.7 Research methodologies deployed within the design phase

This retrospective evaluation drew on a mixed-methods approach. A high-level overview of the methodologies employed is set out below for the statistical, economic and behavioural components of the evaluation. Detailed methodologies for each workstream, by priority service settings, can be found in the relevant appendices.

### 1.7.1 Statistical methodology

Quantitative data were obtained via the secretariat, existing UKHSA repositories, ONS, NHS Digital, and Public Health Scotland; by applying directly to various holders of non-public datasets; and from other, public sources of data where available.

The data were analysed with the aim of 1) providing summaries of outcome indicators, identified in the ToC, in relation to the implementation of each testing service, to better understand the extent and reach of each service; and 2) providing estimates of the impact of each testing service, which fed into the cost-effectiveness evaluations.

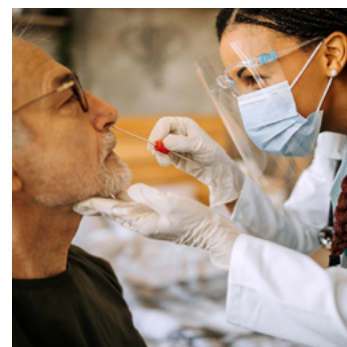
Service-specific statistical approaches were developed for each priority service and also for the universal testing service. These approaches are described here in brief; full descriptions of the methods can be found in the appendix of the relevant chapter for each testing service.

The main analysis for the schools testing service aimed to assess the degree to which asymptomatic testing in school-aged children led to asymptomatic cases being detected and how this varied throughout the course of the pandemic. An additional analysis of a dataset from UKHSA of those being tested by PCR within 72 hours of a reported positive LFD result was conducted to estimate the total number of false-positive results due to asymptomatic testing in school-aged children.

The analyses for healthcare focused on assessing two elements: the impact of asymptomatic testing of healthcare workers on staff absences, and the impact of healthcare worker testing on the prevalence of nosocomial infections of COVID-19. Both of these analyses were conducted at the NHS acute trust level, as a number of our data sources were only available at this resolution. Publicly available NHS data on staff absences and daily new hospitalised cases of COVID-19 reported were used. The nosocomial analysis used individual patient data from the ISARIC (International Severe Acute Respiratory and Emerging Infection Consortium) dataset.

The analyses for care homes focused on the association between testing in staff and residents on reported COVID-19-positive results in residents and staff and COVID-19-related deaths in residents. These regression analyses separately considered the impact of testing on the initial discovery of outbreaks in care homes and on the changes in outbreak size during an outbreak. All analyses were conducted at the individual care-home level and involved a series of models. An additional analysis was conducted to explore the factors influencing the level of testing in residents and staff members in a care home.

Our analysis of the universal testing service focused on whether there were biases in test seeking and/or reporting behaviour. We determined how the seeking of PCR tests and the seeking and reporting of LFD tests varied according to the Index of Multiple Deprivation (IMD) – a widely used metric for quantifying relative deprivation for small geographical areas – and income of the geographical reporting area; we then examined whether these changed following the rollout of the universal testing service. We also examined how the tendency of individuals to seek and report tests when infected compared with when not infected varied according to test type and quantified how this changed throughout the course of the pandemic and according to the IMD. Finally, we used COVID-19 prevalence data to estimate the daily number of COVID-19 infections throughout the course of the evaluation period, both nationally and at smaller geographical scale, which allowed us to explore whether the proportions of infections detected by the testing programme varied by IMD.



## 1.7.2 Economic analysis methodology

The economic analyses, which primarily comprised cost-effectiveness analyses, adopted a provider perspective, incorporating costs to the NHS and to local authorities. For the schools testing service analysis, a societal perspective was adopted, to quantify potential productivity losses. A literature review of publicly available economic data was conducted using keyword searches of scientific databases as well as a search of the grey literature, using Google Scholar. Data relating to the volumes of tests distributed to the various testing services and the associated costs were obtained from the secretariat. Costs were apportioned to the three priority services according to the volumes of tests distributed. Data relating to payments made to individuals who were isolating, and other payments made, were obtained from the DHSC. The costs of hospitalisations were obtained from the National Schedule of NHS costs – Year 2020-21 [27].

The outcome measure of quality-adjusted life-year (QALY) gained was used for the economic analyses. The National Institute for Health and Care Excellence (NICE) defines a QALY as ‘a measure of the state of health of a person or group in which the benefits, in terms of length of life, are adjusted to reflect the quality of life. One QALY is equal to 1 year of life in perfect health. QALYs are calculated by estimating the years of life remaining for a patient following a particular treatment or intervention and weighting each year with a quality-of-life score (on a 0 to 1 scale)’ [28]. The cost per QALY gained is a critical value that is used to determine whether an intervention is cost-effective and is used by NICE to determine whether a proposed new treatment can be covered by the NHS. We used a value of GBP 70,000 as the willingness to pay threshold for interventions for COVID-19, based on HM Treasury’s Green Book (2022) [29]. This means that an intervention that costs less than GBP 70,000 per QALY averted can be considered cost-effective. In any graphs produced, we have also indicated the NICE willingness to pay threshold of GBP 30,000, for reference. QALY weights were obtained from the relevant literature. Sensitivity analyses were conducted to test the outcomes against the assumptions, using ranges of estimates from the statistical analyses and the literature.

The data were analysed with the aim of 1) providing an estimate of the costs for each testing service and 2) providing estimates of the value for money of each testing service. The economic evaluation of the schools testing service included a sensitivity analysis to estimate the threshold for impact on community transmission at which the schools testing service would be considered cost-effective in terms of QALYs gained. The economic evaluation of testing in care homes used the outputs from the statistical analyses to estimate the number of deaths averted, while the economic evaluation of the healthcare workers testing service used the statistical output of nosocomial infections averted. The economic evaluation of the national testing programme included a sensitivity analysis for a range of possible values of reductions in new cases due to the testing programme, to estimate the threshold at which the testing programme would have been cost-effective [30].

Detailed methodologies for all of the economic evaluations are available in the relevant appendices of the testing service chapters [28].

## 1.7.3 Behavioural methodology

A scoping review was conducted to evaluate the barriers and facilitators in England to engaging with COVID-19 testing, reporting results and self-isolating. This review 1) provided a summary of the research undertaken on this topic, 2) identified gaps in research efforts and 3) provided an overview of key barriers and facilitators for each testing service, as well for the overall testing programme. A scoping study approach was selected as the method to synthesise knowledge, as there was a large volume of heterogeneous literature on this topic [31]. The scoping review was conducted following the 2005 Arksey and O’Malley framework [32], incorporating the adaptations proposed by Levac and colleagues in 2010 [33] and using the 2015 Joanna Briggs Institute guidance on conducting scoping reviews [34]. The findings were reported according to the standardised PRISMA-ScR checklist [35].

Following the search of relevant bibliographic databases, all identified citations were collated and uploaded into Rayyan [36], an online application that expedites the initial screening of abstracts and titles, and duplicates were removed. The findings were then triangulated with the results of the statistical analyses and fed back into the developing ToCs, to refine and explain the assumptions and to help form the recommendations. This process was carried out for each priority testing service. In addition, the findings across each of the three priority testing services were compared, with the aim of identifying universal as well as service-specific barriers and facilitators. This enabled an exploration of which issues mattered most to individuals who undertook testing, while also identifying unique considerations pertinent to each testing service.

More than 40 stakeholder interviews were also conducted to identify additional sources of unpublished evidence, sense-check the findings and test the emerging recommendations for feasibility. Additional sources identified through this route were included in the scoping review (PRISMA-ScR) flow diagram as 'stakeholder-identified studies' [37]. All insights from these discussions have been anonymised and incorporated throughout the evaluation report, with further thematic details included in the appendices for each priority testing service.

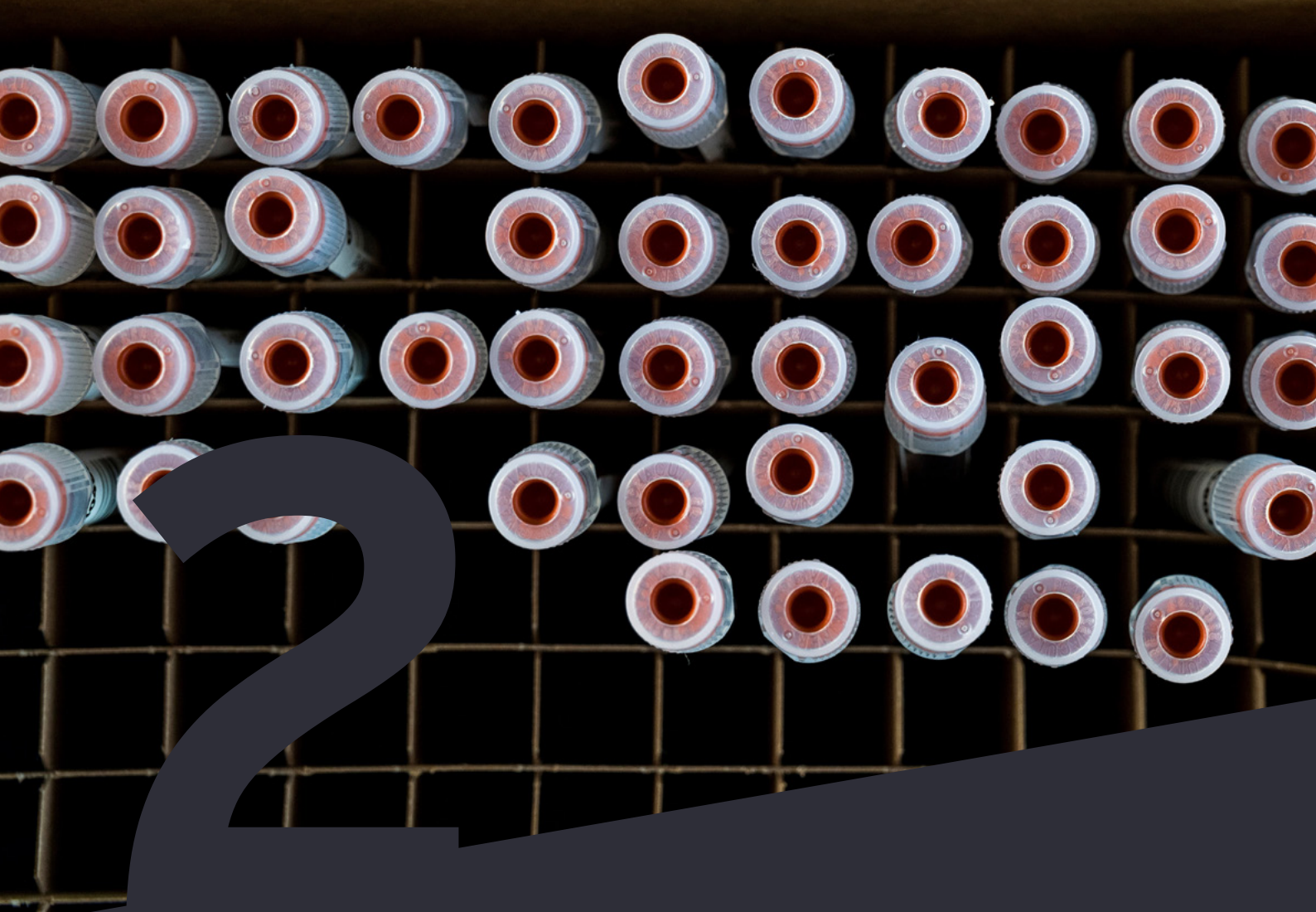
## 1.8 Ethics statement

The study protocol was granted ethical approval by the UKHSA Research Ethics and Governance Group, reference number NR0347. All relevant ethics guidelines were followed throughout. For the purposes of the stakeholder interviews, confidentiality was stringently maintained throughout the evaluation and full, voluntary and informed consent of the participants was obtained. Any views or opinions expressed in these interviews and included in the report have been fully anonymised.

## 1.9 Structure of the report

This report begins with the evaluation of the overall testing programme (chapter 2). There is a specific focus on the overarching evaluation, which includes the universal testing service, introduced on 9 April 2021 when twice-weekly rapid testing (self-testing with LFDs) was made available to everyone in England [26]. This is followed by chapters 3 to 5, which detail the deep dive evaluations of the three priority service settings: schools, healthcare workers and the care homes testing that formed part of the adult social care testing service. Service-specific considerations are provided in the summaries of each of these chapters. A further chapter (chapter 6) provides key considerations and recommendations arising from the evidence gathered, and the analyses conducted throughout the entire evaluation. Detailed descriptions of the methods used for the analyses are provided in appendices 2 to 5. The appendices also include full descriptions of the qualitative evidence and insights obtained throughout the evaluation.





# Overview of the English National Testing Programme for COVID-19



# Overview of the English National Testing Programme for COVID-19

This chapter, focusing on key features of the English national COVID-19 testing programme, including the universal testing service, will cover the following:



## 2.1 Executive summary of the evaluation of the English testing programme for COVID-19

This evaluation of the national English testing programme and universal testing service, covering the period October 2020 to March 2022, demonstrated that, overall, the national COVID-19 testing programme in England mostly achieved its intended aims, objectives and purposes (highlighted within the testing service chapters 3, 4 and 5), particularly given the considerable uncertainty during an evolving pandemic threat. The results also highlighted the trade-offs between the rollout of a generic, universal testing strategy to achieve coverage of the general population versus a more targeted approach for under-represented and high-risk populations. For future pandemic preparedness, we recommend a testing approach centred around clear aims, with a more focused testing strategy for disproportionately impacted groups implemented earlier on, along with data capture to support the continued monitoring of impact and public health surveillance as the pandemic evolves. We summarise our findings with respect to the evaluation hypotheses and research questions below.

### Increasing access and eligibility

We found that the universal testing service, which was aimed at increasing access and eligibility, did increase uptake of testing by disproportionately impacted groups. The universal testing service was a major component of the national testing programme, aimed at expanding asymptomatic LFD testing, and was delivered via various channels, with rollout to the general public from 9 April 2021 [1]. This service alone accounted for the majority of the national testing programme expenditure.

In exploring the distribution volumes and overall costs of the tests for the national testing programme as a whole, it was found that a total of 2 billion lateral flow device (LFD) tests were distributed, and 158 million polymerase chain reaction (PCR) tests were registered during the evaluation period (October 2020 to March 2022), accounting for 84.6% and 89%, respectively, of the total in the UK. LFD tests reported declined over time across all services, likely due to factors surrounding testing fatigue, rapidly changing guidance and a waning intention to report results.

The evaluation of the national testing programme found that it was successful in its aim of increasing the uptake of testing in disproportionately impacted groups and partially successful in improving equity. More-deprived areas consistently reported lower numbers of tests taken per person, with an increase in reporting seen following the rollout of universal testing. However, this increase in uptake was still more pronounced in less-deprived groups, leading to continued inequities. A different and earlier targeting approach in a future strategy could lead to further improvements in access to a national testing programme as a whole. In an analysis of testing equity in the schools testing service, it was found that young people from areas of greater deprivation and from areas with larger ethnic minority populations generally reported fewer test results and that young people from areas of higher deprivation had higher levels of positivity in their reported results. These findings indicate inequities among school-aged young people in accessing, taking or reporting tests and are further detailed in chapter 3.

It should be noted that these insights were based on data attributed to the universal testing service and the national testing programme as a whole only. The targeted community testing service, which was specifically aimed at disproportionately impacted and underserved groups, was not included in this evaluation, due to the way the data were captured and coded at the time of service rollout, which did not allow for a distinction between the results of this service and the universal testing service or the national testing programme.

By combining reported case and prevalence data at the lower-tier local authority (LTLA) level using a novel debiasing statistical methodology, the evaluation consortium was able to determine true case detection ratios, defined as the percentage of all true cases that were captured by the national testing programme. The results of this analysis showed that the national testing programme increased case identification throughout the evaluation period and on average detected



an estimated 26% to 40% of all possible cases (symptomatic and asymptomatic). Incorporation of such methods using both reported cases and prevalence at the LTLA level into future pandemic surveillance could allow for more robust real-time monitoring of public health impacts and evaluation of testing programme performance.

The analysis of case detection ratios also provides evidence for adherence to the guidance on the use of LFD and PCR tests, showing that case identification increased during epidemic waves. This aligns with our behavioural findings, indicating testing behaviour was linked to epidemiological trends. A rapid scoping review performed as part of this evaluation revealed that many individuals perceived that the necessity to test was reduced after vaccination, suggesting that future testing programmes would benefit from clarifications on the need for continued testing, by employing a clear communications strategy when any major new public health interventions are implemented.

## Cost-effectiveness

In terms of cost-effectiveness, using conservative assumptions for the contribution of the testing programme, our economic analysis suggests that the national English testing programme likely achieved its aims in being cost-effective at averting hospitalisations and deaths and in alleviating undue economic burden, particularly considering the counterfactual of productivity losses incurred from staying at home. The testing programme could be seen as an effective insurance policy against the costs of increased transmission, increased hospitalisations and deaths, and increased productivity losses from more lockdowns, in the face of an unpredictable pandemic, during which the knowledge about disease severity and transmissibility was still evolving. Our analysis suggested that the testing programme was cost-effective at a testing effectiveness in reducing new infections of 30% or more. Therefore, for a similar pandemic, targeted testing of higher-risk or higher-contact groups could be the focus of future testing strategies, explored using robust cost-effectiveness models.

In interpreting the results of the cost-effectiveness analysis, previous analyses by other research teams can give us an idea of transmission reductions due to the testing programme and the effects of vaccination. An early model – the Canna model – estimated that the reduction in COVID-19 transmission between August 2020 and April 2021 due to the testing programme varied over time by between 10% and 28% (across a 90% confidence interval) [2]. In comparison, the Covid-SMART study, conducted in Liverpool, analysed the impact of voluntary rapid asymptomatic community testing for the SARS-CoV-2 antigen on COVID-19-related hospital admissions from November 2020 to January 2021. It found that testing led to a 25% (11% to 35%) reduction in COVID-19-related hospitalisations [4].

A systematic review of SARS-CoV-2 vaccine effectiveness against infection found that mean efficacy was 83% in the first month after completion of the original vaccination schedule and decreased to 22% at 5 months [3, 4]. While testing is likely to have a far lower effect size than vaccination, it could be considered as an effective strategy in reducing new infections before vaccinations were available and after the effects of the vaccine have waned before receiving boosters. While several studies on the cost-effectiveness of vaccination have been published, none were identified that specifically explored the cost-effectiveness of vaccination against infection in England.

We summarise the overall testing programme recommendations in chapter 6 of this report.

## 2.2 The evaluation of the English national testing programme sought to answer the following hypotheses and research questions

1. How was the national COVID-19 testing programme delivered and what factors affected this?
2. What were the barriers and facilitators to access, use and deliver the programme?
3. What were the costs and cost-effectiveness of the programme?
4. What proportion of COVID-19 cases were successfully detected by the national testing programme?
5. For the universal testing service specifically:
  - a. Did the diversity of those reporting test results increase? This relates to the overall evaluation hypothesis that the evaluation consortium chose to explore, regarding whether testing services aimed at increasing access to and eligibility for testing and targeting disproportionately impacted groups (e.g., universal testing service) led to increased testing uptake in these populations
  - b. Did the barriers and facilitators for testing, reporting, and acting on a result change?

## 2.3 To evaluate whether the above aims were achieved, it is important to understand the context of the national testing programme and its main component, the universal testing service

### Summary of key findings

- ▶ A total of 2 billion LFD tests were distributed and 158 million PCR tests were registered during the evaluation time period (October 2020 to March 2022) in England, accounting for 84.6% and 89%, respectively, of the total in the UK
- ▶ Of the total number of LFD tests distributed, 15.7% were reported during the evaluation period in England, with reporting decreasing over time
- ▶ The discrepancy between LFD tests distributed and reported could be explained by a low intention to report results and individuals not seeing the value in reporting a negative test result
- ▶ PCR test registrations increased during periods in line with when the Delta and Omicron variants were circulating
- ▶ The variation seen in PCR and LFD test reporting could be explained by confusion surrounding changing testing guidance and mistrust in the accuracy of the tests
- ▶ Test reporting volumes were consistently highest across the 'unknown' and 'other' categories, followed by schools, care homes and healthcare
- ▶ The changing epidemiology of the pandemic, combined with the vaccine rollout, negatively influenced the engagement with and uptake of testing, as observed in the qualitative data
- ▶ The practicality of reporting a result in terms of time taken, technological barriers and mistrust in government use of personal data were deterrents to reporting test results

SUMMARY

The national testing programme was delivered via various channels from early 2020 and evolved to include the following channels: via a home ordering service, onsite testing programmes, community testing by all local authorities, collection at a local PCR test site during specific test collection windows, and a pharmacy collection service. From March 2020, PCR tests, processed using existing laboratory infrastructure, were prioritised for symptomatic testing in clinical settings, key workers and care homes to identify cases and outbreaks and assist infection prevention and control in these settings [5]. Following national scale-up in testing, through expanded laboratory capacity, logistics and supply chain, symptomatic PCR testing was expanded from clinical and keyworker testing to the general public from May 2020 onwards. The arrival of LFDs to the market later in 2020 and the beginning of 2021 then allowed for the expansion of the asymptomatic testing programme.

The universal testing service involved rapid, asymptomatic, at-home LFD testing that was made available to the general public from 9 April 2021 to enable faster detection of cases, thereby allowing more immediate isolation [1, 6]. The universal testing service was a world-first as a government-provided, free-at-the-point-of-use asymptomatic testing service that was available to all. Regular asymptomatic and symptomatic testing, alongside the vaccine rollout programme, formed part of a broader plan to reopen society and the economy while suppressing the transmission of COVID-19. Regular testing was also used to help increase the rate of detection of cases caused by variants of concern, such as the Delta variant.

For asymptomatic testing with LFDs, individuals were encouraged to test at home and register their results online or by calling 119. If an individual tested positive, they were required to isolate and seek a confirmatory PCR test. In December 2021, a major change in the asymptomatic testing strategy was announced, with the rollout of daily rapid testing for fully vaccinated close contacts of a positive COVID-19 case, to reduce the impact of self-isolation [7]; this coincided with an increase in the capacity of test kit delivery and the availability of LFD test kits in pharmacies [8].

On 11 January 2022, confirmatory PCR tests were no longer required following a positive LFD test result, due to the high rates of COVID-19 across the UK [9]. This was followed by a government announcement, in February 2022, that removed the legal requirement to self-isolate following a positive test result and for close contacts who were fully vaccinated to conduct daily tests [10].

From 1 April 2022, the government ceased provision of free universal symptomatic and asymptomatic testing for the general public in England, reflecting a move away from controlling community transmission and towards 'living with COVID-19' while protecting the vulnerable [10]. Free LFD tests for asymptomatic testing were now only made available to a smaller subset of the population, which included adult social care staff and a small number of visitors who provided services including, but not limited to, personal care; hospice staff; patient-facing staff in the NHS and in NHS-funded independent healthcare provision; and some staff in prisons and other places of detention [11].

The targeted community testing service, established in July 2021, aimed to reach disproportionately impacted people and those who were underserved by the national universal testing service [12, 13]. These target populations included those in areas of socioeconomic deprivation; ethnic minority groups; those in high-risk occupations; individuals experiencing homelessness or who were sleeping rough; migrants; asylum seekers; refugees; and Gypsy, Roma and Traveller communities. This service was designed and delivered by local authorities and their partners, through an 'outreach' model, to take testing directly to the targeted community groups. For the purposes of this evaluation, the targeted community testing service was not included due to data availability at the time of the evaluation.

The rationale for inclusion of the universal testing service in this evaluation was that the main driver of this service was unique in its goal to increase both case finding and accessibility to tests, to reduce transmission in the general population as a whole. This service alone accounted for the majority of the national testing programme spend. In contrast, the three population-specific services we evaluated in detail in subsequent chapters were more targeted and aimed at protecting two general categories of individuals: those in high-risk groups (the healthcare and adult social care testing services) and those in high-contact groups (the schools testing service).

A general timeline detailing the main changes in testing policy and other key changes (such as lockdowns and isolation requirements) over the course of the pandemic can be found alongside service-specific timelines reflecting the COVID-19 testing landscape. These can be found in the following service specific appendices:

- ▶ Appendix 3 – Schools
- ▶ Appendix 4 – Healthcare
- ▶ Appendix 5 – Adult social care



### 2.3.1 A total of 2 billion LFD tests were distributed and 158 million PCR tests were registered during the evaluation time period for the national testing programme overall in England (October 2020 to March 2022), accounting for 84.6% and 89%, respectively, of the total in the UK

Table 2-1 shows the total number of LFD and PCR tests distributed and the proportion of the total volume for the national testing programme in England overall and for the priority testing services that were the focus of this evaluation. Totals are presented for the evaluation period, October 2020 to March 2022. Total volumes attributed to the universal testing service alone were not distinguishable from other services in the dataset provided as part of the evaluation and are therefore not included in the table.

For LFDs, the volume of tests refers to the number of tests distributed over time and by use case. For PCR, the volume of tests registered refers to those that were registered in order for an individual's result to be linked following laboratory analysis. The rationale for this inclusion was that laboratory costs were the main driver of PCR costs. Pillar 2-registered PCR test kits comprised 88.5% of the estimated volume of dispatched Pillar 2 PCR test kits. Pillar 2 tests included community LFD and PCR testing of both symptomatic and asymptomatic cases, whereas Pillar 1 testing was carried out in Public Health England (PHE) laboratories and NHS hospitals for those with a clinical need, healthcare workers and, under certain circumstances, for care workers. PCR tests registered under Pillar 1 comprised 27% of the total number of registered PCR tests during the evaluation period.

**Table 2-1. Number of LFDs distributed and PCR tests registered in England throughout the evaluation period.**

Service	Test type*	Total (full value)	Percentage of total
All services in the England COVID-19 testing programme	LFD	1,991,596,000	100% (of all LFDs distributed in England)
	PCR	157,682,300	100% (of all PCR tests registered in England)
Schools (staff and pupils)	LFD	500,091,900	25.1% (of all LFDs distributed in England)
	PCR	388,200	<0.5% (of all PCR tests registered for England Pillar 2)
Secondary schools and colleges (staff and pupils)	LFD	340,715,600	17.1% (of all LFDs distributed in England)
	PCR	321,400	<0.5% (of all PCR tests registered for England Pillar 2)
Healthcare (staff only)**	LFD	140,357,000	7% (of all LFDs distributed in England)
	PCR	4,047,000	9.5% (of all registered PCR tests for England Pillar 1)
Adult social care (all)	LFD	227,317,900	11.4% (of all LFDs distributed in England)
	PCR	40,807,000	35.5% (of all registered PCR tests for England Pillar 2)
Adult social care (care homes only)	LFD	189,541,200	9.5% (of all LFDs distributed in England)
	PCR	33,056,800	28.7% (of all registered PCR tests for England Pillar 2)

\*LAMP, antibody and genomics tests are not included as these comprised less than 0.5% of the total testing volume and less than 3% of the total testing costs; they are captured in the total cost of the national testing service.

\*\*NHS staff accounted for 95.2% of total LFDs distributed to the NHS and 9.5% of Pillar 1 PCR tests.

Note: Secondary schools and colleges are a subset of schools; care homes are a subset of adult social care (all).



### 2.3.2 Of the total number of LFD tests distributed, 15.7% were reported during the evaluation period in England, with reporting decreasing over time

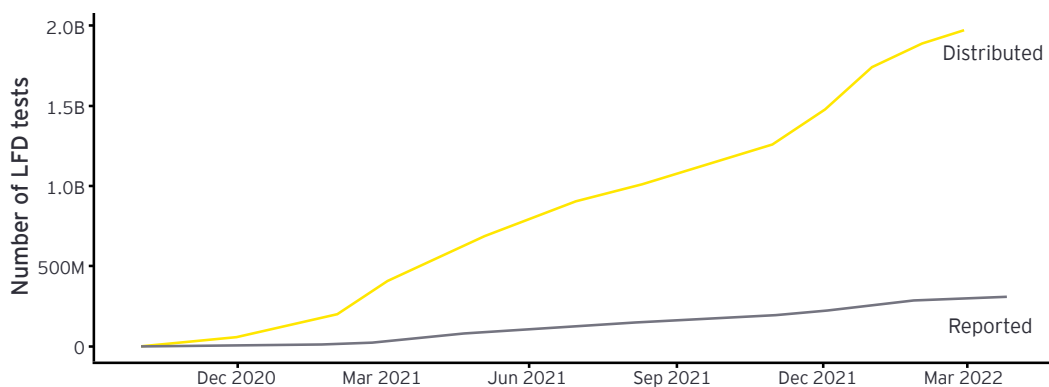


Figure 2-1. Cumulative volume of LFD tests distributed and reported in England overall.

The gap between distributed tests and reported tests increased over time and then plateaued as more tests were distributed (Figure 2-1), with a large discrepancy between the number of LFD tests distributed and the number reported. These findings are consistent with previous findings in the literature on the disparity between tests distributed and reported [14]. The decline in testing volumes distributed and reported from February 2022 coincided with a change in testing policy, when the requirement to self-isolate following a positive test was reversed [15].

The proportion of positive LFD results reported tracked closely with Office for National Statistics (ONS) prevalence estimates throughout most of 2021. This only diverged in 2022, when higher proportions of positive results were reported, reflecting a likely decrease in the reporting of negative test results. In 2020, testing and reporting were more limited, and the estimates of positivity were not stable (Figure 2-2).

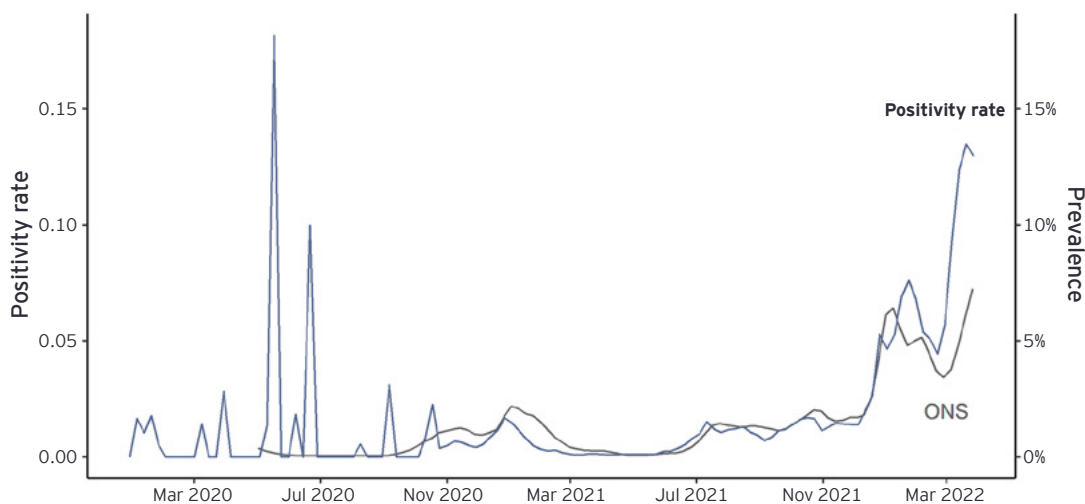


Figure 2-2. Weekly percentage of positive LFD tests across all testing services in England and overall community prevalence of SARS-CoV-2 infections in England based on ONS data (shown on the right-hand y-axis).

### **2.3.3 The discrepancy between LFD tests distributed and reported could be explained by a low intention to report results and individuals not seeing the value in reporting a negative test result**

The findings outlined above, of the discrepancy between LFD tests distributed and reported, have been validated against the findings of other studies [16-20], which have also suggested that low levels of reporting persisted as the pandemic progressed [21]. Furthermore, interviews with UKHSA stakeholders highlighted at the time there was a perceived trade-off between encouraging the public to report test results and the risk of deterring the public from testing altogether, which may have contributed to the low levels of reporting seen. This differed from the more proactive communications strategies taken to encourage the use of testing, face coverings and good ventilation.

These findings may be interpreted as people valuing testing more than reporting a result, a theme that echoed earlier surveys, particularly for LFDs, which showed that there was a relatively low intention to report LFD results [16], and this intention appeared to reduce further during the course of the pandemic. There was also a decrease over time in the number of individuals who reported their test results to NHS Test and Trace, with 48% of people surveyed (of 2359 adults in England) in August to September 2021 reporting their test result compared with 53% in May 2021 [19, 20].

Not seeing the value of reporting a test result if it was negative was described as the greatest single barrier to reporting a test result: 43% of 630 survey respondents between March and June 2021 [17] and 39% of 786 adults in England surveyed between August and September 2021 did not report results [19, 20]. Some did not have a particular reason for not reporting their result [19, 20]. Complacency was also suggested to result from a lack of knowledge of the importance of reporting, specifically reporting negative results [22], as well as reporting fatigue [22, 23].

Demographic factors such as ethnicity and deprivation indices were closely associated with uptake and reporting of tests and are discussed further in section 2.8.

### **2.3.4 The variation seen in test reporting could be explained by confusion surrounding the changing testing guidance and mistrust in the accuracy of the tests**

Behavioural insight studies conducted at the time have suggested a lack of understanding among the general population of when to use LFD and PCR tests, with many people using LFDs when they were symptomatic rather than following the guidance to conduct a PCR test, according to a national survey conducted in June 2021 (n = 3665) [24]. There was also confusion about the need to take a confirmatory PCR test [25-27]. This suggests that the public's intended and actual testing behaviours were out of step with government recommendations. Specifically, people were confused about the role asymptomatic testing played within the broader range of testing requirements and did not understand the difference between the role of PCR testing and that of LFD testing [28].

Scepticism was also described in relation to test performance, with low levels of public trust in the accuracy of test results [29-31]. At the beginning of the PCR testing rollout, there was also some distrust related to PCR sensitivity, which at the time was estimated to be around 70% [32, 33]. For disadvantaged groups, mistrust was described as a particular barrier to testing and reporting [19, 20, 34]. Throughout 2021, trust in the accuracy of PCR tests was higher than that for LFD tests, with trust in government-issued LFDs ranging from 36% to 45%, PCR tests ranging from 61% to 72%, and third-party private tests ranging from 21% to 27% [35].

### 2.3.5 Test reporting volumes were consistently highest for the 'unknown' and 'other' categories, followed by 'schools', 'care homes' and 'healthcare'

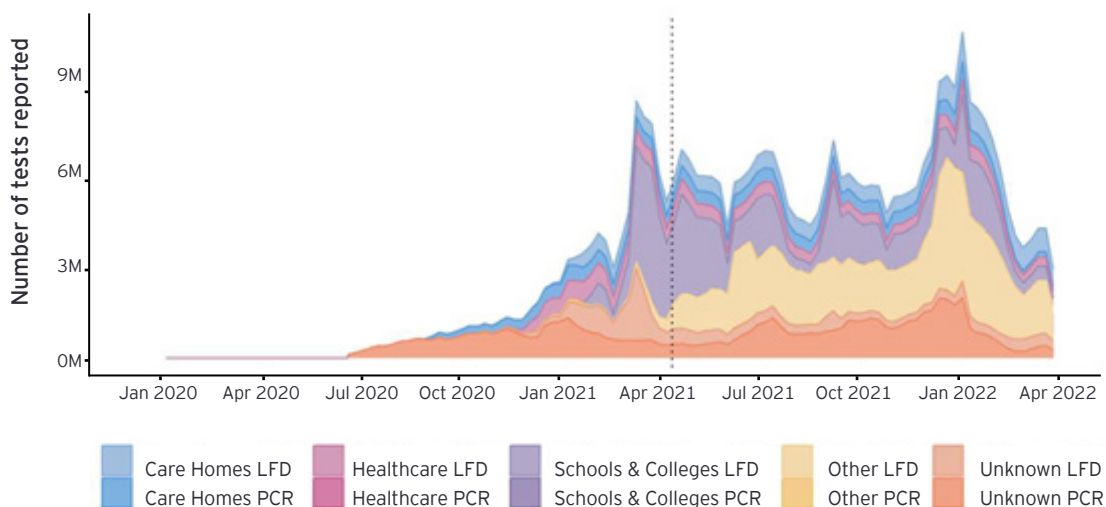


Figure 2-3. Weekly volume of all PCR and LFD tests reported across Pillar 1 and Pillar 2, by testing service. 'Other LFD' and 'Other PCR' include tests taken by members of the public who did not fall into the schools, healthcare or adult social care testing services, including those in independent care settings, public and private industries, and universities. 'Unknown LFD' and 'Unknown PCR' refer to those tests for which no testing service was recorded. The vertical dotted line indicates the start of the universal testing service.

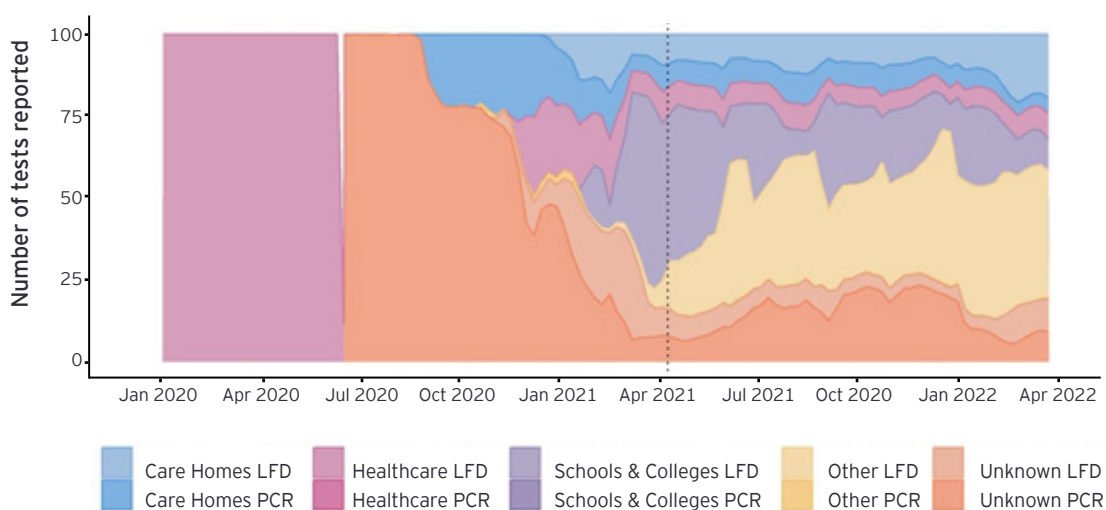


Figure 2-4. Weekly percentage of all PCR and LFD tests reported across Pillar 1 and Pillar 2 by testing service. 'Other LFD' and 'Other PCR' include tests taken by members of the public who did not fall into the schools, healthcare or adult social care testing services, including those in independent care settings, public and private industries, and universities. 'Unknown LFD' and 'Unknown PCR' refer to those tests for which no testing service was recorded. The vertical dotted line indicates the start of the universal testing service.

The overall volumes and percentages of tests reported across all testing services are shown in Figure 2-3 and Figure 2-4, respectively. In early 2020, very few tests were recorded in the available databases and therefore the very high percentages recorded in the first half of 2020 should not be over-interpreted. Of the reported tests where the type of testing service was known, an initial uptick and subsequent consistently high levels of test reporting were seen in the 'unknown' and 'other' categories, followed by care homes and the healthcare testing service. For the purposes of this

evaluation, only care homes were included as part of the adult social care testing service, as this setting accounted for 83% of the testing volume of the entire adult social care testing service. This was likely due to the early initiation of testing and testing policy targeted at these high-risk settings. This was later followed by schools testing. The increase in 'other LFD' and 'other PCR' seen after April 2021 may have been due to the rollout of the universal testing service after this time. A peak in tests reported across all testing services, seen in January 2022, coincided with changes to a more stringent testing policy following the emergence of the Omicron variant, the winter holidays, and possibly also due to public awareness of the need to test more frequently due to the more infectious Omicron variant.

### **2.3.6 The changing epidemiology of the pandemic, combined with the vaccine rollout, negatively influenced the engagement with and uptake of testing, as observed in a retrospective scoping review of the qualitative data**

A low perceived risk of COVID-19 was described as the main barrier to engaging with testing [36, 37], with those who had a low perception of risk feeling that they 'did not need to test' [38, 39]. This perception of risk was related to the epidemiology of COVID-19, such as the likelihood that symptoms were caused by COVID-19, and the perception of vulnerability to COVID-19, including the perceived risk of contracting COVID-19, the severity of disease and the impact of a recent infection on an individual's risk of transmitting the infection [36, 38, 39].

COVID-19 vaccination, along with the immunity gained from a recent COVID-19 infection, were generally associated with a lower perception of risk of contracting COVID-19, transmitting it and experiencing severe disease; among the general public this reduced the feeling of needing to test [36, 38, 39]. The timing of universal testing being rolled out, alongside the vaccination programme, first to adults and later to children and young people, may have impacted the uptake of testing, as people described the vaccination campaign as undermining the necessity to test, both as an alternative to testing to protect the population and because the resultant reduced transmission and severity would negate the need for regular asymptomatic testing [36].

### **2.3.7 The practicality of reporting a result in terms of the time taken, technological barriers and mistrust in the government's use of personal data were observed to be deterrents to reporting test results**

While much consideration was given by the testing programme organisers to improve user experience, the level of reporting and detail required by the programme, including personal information, posed a challenge for some. People expressed practicality issues with reporting results, saying that the time and effort involved was a challenge [22], as well as technology and cache issues [22]. Some people expressed being too busy to report their test results, while others described starting to register online or on the phone, but that the process took too long and so they abandoned the attempt to report the result [19, 20]. There was also variation in people's preference of which platform to report results through. People were more likely to report a result on the gov.uk portal (31% of 2359 adults in England surveyed between August and September 2021) than report a result using the NHS COVID-19 app (19%) or over the phone with NHS Test and Trace (9%) [20]. It should, however, be noted that each of these reporting mediums served different purposes during the pandemic: telephonic reporting was enabled for those who could not register digitally, while reporting test results on the NHS COVID-19 app was required for contact-tracing alongside the reporting of test results on the gov.uk portal for surveillance purposes.

Mistrust was particularly strong around the use of data, privacy, and the potential loss of control of data when reporting a positive test result [40, 41]. In one survey of 2029 adults, data privacy concerns were the second largest perceived barrier to using the NHS Test and Trace programme [41] and were consistently stated as a reason for not reporting results [19, 20]. In some studies, people stated they were willing to share their own and their close contacts' data [42], while people (1504 adults in England surveyed during the second epidemic wave between August and September 2021) also stated they would be willing to provide at least some personal information



when registering test results. However, less than half (41%) were willing to provide all the information requested when reporting a test [19, 20]. Furthermore, people who had previously lived in countries with low levels of trust in governments (such as international students participating in university testing programmes) had lower trust in reporting test results and the use of their data [40]. Mitigating this level of mistrust needs to be considered against the benefits of obtaining granular data for future public health intervention implementation and evaluation.

For the testing programme as a whole, being clear about public health-centred aims and objectives of the service could enable the streamlining of reporting and the user experience to minimise this reporting burden on individuals in any future testing strategies.

## **2.4 Case detection ratios for the national testing programme (defined as the percentage of all true cases that were captured by the national testing programme)**

### **Summary of key findings**

- The national testing programme detected 26% to 40% of all COVID-19 cases and mirrored the trends in population incidence and prevalence, increasing as the national testing programme was rolled out and during epidemic waves and then decreasing in 2022.

**SUMMARY**

### **2.4.1 The national testing programme detected 26% to 40% of all cases and mirrored the trends in population incidence and prevalence until 2022**

The success of the national testing programme in general was contingent on identifying as many infections (be they symptomatic or asymptomatic) as possible, so that actions taken upon receiving a positive test result would have the potential to reduce onwards transmission to high-risk groups, either directly from their contacts or indirectly through reductions in community transmission.

Media commentary and public health decision-making was primarily focused on the numbers of cases, with a secondary focus given to hospitalisations and deaths [41]. The benefit of using case data is that increases in cases are considered a precursor to increases in hospitalisations and deaths. However, the limitation of using case data is that it may be influenced by changes in the true incidence of infection and changes in testing and/or reporting behaviour, or both. Case data are therefore less reliable than hospitalisations and death data.

The availability of two prevalence datasets (from the REACT (Real-time Assessment of Community Transmission) surveys [42] and from the UK Office for National Statistics (ONS) [43]) made it possible for us to infer the true incidence of infection for comparison with the reported cases derived from the national testing programme [42, 43]. Figure 2-5 shows two estimates of the true incidence of infection, derived from each of these two prevalence datasets, against the incidence data from the UKHSA datasets (Pillar 2 only) and the official government case numbers [44].



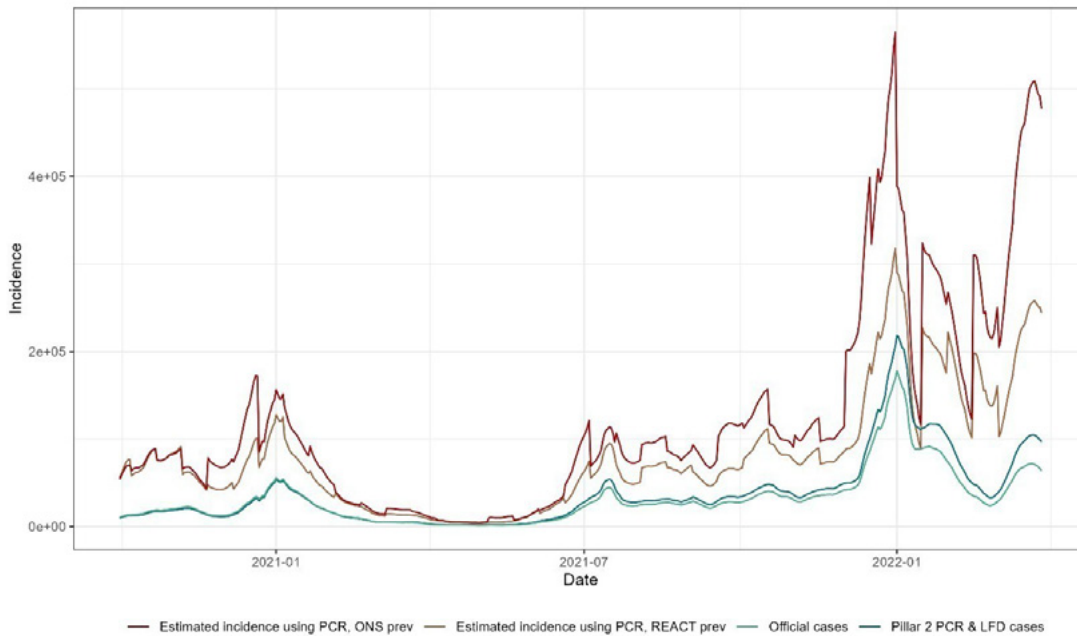


Figure 2-5. UKHSA and official government numbers of new cases of COVID-19 per day over time, compared with estimates of true infection counts. Smoothed official government numbers of new cases per day [46] over time (light blue) and Pillar 2 PCR and LFD positive cases (dark blue) compared with estimates of true case numbers using debiased REACTour estimates of prevalence at the lower-tier local authority (LTLA) level by debiasing Pillar 2 testing data using REACT prevalence, which have been aggregated at national level (brown), and case numbers estimated using ONS national prevalence estimates (red). See appendix 2.2 for details about the methodology.

The case detection ratio (defined as the percentage of all true cases – here defined as all COVID-19 infections – that were captured by the national testing programme [46]) was inferred overall to be between 40% and 26% using REACT and ONS prevalence data, respectively. Figure 2-6 shows that the case detection ratio varied over time, increasing as the national testing programme was rolled out and during epidemic waves, and then decreasing in 2022.

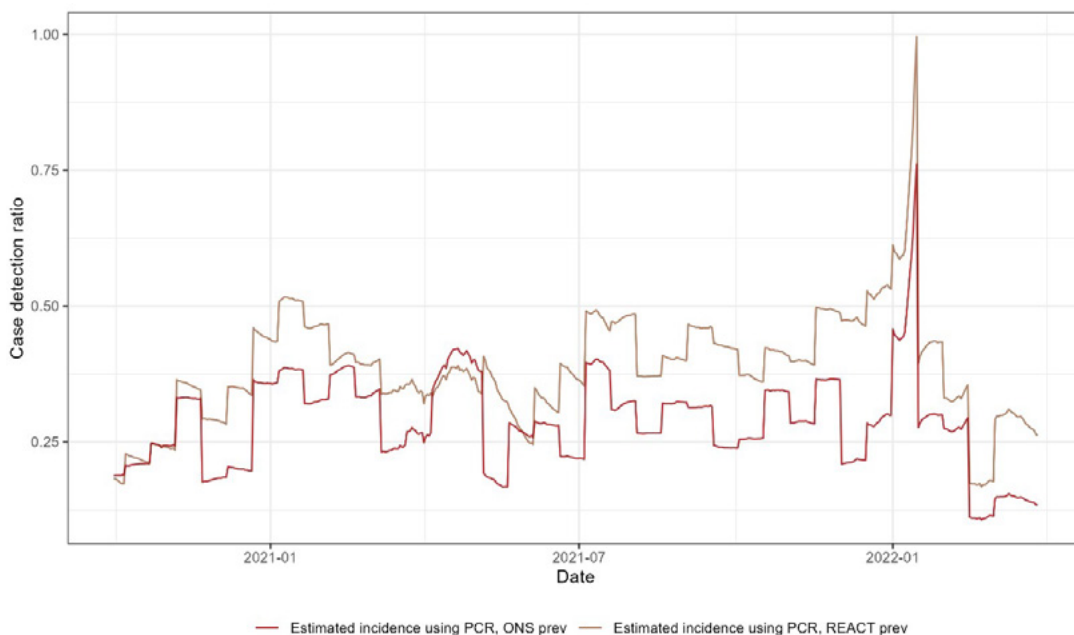


Figure 2-6. The estimated case detection ratio over time, using official cases reported and estimated incidence using Pillar 2 PCR data. The brown and red curves represent the estimated infection incidences using REACT and ONS prevalence data, respectively.

Although there was some variation and an overall increasing trend in the case detection ratio, the UKHSA case reports broadly reflect the trends in the estimated true incidence, reproducing the timing of peaks, troughs and plateaus from October 2020 through to December 2021. However, for the remainder of the evaluation period (January 2022 to March 2022), the case detection ratio declined, and the resemblance to the underlying incidence dynamics was lost. This was likely due to the drawing down of self-isolation requirements and a government announcement, in February 2022, that removed the legal requirement to self-isolate following a positive test result and for close contacts who were fully vaccinated to conduct daily tests [10]. At the public health decision-making level, therefore, we conclude that the use of national case data as an early warning system for increases in hospitalisations and deaths averted, even given low and/or variable reporting rates, was justified. In future, more explicit incorporation of nowcasting results [47] into official surveillance data and the use of estimated case detection ratios to assess programme performance in real time is advised.

The relationship between the case detection ratio and the impact of testing on onwards transmission and thus direct and indirect protection of high-risk groups is more challenging to interpret. To achieve direct and indirect protection, individuals must test frequently and then act on their positive result and self-isolate. For both reported and unreported cases, action following a positive result remains largely unobserved. As mentioned earlier in this chapter, PCR test data were routinely captured by laboratories, taking away the variation seen with LFD tests reported, where the onus was on the individual to report. Estimates have been derived for testing through specific services (see chapter 4 for healthcare workers and chapter 5 for adult social care homes) and through clinical trials [48], which were similar in effect size to the case detection ratio estimated here.

## 2.5 Programme costs for the evaluation period

### Summary of key findings

- ▶ The total cost of the COVID-19 testing programme in England was GBP 25.8 billion, with an average cost of GBP 457 per person.
- ▶ Schools, healthcare, adult social care and the universal testing service were the highest cost-drivers.

SUMMARY

### 2.5.1 The total cost of the COVID-19 testing programme in England was GBP 25.8 billion, with an average cost of GBP 457 per person

Table 2-2. Summary of the costs of the national COVID-19 testing programme in England for the full period under evaluation (October 2020 to March 2022).

	Full evaluation period (October 2020 to March 2022)
Total cost of the full testing programme in England (GBP), excluding support payments	23.46 billion
Total cost of the full testing programme in England (GBP), including support payments	25.8 billion
Cost of the full testing programme per capita in England (GBP)	457

The cost of the overall testing programme was evaluated using test volume and cost data provided by the secretariat; for the entire evaluation period the cost was GBP 25.8 billion (Table 2-2), which included the cost of laboratory setup. It also included support payments made to individuals when isolating, through the Contain Outbreak Management Fund (COMF), the Test and Trace Support Payment scheme (TTSP) and



the Practical Support Payment scheme (PSP). A full breakdown of costs by test type (LFD and PCR tests), financial year and testing service is provided in appendix 2.3. The total programme cost translated to an average cost per person of GBP 457 over the 18-month evaluation period. For comparison, this translates to about 36% of the UK financial year 2021-2022 (FY22) budget (Departmental Expenditure Limit) for the Ministry of Defence, which equates to a monthly spend of GBP 68 per person; and 9% of the FY22 budget for the Department of Health and Social Care (DHSC), which equates to a monthly spend of GBP 280 per person. The total funding available for the COVID-19 vaccination programme up to the end of March 2022 was GBP 8.3 billion, consisting of GBP 4.6 billion for the Vaccine Taskforce, primarily to purchase vaccines, and GBP 3.7 billion for vaccine deployment [50]. The average unit cost to deliver an LFD and a PCR test for the national testing programme was GBP 6.06 and GBP 68.34, respectively, including direct, indirect and overhead costs. Unit costs capture the purchase price of tests, as well as all other direct, indirect, and overhead costs associated with the programme, including the logistics, human resources and other costs to deliver the test to the point of care. Unit costs for the three priority services exclude COMF, TTSP and PSP costs and laboratory set-up costs. It is important to note that the total unit costs were not the same for each service. The unit cost for the entire evaluation period for each service depends on the point in time when tests were purchased and distributed for that service and the various logistical costs needed to deliver the tests.

As is to be expected, the procurement or purchase price of the tests decreased over time. As evidenced by UKHSA stakeholder interviews, the initial high purchase price was likely driven by demand on the worldwide supply chain for testing consumables, including swabs and viral transport media, for which the UK was competing. For example, for LFDs, the purchase price decreased by more than half between September 2020 and March 2022; hence, services that had a higher proportion of tests distributed later in the evaluation period would have benefited from lower purchase prices and increased technical efficiencies accrued. More details on the unit cost calculations can be found in appendix 2.3.

## 2.5.2 Schools, healthcare, adult social care and the universal testing service were the highest cost-drivers

Figure 2-7 illustrates the breakdown of the total COVID-19 testing programme cost by testing service, with schools, healthcare and adult social care being the highest cost drivers. These settings also formed the focus of this evaluation's deep dives, in chapters 3, 4 and 5. It must be noted, however, that the demarcation of costs by testing service was less apparent following the introduction of the universal testing service in April 2021. The 'other' category includes all testing not falling under schools, healthcare or adult social care (e.g., the universal testing service, community testing, and public sector, private sector and universities testing).

Figure 2-8 illustrates the breakdown of the total costs. About 49% of costs were direct costs, 18% indirect costs, 11% overhead direct costs, 12% overhead costs, 1% laboratory set-up costs and 9% costs for support payments.

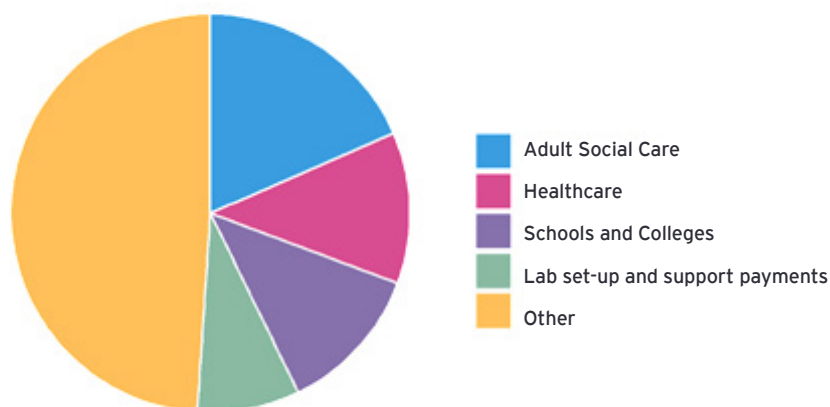


Figure 2-7. Cost of the priority testing services and overall national programme costs for the national COVID-19 testing programme in England.

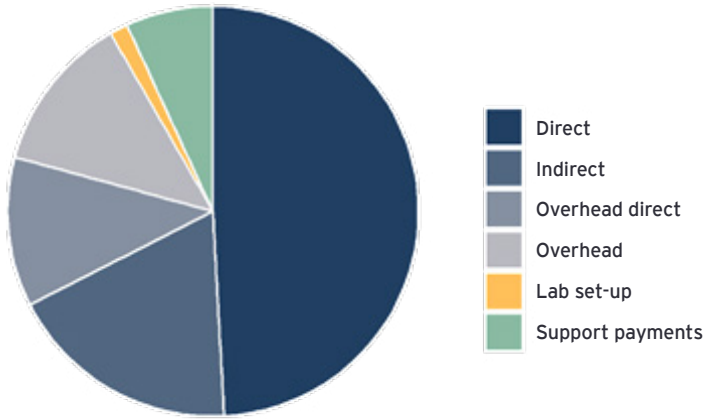


Figure 2-8. Breakdown of costs for the national COVID-19 testing programme in England.

The cost breakdown was obtained from the secretariat. All costs were broken down into direct, indirect, overhead direct and overhead costs. Direct and overhead direct categories were volume-driven costs. Staff costs were captured across different categories (e.g., staff involved in logistics were an indirect cost, administrative staff were an overhead cost). The definitions of the categories (defined by UKHSA) are available in appendix 2.3.

## 2.6 Testing equity

The universal testing service, as part of the national testing programme, partially achieved its aims in increasing the uptake of testing among deprived populations, but there was a lack of data to conclusively demonstrate whether the improvement in the equity of testing overall could be explained by the rollout of the programme.

### Summary of key findings

- ▶ More-deprived areas consistently reported lower numbers of tests taken per person, with an increase in reporting seen following the rollout of universal testing.
- ▶ More data are needed to establish whether this increase in reporting was due to universal testing alone or due to other factors.
- ▶ While universal testing may have led to an increase in the uptake of testing among disproportionately impacted groups, the concomitant disproportionate increase in higher-income decile groups may have exacerbated testing inequities.
- ▶ While the universal testing rollout did coincide with increased test reporting in the most-deprived and lower-income deciles, it is difficult to ascertain whether this was due to increased access to testing or if increased prevalence and transmission also played a role.
- ▶ The odds of PCR testing when infected versus testing when not infected were higher in more-deprived areas, mainly during the invasion phases of the Delta and Omicron variants of concern; however, for LFD tests, we did not observe any striking differences in test-seeking behaviour by level of deprivation.
- ▶ In examining case detection ratios, coverage was highest in the more-deprived populations during the invasion process of variants of concern in the pre-Omicron phase, but this reversed during the Omicron phase, with the case detection ratio becoming highest in the least-deprived populations.
- ▶ Despite reports of confusion around the use of PCR and LFD tests and generally low reporting behaviour seen for LFDs in other UKHSA behavioural data, our analysis indicates that the guidance was generally followed.
- ▶ The targeted community testing service, introduced in July 2021, attempted to address many of the barriers to testing among disproportionately impacted groups and underscored the importance of such targeted testing strategies.

SUMMARY

In this section, we explore total volumes of PCR and LFD tests taken (and for LFDs, reported) across the entire national testing programme for the evaluation period, at different levels of deprivation, and attempt to explain how this differed before and after the rollout of the universal testing service in April 2021. The universal testing service was a major component of the national testing programme, aimed at increasing access and eligibility to testing by offering free asymptomatic LFD testing to the general public from 9 April 2021.

### 2.6.1 More-deprived areas consistently reported lower numbers of tests taken per person, with an increase in reporting seen following the rollout of universal testing; however, more data are needed to establish whether this was due to universal testing alone or due to other factors

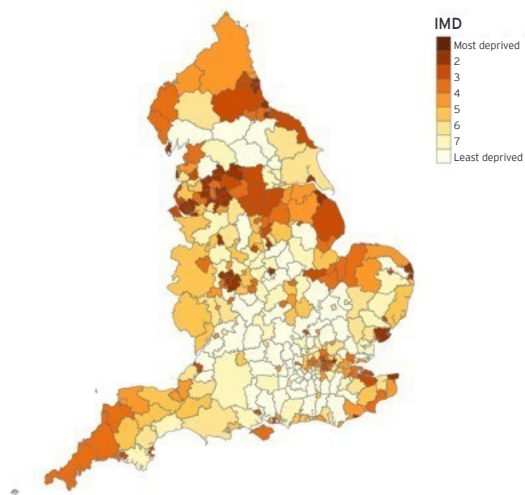


Figure 2-9. Index of multiple deprivation across England according to the population-weighted average of the combined scores for the lower-layer super-output areas (LSOAs) in a given LTLA.

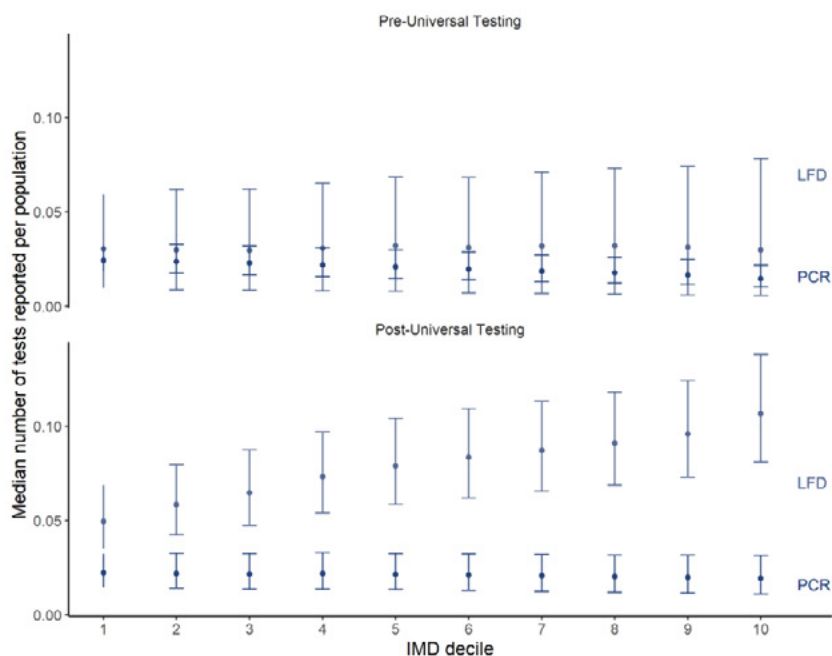


Figure 2-10. Median volume of tests reported per person, by deciles of the Index of Multiple Deprivation (1 = most deprived, 10 = least deprived). Error bars show interquartile ranges.



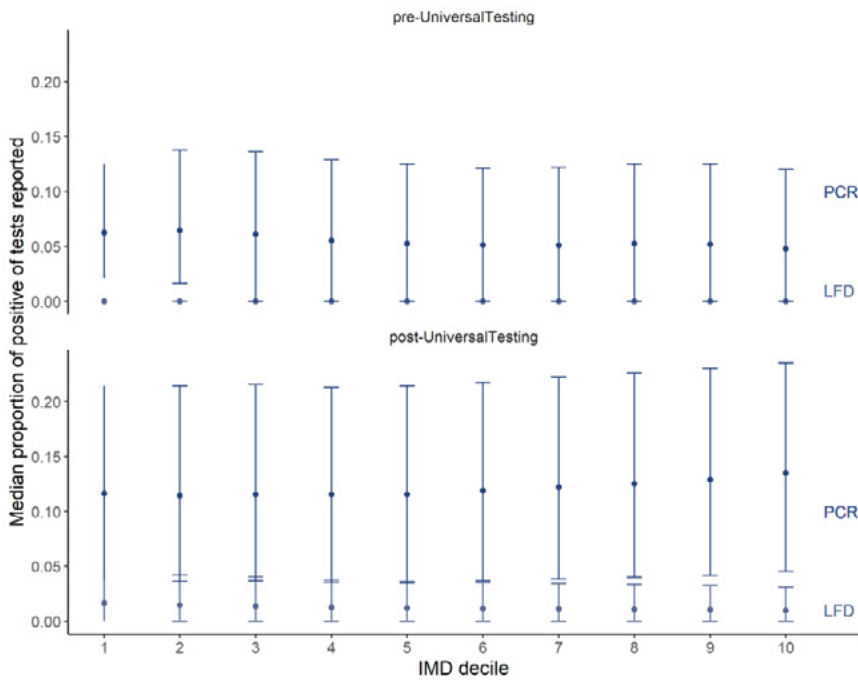


Figure 2-11. Median proportion of positive tests per person per English LTLA according to Index of Multiple Deprivation (IMD) deciles. (1 = most deprived, 10 = least deprived). Error bars show interquartile ranges.

Figure 2-9 shows the distribution of deprivation across England according to the population-weighted average of the combined scores for the lower-layer super-output areas (LSOAs) in a given lower-tier local authority (LTLA). Analysis of the median volume of tests reported per person by IMD decile (Figure 2-10) showed that more-deprived areas consistently exhibited lower numbers of tests reported per person, with an increase seen in LFD test reporting following the rollout of the universal testing service in April 2021. This suggests a positive outcome, in that the universal testing service achieved its intended outcome of increasing accessibility to tests among members of lower socioeconomic groups. It should be noted that pre-universal testing service rollout, the population reporting LFD test results could only have been adult social care staff, healthcare staff, university students, some critical national infrastructure workers, and the citizens of Liverpool enrolled in the mass testing programme ([48] and also noted by a policymaker from UKHSA).

Furthermore, an analysis of positivity (Figure 2-11) showed that the proportion of PCR tests that were positive was consistently higher for all areas following the universal testing rollout than it was prior to the rollout. This may have been due to higher uptake of testing, especially as confirmatory tests were encouraged following the introduction of the universal testing service; it may also have been due to a lower number of PCR tests being performed in general.



**2.6.2 The median number of LFD tests reported was almost twice as high in the upper-income decile than in the lower-income decile in England, with an increase seen in the reporting of LFD tests for lower-income deciles following the introduction of universal testing. While universal testing may have led to an increase in testing uptake among disproportionately impacted groups, the concomitant disproportionate increase in higher-income decile groups may have exacerbated testing inequities**

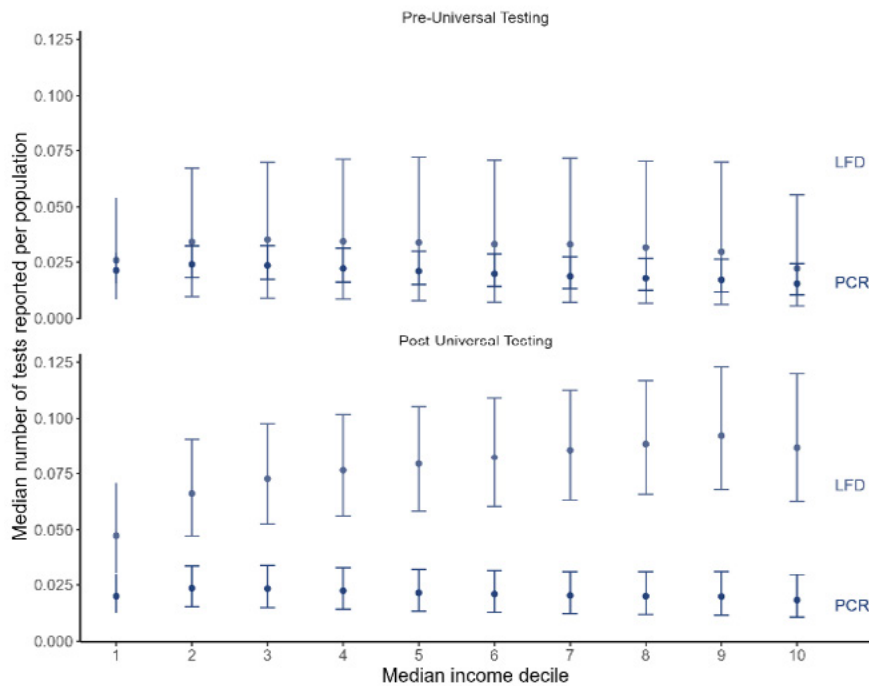


Figure 2-12. Median number of tests reported per population by income decile.

Decile 1 corresponds to the lowest median income, and decile 10 corresponds to the highest median income (minimum and maximum median incomes in GBP for each decile are given in Table 2-3). The error bars show interquartile ranges.

Table 2-3. Breakdown of income deciles used.

Income decile	Minimum (GBP)	Maximum (GBP)
1	2241	14,424
2	14,424	15,260
3	15,260	15,879
4	15,879	16,438
5	16,438	16,999
6	16,999	17,584
7	17,584	18,314
8	18,314	19,319
9	19,319	20,996
10	20,996	51,116

Using data for median income for each LSOA in England, to group the areas into income deciles, where decile 1 corresponds to the lowest median income and decile 10 corresponds to the highest median income (minimum and maximum median incomes in GBP for each decile are given in Table 2-3), data on the number of LFD and PCR tests reported by each LSOA, between 24 October 2020 and 02 April 2022, were combined with data on incomes [51]. This was then further divided by the population size of each LSOA to produce Figure 2-12, to demonstrate the impact of universal testing [52].



The mean number of LFD tests reported was almost twice as high in the upper-income decile than in the lower-income decile in England. This is most likely explained by the disproportionately low access to LFDs among the lower-income quintile groups as well as a propensity not to report a positive test either due to lack of access to the online reporting system or due to the potential loss of income due to isolation [46, 51]. As seen in Figure 2-10 and Figure 2-12, there was a shift upwards in the level of LFD test reporting across all deprivation and income deciles in the post-universal testing period, which may be attributed both to changes in the epidemiological course of the pandemic between the two periods as well as increased uptake due to the rollout of universal testing. It is, however, difficult to attribute this effect to rollout of the universal testing service alone.

The findings relating to LFDs are consistent with those of a study carried out by University College London (UCL), in which a population was surveyed to determine the likelihood of requesting a COVID-19 test if developing symptoms, by income group [53]. It was demonstrated that individuals on lower incomes were less likely than those on higher incomes to request any test (LFD or PCR) if they developed symptoms. Other studies have observed similar trends [54]. It must be noted, however, that testing and isolation of positive cases in any income decile would have had an impact on other groups, due to the removal of a potential source of infection. While there was increased LFD and PCR test reporting seen in the most-deprived and lower-income deciles following the rollout of universal testing, it is difficult to ascertain whether this was due to increased access to testing or whether increased prevalence and transmission also played a role.

To further examine the impact of the rollout of universal testing in April 2021, the evaluation consortium tested whether the Index of Multiple Deprivation (IMD) (where decile 1 corresponds to the most-deprived areas) was associated with the number of LFD tests reported before and after (see appendix 2.1) the rollout of universal testing (9 April 2021), by using a generalised linear model (Poisson regression) while adjusting for population size [55]. Additionally, these results were adjusted for the COVID-19 prevalence (controlling for confounding by prevalence) at the time, using data from the REACT study [56]. Across all three models, in both the pre- and post-universal testing periods, individuals in more-deprived areas were less likely to report an LFD test result than those in the least-deprived areas. In the post-universal testing period, people living in the least-deprived areas were still, on average, twice as likely to report an LFD test compared with people living in the most-deprived areas in England. This effect can also be seen in Figure 2-10.

Following the rollout of universal testing, the most-deprived areas still had substantially lower reporting of LFD tests compared with the least-deprived areas, which suggests that the universal testing service did not completely achieve its objective of improving equity. There did not appear to be a large difference in the numbers of PCR tests taken among the various income groups (either before or after the rollout of universal testing). This lack of association seen in PCR test reporting and deprivation may be because that PCR test results were automatically registered by laboratories, whereas with LFD tests, the onus was on the individual to report. In addition, it may also be that PCR tests for symptomatic diagnosis were readily accessible and widely understood by individuals, a reflection of the success of PCR testing rollout. However, further analysis is warranted in the future to explore this relationship further between symptomatic PCR testing and equity. Figure 2-13 addresses PCR test reporting, accounting for the level of transmission across IMD or income deciles.

An NHSTT behavioural evaluation, conducted in February 2021, also found that individuals from ethnic minority groups undertook less testing (all test types) in more-deprived areas, whereas those identifying as White British undertook more testing in more-deprived areas, suggesting cultural differences in testing behaviour, which may have affected access [57]. It has also been suggested that people from deprived areas, who may have limited access to the internet, may face barriers to testing [25], with digital exclusion identified as a barrier to testing, even though the 119 phoneline route was available [34, 48].

### 2.6.3 The odds of PCR testing when infected versus testing when not infected were higher in more-deprived areas mainly during the invasion phases of the Delta and Omicron variants of concern

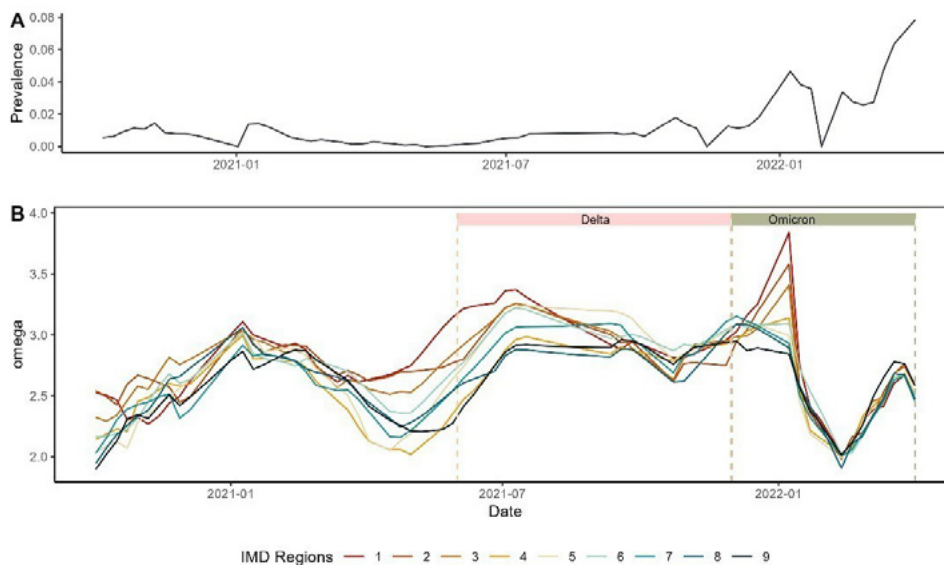


Figure 2-13. A) COVID-19 prevalence over time in England using data from the REACT study. B) Estimated mean ascertainment bias (omega: log odds of being PCR tested in the infected versus uninfected subpopulation) by deprivation regions of England over time. 1 and 9 correspond to the most- and least-deprived regions, respectively.

To examine the role of deprivation on testing behaviour, the evaluation team used coarse regions defined by level of deprivation (one to nine IMD regions, one being most deprived), instead of the nine administrative regions of England, in the debiasing methodology of Nicholson et al [58] and as described in appendix 2.2.

All LTLAs were then divided into nine groups according to the population-weighted average of the IMD scores of all the LSOAs within the given LTLA [59]. The implicit assumption within this method is that test-seeking behaviour, test availability and other factors that influence the likelihood of being selected for targeted testing are expected to be similar between LTLAs within the same level of deprivation. Figure 2-9 demonstrates the geographical spread of deprivation by LTLAs using this method.

Throughout the evaluation period, there were periods when deprivation levels were not associated with omega for PCR tests, punctuated by periods where this bias increased with deprivation (Figure 2-13 and appendix 2.2). From mid-February 2022, individuals in areas with different levels of deprivation were more similar in their PCR test-seeking behaviour. The explanation could have been the lifting of the legal requirement to self-isolate from 24 February 2022, followed by the removal of all remaining restrictions in England from 1 April 2022 [60].

For PCR tests, during the Delta variant wave, from June 2021 onwards (the first vertical dashed line in Figure 2-13), the odds of testing in the most-deprived areas (IMD= 1) were  $\exp(3.21) \approx 24$  times higher in individuals with infection compared with individuals without infection. In the least-deprived areas (IMD=9) for the same time period, the odds of testing when infected were  $\exp(2.41) \approx 11$  times higher than when not infected. During the Omicron wave (week when the curve for IMD 9 was highest: 8 January 2022), the odds of testing when infected were  $\approx 46$  and  $\approx 17$  times higher than when not infected in the most- and least-deprived areas, respectively. There is a range of hypotheses that could in principle explain these behavioural differences, such as differential costs of self-isolation, differences in test accessibility and different views about the risks posed by infection. However, more data are needed to be able to establish which, if any, of these may be the primary explanation for these trends.

A general temporal trend in the omega parameter showed that individuals who were infected tended to seek PCR tests more during the invasion phases of key variants of concern (Figure 2-13). However, for LFD tests, we did not observe any striking differences in test-seeking behaviour by level of deprivation (Figure 2-17). To check the robustness of our model, we compared models that used administrative regions and a combination of administrative and IMD regions as coarse groupings. (Details of these model comparisons are provided in appendix 2.2, in the section about model comparison.) These findings were derived using a novel statistical technique to account for weekly prevalence at the LTLA level, using a debiasing methodology to allow for more accurate, real-time estimates of the level of transmission at a fine scale [58] (see also appendix 2.2, Figure 11).

### 2.6.4 In examining case detection ratios, coverage was highest in the more-deprived populations during the invasion process of variants of concern in the pre-Omicron phase; however, this reversed during the Omicron phase, with the case detection ratio becoming highest in the least-deprived populations

We stratified the case detection ratio by LTLA, each with its related IMD, and periods of variant dominance (pre-Delta, Delta and Omicron) [61]. Our preliminary results indicate that coverage was highest in the more-deprived populations during the invasion process of variants of concern in the pre-Omicron phase, but that this ordering reversed during the Omicron phase, with the case detection ratio becoming highest in the least-deprived populations (Figure 2-14). As prevalence increased during the Delta wave in England, there was also an increase in the case detection ratio.

An analysis of equity in test reporting and positivity for school-aged children is detailed in chapter 3.

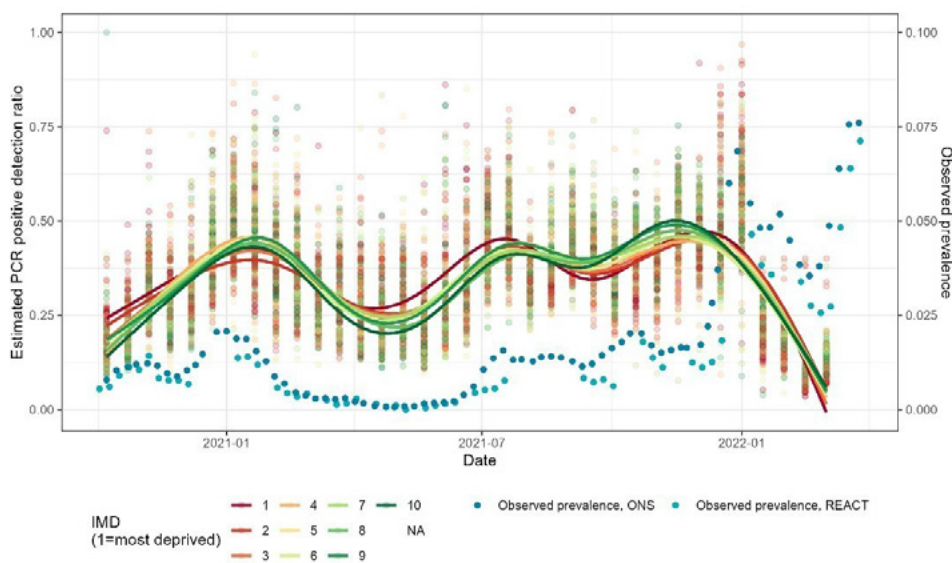


Figure 2-14. Estimated PCR-positive detection ratio over time by deprivation deciles (IMD).

Here, we used Pillar 2 PCR-positive data along with debiased LTLA-level prevalence derived from debiasing Pillar 2 testing data using REACT data to estimate daily incidence and fortnightly PCR-positive detection ratios for each LTLA (see appendix 2.2 for the detailed methodology). The dots represent the maximum a posteriori estimates of the detection ratio and the curves are smooth LOESS fits. The non-blue points and curves are coloured by deprivation indices assigned to each LTLA, where 1 (red) and 10 (green) refer to the most- and least-deprived areas, respectively. The light blue and dark blue points, respectively, are the estimated prevalence from ONS and REACT data (these are crude estimates of the proportion of positives from REACT data at the national level here).



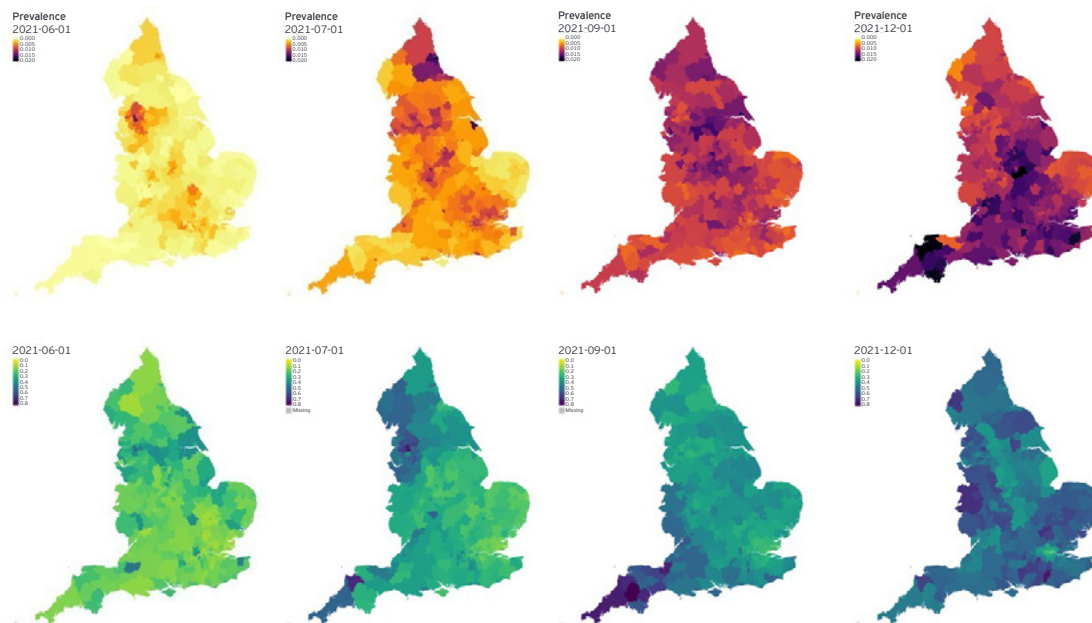


Figure 2-15. Maps of the geographic distribution of estimated prevalence (prevalence estimated by debiasing pillar 2 testing data using REACT data, as explained in appendix 2.2) and estimated PCR-positive detection ratio at the LTLA-level over time, when the Delta variant was predominant during the evaluation period. Light colours correspond to low estimates of prevalence and the PCR-positive detection fraction.

We analysed the relative reporting of test results in infected versus uninfected individuals for LFD and PCR tests and compared our results with the guidance on the use of these tests.

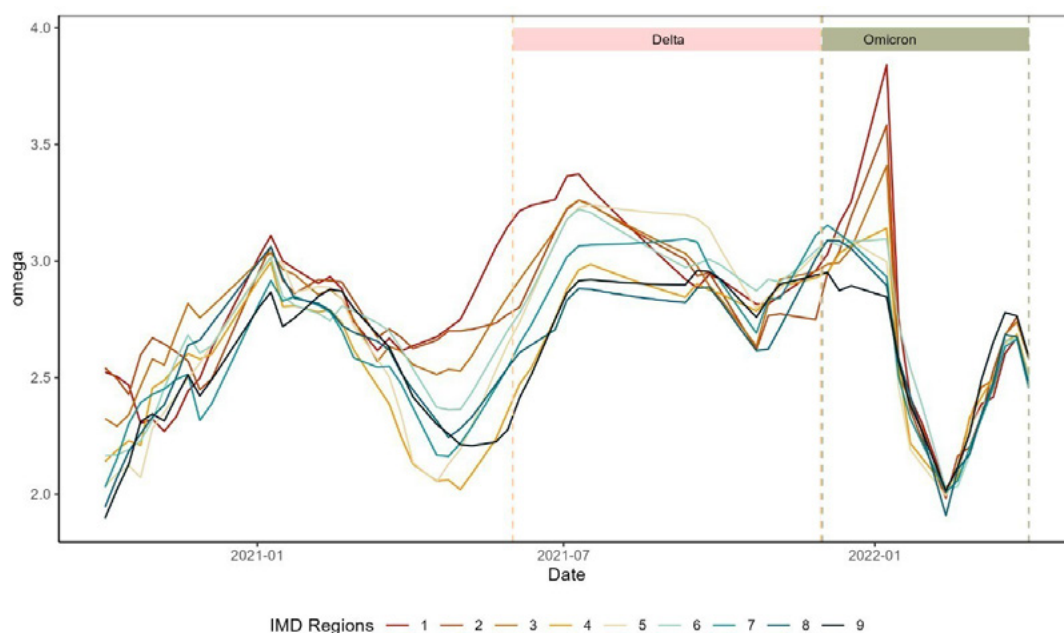
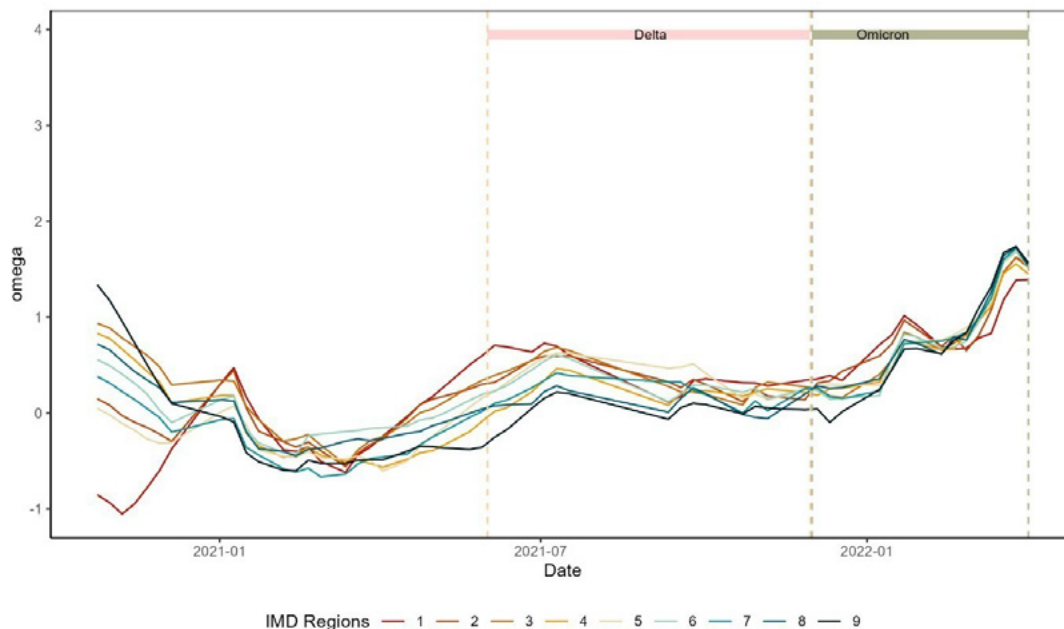


Figure 2-16. Estimated mean ascertainment bias (omega: log odds of reporting a PCR test result in the infected versus uninfected subpopulations) by deprivation regions in England over time. 1 and 9 correspond to the most- and least-deprived regions, respectively.



**Figure 2-17. Estimated mean ascertainment bias (omega: log odds of reporting an LFD test result in infected versus uninfected subpopulations) by deprivation regions in England over time. 1 and 9 correspond to the most- and least-deprived regions, respectively.**

Figure 2-16 and Figure 2-17 demonstrate the log odds of PCR testing and LFD testing then reporting, respectively, in infected versus not infected individuals (which we term ‘omega’) for the nine IMD regions. As an example, if the probability of reporting an LFD test result was the same regardless of whether people were infected, then omega would be equal to zero (= log (1)). A large omega value correspond to a higher chance of an infected individual taking (and for LFD also reporting) a test result compared with an uninfected individual.

For the most part, across the services of the national testing programme, guidance was issued for PCR tests to be used for testing symptomatic cases or for confirming positive LFD test results, whereas LFD were advised to be used for asymptomatic testing. Our analysis indicates a very strong bias towards infected individuals seeking PCR tests (Figure 2-16), which would be expected if the guidance had been followed and PCR testing was mainly used for those with COVID-19-like symptoms or for confirming a positive LFD result. Our analysis indicates relatively small differences in the likelihood of reporting an LFD test result between infected and uninfected individuals during the pre-Omicron phase (Figure 2-17). This result would be expected given the guidance on the use of LFDs for asymptomatic testing. The bias towards infected individuals reporting LFD results increased steadily throughout the Omicron phase (Figure 2-17). So, despite reports of confusion around the use of PCR and LFD tests and generally low reporting behaviour seen for LFDs in other UKHSA behavioural data, our analysis does not contradict that the guidance was generally followed.

### **2.6.5 The targeted community testing service, introduced in July 2021, attempted to address many of the barriers to testing among disproportionately impacted groups and underscored the importance of such targeted testing strategies**

The targeted community testing service, established in July 2021, aimed to reach disproportionately impacted groups and those who were underserved by the national universal testing service [12]. However, for the purposes of this evaluation, it was difficult to quantify the impact of this service based on the available testing data, suggesting a need for more robust real-time evaluation and data monitoring of targeted testing interventions in the future to truly assess their impact (see ‘Recommendations’, chapter 6).

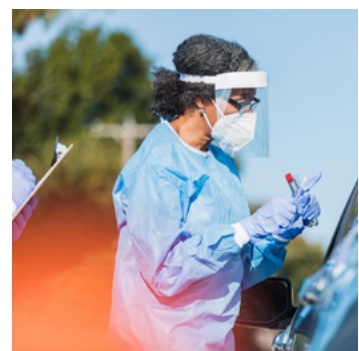
For marginalised groups, some success was seen with targeted testing activities. For women and children seeking refuge from domestic violence, a project that focused on providing tests within the refuge and making testing part of the procedure and protocol had successful outcomes, increasing testing and shifting misconceptions about testing [62]. One route to accessing these vulnerable individuals was to use services that already provide other care for them, such as the public dental service that is the main provider of dental care in certain areas of the UK for individuals who are homeless or who are incarcerated [63]. Multiple studies have also recommended that more consideration be given to the impact that socioeconomic status (such as homelessness or refugee status) or social issues (such as substance abuse) could have on people's access to testing and for the planning of future testing strategies [37, 63].

The CORSAIR study, conducted between March 2020 and January 2021 and comprising 74,699 survey responses, found that financial hardship, IMD, lower socioeconomic status and having a dependent child in the household were associated with lower adherence to full self-isolation, not requesting a test and poorer recognition of symptoms [64]. UKHSA testing data from February 2021 showed that, at all ages, people of white ethnicity appeared to take the shortest length of time before booking a COVID-19 test, whereas the African ethnic group appeared to take the longest time before booking a test, followed by the Bangladeshi and Caribbean ethnic groups [57, 65]. This disparity suggests that individuals from ethnic minority backgrounds may not have sought a test until they were more confident that their symptoms were due to COVID-19, unlike the approach taken by those of white ethnicity.

Designing communications materials with the challenges faced by non-English speakers in mind could increase engagement with testing [66]. We recognise that the pandemic response subsequently evolved, through the efforts of the targeted community testing service, to try and reach non-English speakers and produce guidance in a variety of languages, as well as via the dissemination of communications through community and cultural intermediaries. The need for such tailored communications is underscored by research undertaken during the pandemic. First, designing communications materials with the challenges faced by non-English speakers in mind and in different languages was found to increase engagement with testing [66]. Second, involving voluntary, faith and community sector organisations in the dissemination of public health information to migrant communities was also suggested to be a useful strategy [40, 63]. Furthermore, the framing of information in a culturally sensitive way could have helped to avoid culturally specific aversions to 'being told what to do', which was described as being a sentiment among migrant workers that led to hesitancy to test for COVID-19 [67].

There is also ample evidence in the literature to suggest that ethnic minority groups, those in low-paid employment who were unable to self-isolate, young adults, and people with low trust in authority who were least likely to engage with testing were the same groups who were least likely to have been vaccinated, thereby increasing the possibility of these groups being drivers of COVID-19 transmission [68-70].

Protection of their community was a primary motivator for testing in under-represented groups, indicating different motivations for testing when compared with the general population. In January 2021, when members of under-represented groups were asked about their motivations to test, responsibility to their community was identified as a primary motivator. In particular, the 'look like me, speak like me' ethos was a contributing factor. Other motivators included their personal health, family or friends' health, a need to do the right thing, to continue to work, and testing to enable, for example socialising at Christmas [71]. Similar findings from a later study suggested people tested for peace of mind or because it was the 'right thing to do' [19]. These findings were also reflected among migrant workers, with the most common reason given for following the guidelines being for the safety of other people [72].



## 2.6.6 The consequences of testing and needing to isolate had disproportionate financial and practical implications for deprived populations and ethnic minorities

Major barriers to testing for people in deprived areas were the financial and practical implications of having to self-isolate following a positive COVID-19 test [34, 48]. A study conducted early in the pandemic (March 2020) found that those on the lowest household incomes were three times less likely to be able to work from home and less likely to be able to self-isolate [73]. Individuals with precarious incomes or those working in certain sectors, e.g., in a 'shut down sector', particularly young people or women, were more likely to face economic insecurity and therefore find it more difficult to self-isolate [74-76]. Financial considerations and the implications of a loss of work were also seen to be particularly challenging for people from an ethnic minority background, especially those who were on lower incomes and in self-employment [77]. While the Test and Trace Support Payment scheme [78] aimed to mitigate the financial burden on those who were required to self-isolate because of COVID-19 regulations, there were various issues related to the access to the scheme that meant for many individuals it did not translate into alleviating the financial burden associated with isolation [79].

After the first and second epidemic waves of the pandemic, ONS data showed that individuals aged more than 70 years in the Bangladeshi and Pakistani ethnic groups were much more likely to have contact with other adults and school-aged children within the same household, likely due to the multigenerational household structure within these ethnic communities (56.4% and 34.7%, respectively, versus 1.5% of white adults) [80]. Findings from mass testing pilots within schools found that multigenerational households experienced barriers to testing due to parents' reluctance for children to be tested; this was related to the negative consequences of isolating in these households [80-82].

## 2.7 Our analysis suggests that the English national testing programme was likely to have been cost-effective if it reduced new infections by 30%; if the economic burden and the loss of productivity from lockdowns is taken into consideration, the programme can be considered to have been highly cost-effective

### Summary of key findings

- ▶ The national COVID-19 testing programme was predicted to be cost-effective in terms of cost per QALY (quality-adjusted life-year) gained if the testing efficacy in reducing new infections was 30% or more, using a willingness to pay threshold of GBP 70,000.
- ▶ The testing programme could be seen as an effective insurance policy against the risk of increased severity of disease in the face of an uncertain pandemic, particularly when the knowledge on disease severity and transmissibility was still evolving.

Our findings on the effectiveness of the testing programme in reducing transmission were inconclusive. In light of this uncertainty and to understand the levels of reductions in new cases that would need to be achieved for the programme to be cost-effective, we conducted an uncertainty analysis, as described in the following section.

### 2.7.1 The national COVID-19 testing programme was predicted to be cost-effective in terms of cost per QALY (quality-adjusted life-year) gained if the testing efficacy in reducing new infections was 30% or more, using a willingness to pay threshold of GBP 70,000

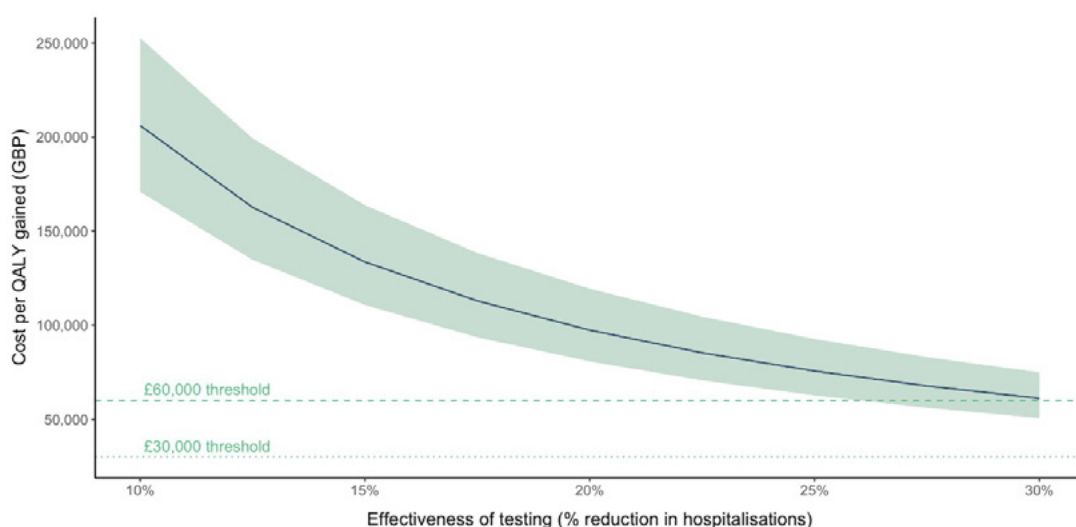
Table 2-4. Uncertainty analysis of the cost-effectiveness of the national COVID-19 testing programme in England, at various assumptions of testing effectiveness on reducing new infections.

SUMMARY

<b>Reductions in new infections due to testing</b>	<b>20%</b>	<b>25%</b>	<b>30%</b>	<b>35%</b>
Number of infections averted	10,413,200	13,016,500	15,619,800	18,223,100
Number of hospitalisations averted	111,400	139,300	167,100	195,000
Number of ICU admissions averted	12,300	15,300	18,400	21,400
Number of deaths averted	22,400	28,000	33,700	39,300
Number of life-years saved	235,600	294,400	353,300	412,200
Number of QALYs gained	239,500	299,400	359,200	419,100
Cost per hospitalisation averted (GBP)	231,500	185,200	154,400	132,300
Cost per death averted (GBP)	1,135,200	905,200	751,900	642,400
Cost savings from hospitalisations & ICU admissions averted (GBP)	330,527,800	413,159,700	495,791,600	578,423,600
Cost per QALY gained (GBP)*	106,300 (89,400-127,900)	84,800 (71,300-102,000)	70,400 (59,200-84,700)	60,200 (50,600-72,400)

\*Cost per QALY gained using a value of 6.78 QALYs per death averted (range: 4.98-8.8).

Hospitalisation fatality ratio (HFR) = 20.13; infection hospitalisation ratio (IHR) = 1.07; false-positivity: 14%; ICU, intensive care unit; QALY, quality-adjusted life-year (calculated for the 18-month period of the evaluation).



**Figure 2-18. Cost-effectiveness of testing at different levels of testing effectiveness on reducing new cases in England.**

The shaded area is the cost per QALY gained at an upper level of 8.8 QALYs per death averted and a lower level of 4.98 QALYs per death averted. The line shows the analysis conducted at 6.78 QALYs per death averted.

Modelled incidence rates and actual hospitalisation and death data for the evaluation period (October 2020 to March 2022) were used to calculate the actual infection hospitalisation ratios (IHRs) and hospitalisation fatality ratios (HFRs) during the



18-month period [83]. A sensitivity analysis was developed, assuming reductions of 10% to 35% due to the testing programme. Infections, hospitalisations and deaths averted were modelled at these various potential reduction levels. Cost savings from hospitalisations and intensive care unit (ICU) admissions averted were estimated. Combined with the total cost of the testing programme, these were used to estimate the cost per infection averted, cost per hospitalisation averted, cost per death averted and cost per QALY gained. Table 2-4 summarises the input parameters and Figure 2-18 illustrates the sensitivity analysis. The shaded area reflects the minimum and maximum values for QALYs for deaths found in the literature [83]. (See appendix 2.3 for further details on the methods and assumptions used.)

Figure 2-18 shows that the full testing programme was cost-effective in terms of cost per QALYs gained at a testing effectiveness of 30% and more at reducing new infections (using the Green Book willingness to pay threshold of GBP 70,000 [84]). At a testing efficacy of reducing new infections by 30%, more than 167,000 hospitalisations would be averted, an excess volume that the NHS may have had difficulty in absorbing. The cost per hospitalisation averted was GBP 154,000, cost per death averted was GBP 751,900 and cost per QALY gained was GBP 70,400.

The Canna model estimated that the reduction in transmission from the testing programme, between August 2020 and April 2021, varied over time by between 10% and 28% (across a 90% confidence interval) [2]. The Covid-SMART study conducted in Liverpool analysed the impact of voluntary rapid testing for the SARS-CoV-2 antigen on COVID-19-related hospital admissions from November 2020 to January 2021 and found that testing led to a 25% (11% to 35%) reduction in COVID-19-related hospitalisations [83]. The similarities in the reductions in new cases and hospitalisations observed in these studies implies that a reduction in hospitalisations of 30% is not implausible and that the overall testing service was likely to have been cost-effective in terms of cost per QALY gained at a willingness to pay threshold of GBP 70,000.

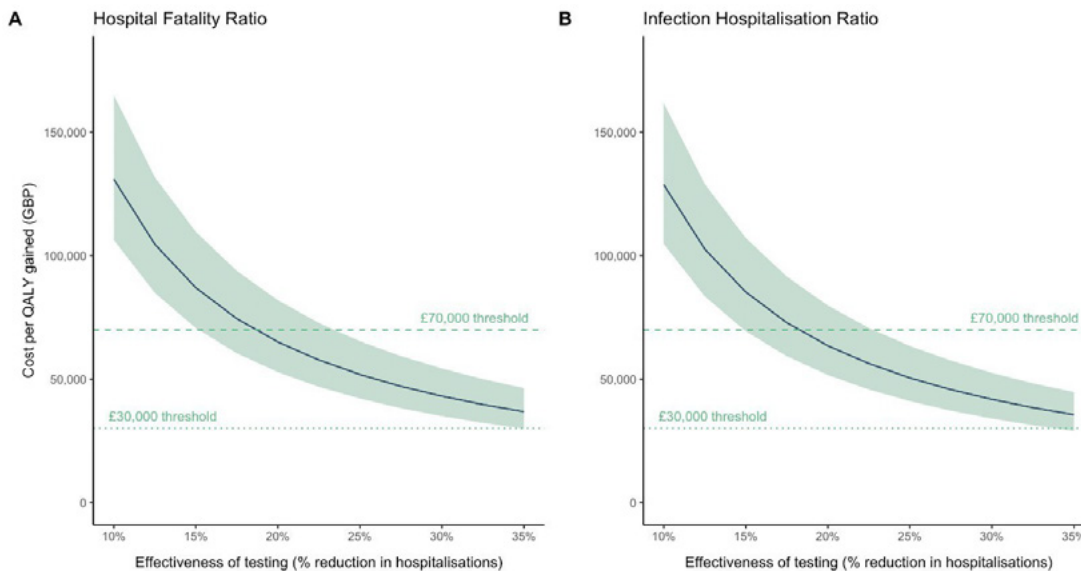
While not equivalent, it is interesting to note that a systematic review of SARS-CoV-2 vaccine effectiveness against infection found that mean efficacy was 83% in the first month after completion of the original vaccination schedule and decreased to 22% at 5 months [4]. While several studies into the cost-effectiveness of vaccination have been published, none were identified that specifically explored the cost-effectiveness of vaccination against infection in England.

## 2.7.2 The testing programme could be seen as an effective insurance policy against the risk of increased severity in the face of an uncertain pandemic, particularly when the knowledge on severity and transmissibility was still evolving

As the testing programme was established in the presence of substantial uncertainty regarding the eventual severity of the pandemic, several scenarios were modelled to capture the potential cost-effectiveness had the pandemic played out differently. The scenarios considered an increased HFR and an increased IHR (Table 2-5). These scenarios may have occurred in the presence of a more severe variant or delayed vaccination availability and rollout. The scenarios used show that the testing programme was robust to uncertainties in the severity and transmissibility of COVID-19 variants, with higher severity implying increased cost-effectiveness. Figure 2-19 illustrates the cost-effectiveness of the testing programme under the risk scenarios of higher IHR and HFR.

Table 2-5. Cost-effectiveness under various risk scenarios and test effectiveness rates (cost per QALY gained).

Risk scenario	Testing effectiveness at reducing new infections				
	15%	20%	25%	30%	35%
Double hospitalisation fatality ratio (HFR = 40.26)	87,000	65,000	51,900	43,100	36,800
Double infection hospitalisation ratio (IHR = 2.14)	85,300	63,500	50,500	41,800	35,600



**Figure 2-19. Cost-effectiveness of testing at different levels of testing effectiveness on reducing hospitalisations under potential risk scenarios in England.**

The shaded area is the cost per QALY gained at an upper level of 8.8 QALYs gained per death averted and a lower level of 4.98 QALYs gained per death averted. The line shows the analysis conducted at 6.78 QALYs gained per death averted.

If the HFR of COVID-19 had been twice as high as the actual HFR, the programme would have been cost-effective at an effectiveness in reducing new infections of less than 20%. The cost per QALY gained would have been GBP 65,000, making the testing programme cost-effective at a willingness to pay threshold of GBP 70,000 per QALY gained. The testing programme in this scenario would have averted a further 111,400 hospitalisations, 44,900 more deaths and more than 10 million infections (at a testing effectiveness of 20%) and a total financial gain of more than GBP 27.7 billion.

Had vaccinations been delayed and IHRs double those that were experienced, at a testing effectiveness of 20%, the cost per QALY gained would have been GBP 63,500 per QALY gained, which would have made the programme cost-effective. The testing programme in this scenario would have averted a further 222,800 hospitalisations, 44,900 more deaths and over 10 million infections (at a testing efficacy of 20%), with a total financial gain of more than GBP 28.4 billion.

These findings demonstrate the important role that the testing programme played as an insurance policy during an unprecedented pandemic situation. Had a more severe variant emerged, leading to either increased likelihood of hospitalisation upon infection or increased likelihood of death for those requiring hospitalisation, the testing programme would have averted even more deaths.

Figure 2-19 illustrates the cost-effectiveness under the hypothetical risk scenarios of a higher HFR (Figure 2-19, panel A) and IHR (Figure 2-19, panel B).

It must be recognised that these estimates of cost-effectiveness are undervalued as they do not consider the economic cost of a counterfactual of protracted lockdowns and other non-pharmaceutical interventions that may have been imposed to flatten the epidemic curve and curb hospitalisations. Previous studies have estimated that one year of lockdowns cost the UK economy approximately GBP 251 billion [85] and that delaying lockdowns by even a few weeks would have had a huge impact on the economy. If testing contributed at least a part to the reopening of the economy, we examined three potential scenarios for the 18-month evaluation period:

- ▶ **Lower economic estimate:** testing was able to avert 2% of the economic burden of lockdowns, translating to an additional economic benefit of GBP 5 billion.
- ▶ **Mid-economic estimate:** testing was able to avert 6% of the economic burden of lockdowns, translating to an additional economic benefit of GBP 15 billion.
- ▶ **Upper economic estimate:** testing was able to avert 10% of the economic burden of lockdowns, translating to an additional economic benefit of GBP 25 billion.



Other studies have suggested that such direct economic costs are just the ‘tip of the iceberg’ with respect to the damage inflicted on the social, economic, mental and physical wellbeing of the population [86], including the delays to treatments for other conditions including cancer and long-term diseases. Although the quantification of these impacts is beyond the scope of this evaluation, our estimates suggest that, under the uncertainties presented, if the testing programme was able to avert a fraction of the economic costs described, it could be considered to be highly cost-effective, particularly prior to the launch of the vaccination programme when the risk of severe disease was higher.

## 2.8 Key considerations for future testing strategies

### Summary of key considerations

- ▶ Our analysis of testing equity supports the need for earlier implementation of targeted testing strategies aimed at disproportionately impacted and underserved groups.
- ▶ Wider indirect effects (e.g., community transmission, hospitalisations and deaths) and the impact of targeted community testing were not retrospectively measurable due to the way the services were implemented – through improved clarification of service aims and objectives, universal testing strategies of the future could ensure relevant data capture to measure success and allow for consistent evidence-based communication strategies to the public.
- ▶ National case and prevalence data were not always readily available in real-time and fully integrated at an LTLA level to guide public health decision-making – for future public health threats, formal incorporation of national case and prevalence data as part of public health surveillance using novel debiasing approaches could allow for robust disease surveillance and assessment of programme performance in real time.
- ▶ The impact of testing changed over time – for a similar pandemic, testing could still be cost-effective in reducing deaths and hospitalisations at lower levels of effectiveness, therefore targeted testing of higher-risk groups could be the focus of future testing strategies.

SUMMARY

### 2.8.1 Our analysis of testing equity flags the need for earlier implementation of targeted testing strategies aimed at disproportionately impacted and underserved groups

- ▶ Any public health intervention requires focused efforts to ensure access for hard-to-reach groups and an awareness that large-scale efforts can unintentionally exacerbate existing health inequities. Well-designed future strategies should include, from the outset, deliberate and supportive activities to address barriers or unintended consequences disproportionately impacted and underserved populations may face during a pandemic. Although the targeted community testing service addressed some of these issues, such a service should be implemented early on and designed into the foundation of any future testing strategy.
- ▶ Tailored testing approaches rather than a one-size-fits-all approach have been shown to be successful during the pandemic response and should therefore continue to be prioritised in future, along with central government support and funding for this. These approaches should continue to take into account differing cultural values, behavioural motivators, and communication and language styles that may help to increase uptake in disproportionately impacted groups, with these insights being collected and developed continuously, reducing the reliance on doing so during a pandemic situation.
- ▶ Testing, effective tracing, and financial support packages for those isolating should be communicated more widely and clearly to all disproportionately impacted and underserved populations.
- ▶ In designing these strategies and communications, it is vital to ensure that community, cultural and religious intermediaries continue to be included as they were for the targeted community testing service, in a participatory manner.

- ▶ A universal, mass testing delivery system should be ready-to-deploy earlier rather than later for future pandemics. Using a 'switch on, switch off' delivery mechanism, targeted at specific groups to ensure equity of access, could be more cost-effective and successful in reducing transmission, underpinned by behavioural research, recognising that this delivery mechanism is not an easy one to action. This mechanism should also include clear, population-level data capture that is aligned with service aims to allow real-time evaluation of the service to assess impact and build the evidence base for effective interventions. A system designed to do this should be built in a participatory manner, with public involvement. Furthermore, clear performance measures should be established at the outset of any testing service, underpinned by real-time data collection and monitoring.

### **2.8.2 Wider indirect effects (e.g., community transmission, hospitalisations and deaths) and the impact of targeted community testing were not retrospectively measurable due to the way the services were implemented – through improved clarification of service aims and objectives, universal testing strategies of the future could ensure relevant data capture to measure success and allow for consistent evidence-based communication strategies to the public**

- ▶ A universal, national-scale testing delivery system could be ready-to-deploy earlier rather than later, through the establishment of draft standard operating procedures (SOPs) and operational frameworks for future pandemics.
- ▶ Using a 'switch on, switch off' delivery model, steeped in behavioural/user research to ensure the feasibility of such a dynamic application, could be targeted at specific groups to ensure equity of access, to be more cost-effective and successful in reducing transmission. A system designed to do this should be developed in a participatory manner, with public involvement.
- ▶ Building on existing data, there is room for further behavioural research to be undertaken, to understand how best to reach target populations with such a switch on/switch off delivery model and at the same time ensure adequate, streamlined, real-time data collection of test results to monitor health at the population level, alongside optimising the user experience to minimise the reporting burden.
- ▶ As demonstrated by the scoping review of existing behavioural evidence performed as part of this evaluation, and drawing on the success seen in the targeted community testing service, continued emphasis on different communication strategies around testing for different target groups is of utmost importance, especially in light of changing guidance. Clear, consistent messaging across a variety of media, both digital and non-digital, and through religious, community and cultural intermediaries were shown to be important. Ample provision could also be made for those who are not digitally literate, with an easy to use and easily accessible alternative, expanding on the 119 phonenumber model.
- ▶ The previous pandemic testing strategy demonstrated the need to make trade-offs between regimented guidance that enforced the reporting of LFD test results and that of a more liberal policy to offer unlimited public testing to all who needed it, free from the obligation to report, with the hope that this would have a positive impact on COVID-19 transmission. The downside of not enforcing the reporting requirement resulted in a lack of data through which testing and reporting, and the associated public health outcomes, could be evaluated in real-time. Further qualitative research could be undertaken to understand the effects of reporting requirements on testing behaviour, identify ways to optimise the user experience to minimise reporting burden and to explore whether further focus on mandatory reporting of results is warranted in future.



### **2.8.3 National case and prevalence data were not always readily available in real-time and fully integrated at an LTLA level to guide public health decision-making – for future public health threats, formal incorporation of national case and prevalence data as part of public health surveillance using novel debiasing approaches could allow for robust disease surveillance and assessment of programme performance in real time**

- ▶ National case and prevalence data could be used as an early warning model for public health surveillance, to determine potential impacts on hospitalisations and deaths for high-risk groups, even when reporting rates are variable or low.
- ▶ Such a model would be more real-time and granular (to include service, age, demographics, prevalence) and potentially a less biased measure of overall cases than provided by a mass testing programme.
- ▶ The model could include clear, population-level data capture aligned with the aims of the service, to allow for evaluation of the service and build the evidence base for effective interventions, in addition to case detection and disease surveillance.

### **2.8.4 Our analysis showed that the impact of testing changed over time – for a similar pandemic, testing could still be cost-effective at lower levels of effectiveness in reducing deaths and hospitalisations, therefore targeted testing of higher-risk groups could be the focus of future testing strategies**

- ▶ To optimise the use of resources, and to reduce confusion by streamlining guidance, different strategies could be considered for high-risk populations versus high-contact populations, through the use of robust cost-effectiveness models.
- ▶ In the first instance, high-risk groups and high-contact groups should be identified. Different strategies may be considered for each group, e.g., a high-intensity versus a high-efficiency strategy, within the constraints of cost-effectiveness thresholds; this is further elaborated in chapter 6, with the overarching recommendations.
- ▶ When planning new testing policies and other public health interventions for a pandemic threat, the timing of the introduction of new vaccines or treatments could be considered and communication strategies streamlined accordingly, to minimise confusion among the public and mitigate negative impacts on testing or other public health interventions.

## **2.9 Conclusion**

This evaluation demonstrated that, overall, the national COVID-19 testing programme in England achieved its aims in a timely fashion and under considerable uncertainty about an evolving pandemic threat. The programme also collected data that may be used to inform future strategy. The evaluation results suggested areas of improvement when designing testing programmes for future pandemics and tools for public health surveillance. These include a greater focus on direct effects, increasing equitable access to testing as a priority earlier on in a pandemic, combining insights from both case reporting and prevalence data using debiasing methodologies and streamlining specific testing services. While the universal testing service improved access and the reach of testing, our findings suggest that efforts at targeting disproportionately impacted population groups earlier in a pandemic could improve both uptake and equity in these populations. However, these results are difficult to interpret in isolation, given that the targeted community testing service could not be included in this evaluation as testing data were not available. Should such data become available for future evaluations, a combined assessment of both targeted community testing and universal testing should be made, to examine the impact on community transmission and testing uptake.



**Case study: Testing has proven to be a valuable intervention, but finding the optimal level of testing is critical – learning from our Nordic neighbours**

Denmark pioneered one of the world's most prolific COVID-19 testing regimes early on in the pandemic, in an effort to keep COVID-19 under control. In a period of just two years, Denmark's population of 5.8 million logged more than 127 million PCR and rapid tests, an average of 22 tests/person (compared with 56.5 million people in England logging more than 2.15 billion PCR and rapid tests, an average of 38 tests/person between October 2020 and March 2022), with the country spending more than US\$ 2.36 billion (16 billion krone) on testing alone [87].

The major criticism Denmark faced was how much the testing programme and subsequent isolation of confirmed cases actually helped reduce transmission [88]. Testing did not yield as great a benefit as expected, with neighbouring Norway (with a similar population size) managing to achieve a lower cumulative COVID-19 deaths per million figure while performing just 11 million PCR tests in the same timeframe [88].

Sweden, on the other hand, opted for a different strategy, with mass testing rolled out much later, amid discussion over responsibility and funding [89], with the government criticised for being 'lax' [90]. Compared with other European countries, it took Sweden a long time to build sufficient testing capacity. According to the World Health Organization, Sweden had recorded 18,546 COVID-19-related deaths by 28 March 2022, many times the per capita level of its Nordic neighbours [91].

Ultimately, Sweden's relaxed and delayed COVID-19 testing response did not benefit its economy in the short term, while leading to disproportionate COVID-19 hospitalisations and mortality in the country [92].

In chapters 3, 4 and 5, we perform an in-depth evaluation of each of the priority testing services (the healthcare, schools, and adult social care testing services) and provide further, service-specific recommendations.



# Priority Service 1: Schools Testing Service

# Schools Testing Service

This chapter on the evaluation of the schools testing service will cover the following:

## Definitions

We refer to the 'schools testing service' and 'pupils' throughout this chapter. The term 'pupils' refers to young people aged 11 to 18 years. These were predominately young people who attended secondary school and among whom considerable testing was carried out. However, it should be noted that the term 'pupils' also includes the approximately 50% of 16- to 18-year-olds who attended sixth form/further education colleges, where the disease dynamics may have been different from secondary schools. The schools testing service also covered the workforce in pre-school settings, primary schools, secondary schools and sixth form/further education colleges.

Special schools, other specialist settings, primary schools and staff testing were excluded from the statistical analyses but were included in the behavioural and operational insights. The analysis was conducted on testing data for 11-18-year-olds and therefore excludes primary school and staff testing. Special schools and other specialist settings could not be distinguished within the dataset and therefore splitting out the data to produce targeted findings was not feasible for this evaluation<sup>1</sup>. Universities were also not considered, as this setting had an entirely different testing regimen.

Different types of 'bubbles' are referred to within the report. Pillar 2 data refer to 'school-house bubbles' and 'school support bubbles'. These may be collectively referred to as 'school bubbles', which were school administered, e.g., grouping children in bubbles via their class group or year group; however, the terms are not clearly defined in the Pillar 2 methodology report [1]. The definition of a 'childcare bubble' is 'when one household with a child under 14 is paired with another household to provide informal childcare' [2]. A 'support bubble' is referred to as two households paired, where one household consisting of a single adult or with a child under the age of one is paired with another household of any size [2]. The assumption is made that a 'household bubble' includes any individual who resides within the same household.

Different types of 'effects' are referred to with respect to the schools testing service, namely 'direct effects' and 'indirect effects'. Direct effects are defined as the effects of the service on pupils and staff, for example changes in confidence in attending face to face education. Indirect effects are defined as the effects of the service on other members of the population, for example changes in community hospitalisations.

## Data limitations

In addition to the definitions outlined above, it should be noted that the evaluation consortium experienced limitations in gaining the necessary data to perform relevant analyses to answer all of the research questions outlined in the next section. The two key data limitations can be summarised as follows:

First, to determine indirect, downstream effects on community transmission and subsequent hospitalisations, ONS data of the appropriate granularity could have been explored or the evaluation consortium would have needed randomised controlled trial data during the evaluation period. The ONS Schools Infection Survey (SIS), which was aimed at assessing the role played by schools in COVID-19 transmission, could have provided estimates of within-school transmission. However, due to time constraints/data not collected via a randomised controlled trial (RCT) approach as a result of the way the services were rolled out, it was not possible to form a reasonable counterfactual scenario. A small, phased policy implementation of the testing service in different regions could have provided a natural experiment, and synthetic control methods could potentially have been utilised for counterfactual modelling. The evaluation consortium notes that this approach to a rollout is not always feasible or equitable, as it would have meant that certain geographies would have had access to testing earlier than others and raises an ethical consideration that we explore in chapter 6 [5].

Second, granular data sharing between government organisations requires a longer lead time than this evaluation's timeframe could support. To determine direct effects on face to face education, the evaluation consortium would have required attendance data at a granular level, specifically at an individual school level. This level of data is collected by the Department for Education (DfE); however, at the time of request, it was collectively deemed unfeasible to deliver these data within the timeframe of the evaluation. Data at the lower-tier local authority (LTLA) level were provided, but

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<sup>1</sup>Targeted analysis of special schools and other specialist settings was not feasible for the following reasons. First, a proportion of the reported tests came from records that had school names missing (or NULL), and manually attempting to link school names in the Pillar 2 database to other publicly available schools datasets was not considered feasible within the evaluation timeframe, given that there are more than 24,000 schools in England (source: <https://explore-education-statistics.service.gov.uk/find-statistics/school-pupils-and-their-characteristics>). Second, attendance data at an individual school level was not available at the time of the evaluation; therefore, a targeted analysis of schools for children with special educational needs and disabilities (SEND) was also considered unfeasible within the timeframe of this evaluation. Wider issues relating to equity were considered in chapter 2.



these data were deemed not suitable for modelling the volume of face to face school days lost through self-isolation, because assessing the direct impact of test results on absenteeism would require the number of positive tests reported at the level of individual schools. Aggregated data at the LTLA level would have masked the likely large inter-school variation and hence the results would have been susceptible to ecological bias.

### 3.1 Executive summary of the schools testing service evaluation

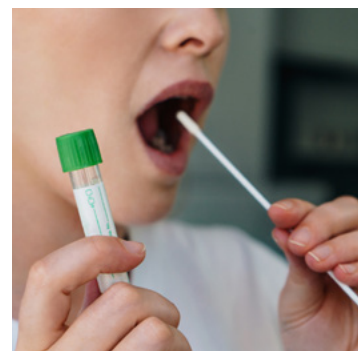
Here, we summarise the findings of our evaluation of the schools testing service and compare them with key indicators developed during the evaluation process through the ToC approach (see appendix 3.2). The schools testing service in England was responsible for the introduction of asymptomatic testing models in educational settings, and sought direct and indirect effects, to safeguard the health of the teaching workforce, keep as many staff and pupils in schools and colleges as possible (by increasing confidence to attend), identify asymptomatic cases of COVID-19 and limit the spread of the SARS-CoV-2 virus among pupils aged 11 to 18 years and the workforce in schools and colleges [6, 7]. A further intention of the schools testing service was that it would help reduce the spread of the virus in society, reducing pressure on healthcare settings and ultimately reducing the number of deaths. It was also an opportunity to disseminate test kits to families of school pupils as a supply chain route.

Young people are at low risk of severe outcomes of COVID-19 and therefore quantifying the effectiveness of testing is more challenging than for other services. Marginal direct effects are difficult to quantify in relation to COVID-19 interventions in young people, such as the costs and impact of disruptions in face to face education, the costs and impact of long-COVID, and the costs and benefits of hedging against uncertainties in current and future severity of the infection. These and other social and economic benefits, such as the short- and long-term cognitive impact of increased school days and their impact on future earnings, the aversion of mental health impacts of social exclusion, and the ability of parents to return to the workforce, are challenging to quantify and have therefore not been included. We explored this challenge using uncertainty analyses focused on typical drivers of indirect and direct effects.

#### 3.1.1 Outline of the hypothesis and research questions

Our evaluation aimed to answer the following questions:

- ▶ Did the schools testing service achieve its intended aims and purposes?
  - ▶ Our evidence review found that the service aims were nuanced differently across NHS Test and Trace (NHSTT), DfE (via the Testing Evaluation Report [7, 8] and stakeholder conversations), the government (through gov.uk briefings) [6, 9, 10] and UKHSA (where the aims were confirmed retrospectively through stakeholder conversations). Nuances specifically occurred in relation to what the aims were, whether these changed over time and in which order they were prioritised. The aims largely fell into and were evaluated against three main categories:
    - ▶ Increasing pupil/parent/teacher confidence in attending educational settings
    - ▶ Reducing disruption, both in terms of face to face school days lost and parent/guardian days lost due to caring for a self-isolating pupil
    - ▶ Reducing community transmission and thereby reducing the pressure on healthcare settings and ultimately reducing the number of deaths
  - ▶ Increasing case detection was a key objective to support aims in all of the above categories.
- ▶ Was the schools testing service a cost-effective intervention?
- ▶ What were the behavioural barriers and facilitators to taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?





### 3.1.2 Description of the context of the evaluation

- ▶ The schools testing service made up 25.1% of the total volume of LFD tests distributed and 15.5% of the total spend of the testing programme in England.
- ▶ The testing delivery mechanism was voluntary and initially began as an onsite model, with the use of LFDs to test all pupils, moving to home testing in March 2021.
- ▶ Onsite tests were used at the start of school terms in September 2021 and January 2022.
- ▶ Of the LFD tests that were distributed, 22% were officially reported.
- ▶ The gap between tests distributed and tests reported increased over time as more tests were distributed.
- ▶ The number of tests reported per young person per week was well below both the adjusted and intended targets of the schools testing service; specifically, LTLAs that had a larger proportion of people from ethnic minority groups and were lower on the deprivation index reported fewer tests per person per week.

### 3.1.3 Results of the evaluation

Did the schools testing service fulfil its intended aims? Was the schools testing service a cost-effective intervention?

- ▶ The schools testing service did increase pupil/parent/guardian and staff confidence in sending young people back to school.
- ▶ The schools testing service did enhance case-finding through the use of asymptomatic testing with LFDs. Previous research has shown that detection was lower in those pupils who were older, were from ethnic minority groups, or who had special educational needs or disabilities (SEND). In our analysis, young people from areas of greater deprivation and from areas with larger ethnic minority populations generally provided fewer test results. We also found that young people from more-deprived areas had higher levels of positivity in their reported results. These findings indicate inequities among school-aged young people in accessing, taking and reporting tests.
- ▶ We assume the main aim of finding more cases was to increase the propensity for indirect effects downstream. Our statistical analysis found an association with testing and enhanced case finding but was unable to measure an onward indirect reduction in community hospitalisations and deaths, due to a lack of data collected at the time or accessible at the time of this evaluation (see 'Data limitations' section earlier in this chapter).
- ▶ Our statistical analysis was unable to determine how many face to face school days were lost through self-isolation, due to the relevant data relating to COVID-19 school absenteeism not being available at the level of individual schools at the time of undertaking the evaluation (see 'Data limitations' section earlier in this chapter for why nationally available datasets would not have been suitable for this analysis).
- ▶ Our statistical analysis was unable to determine how many parent/guardian days were lost through caring for a self-isolating pupil, due to the lack of data available at the level of individual schools at the time of undertaking this evaluation; however, we were able to determine the impact of false-positive results on time spent self-isolating. An economic modelling exercise was performed, using plausible assumptions for the impact of testing on chains of onward transmission that would lead to gains in parent productivity as a result of infections averted. In this way, we were able to consider the potential of testing to reduce parent/guardian workdays lost due to caring for a self-isolating pupil.
- ▶ Our economic analysis predicted that the testing service in secondary schools and colleges would have been cost-effective in terms of quality-adjusted life-years (QALYs) gained if it reduced new infections in the wider community by more than 3%.
- ▶ We estimate that the testing service in secondary schools and colleges would have been cost-effective in terms of quality-adjusted life-years (QALYs) gained in preventing the direct impact of COVID-19 if the infection fatality ratio (IFR) in this age group was at least ten times higher, although this warrants further analysis.
- ▶ We found that the aims of the schools testing service were in conflict, in terms of the intensity of the testing they would require.



The findings of our qualitative and behavioural analyses point to wider societal benefits of face to face education; these benefits have also been evidenced in the wider academic literature and government publications [11, 12]. We quantified the total cost per pupil of the schools testing service to be about GBP 600. The testing service was provided through UKHSA, as a service provided by the government and alongside young people's education, to allow them to return to school and meet educational targets during a pandemic.

What were the behavioural barriers and facilitators to taking a COVID-19 test, reporting of a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?

- ▶ Support provided to the education sector, specifically in relation to training and guidance, was useful for reassuring pupils, parents and staff
- ▶ Setting up and running an asymptomatic testing site (ATS) within schools was resource-intensive, so financial and logistical support was crucial for ATS rollout
- ▶ Taking a test at home increased between March 2021 and July 2021, while at-school testing decreased; however, a minority of pupils felt concerned about self-testing at home
- ▶ Establishing stronger partnerships between local health authority teams and schools enabled systems for reporting outbreaks and receiving support to be set up
- ▶ Reporting results on both school and NHSTT platforms was burdensome for some parents and pupils
- ▶ Consequences following a potential positive test result were a barrier to testing for some families
- ▶ Pupils from more-deprived areas may need more support to test in any future pandemic [3, 4]

### **3.1.4 Key considerations and service-level recommendations for future testing strategies**

We summarise the overall testing programme recommendations in chapter 6 of this report, with recommendations referring to testing services for high-contact groups being particularly relevant to schools. Additional considerations and recommendations specific to schools are as follows:

#### **3.1.4.1 Considerations:**

- ▶ Data limitations (Office for National Statistics (ONS) hospitalisations data, attendance data etc) prevented a holistic analysis of the effectiveness of the schools testing service. Therefore, identifying clear, measurable endpoints and having existing data sharing agreements in advance may aid future evaluations and policy decision-making.
- ▶ Stakeholder workshops (involving school leaders, local authority public health and educational leads) and insights from qualitative research indicated that reporting test results to schools and NHSTT platforms was seen as time-consuming and confusing at times, with suggestions made regarding streamlining platforms and enabling multiple test result registration to incentivise higher reporting rates among pupils, staff and parents.
- ▶ Partnerships between schools, local authority public health teams and local education leads were seen as integral for the success of managing testing services within schools and the community. Case studies and best practice standard operating procedures (SOPs) may be considered for use among local authorities and schools where additional support is needed.

#### **3.1.4.2 Recommendations:**

- ▶ Timely and efficient dissemination of guidance, or updates to guidance, to enable school and local health protection teams to mobilise and operationalise actions.

## 3.2 The schools testing service evaluation sought to answer the following research questions

Did the schools testing service achieve its intended aims and purposes?

Our evidence review found that the service aims were nuanced differently across NHSTT, DfE (via the Testing Evaluation Report [7, 8] and stakeholder conversations), the government (through gov.uk briefings) [6, 9, 10] and UKHSA (where the aims were confirmed retrospectively through stakeholder conversations). Nuances specifically occurred in relation to what the aims were, whether these changed over time and in which order they were prioritised.

The aims largely fell into and were evaluated against three main categories:

- ▶ Increasing pupil/parent/teacher confidence in attending educational settings [7, 8]
- ▶ Reducing disruption, both in terms of face to face school days lost and parent/guardian days lost due to caring for a self-isolating pupil [7, 9, 10]
- ▶ Reducing community transmission and thereby reducing the pressure on healthcare settings and ultimately reducing the number of deaths

Increasing case detection was a key objective to support aims in all of the above categories [7, 9, 10].

In addition, was the schools testing service a cost-effective intervention?

Insufficient data were available to quantify an association between testing and the rate of change of prevalence, hospitalisations or deaths to explore this impact or feed into the cost-effectiveness analysis. As a result, we were unable to ascertain cost-effectiveness in the school setting in the way that we were able to for other settings (explained further in section 3.4.2.5). Instead, we have explored an uncertainty analysis that quantifies at which transmission effect size the schools testing service would have been cost-effective for:

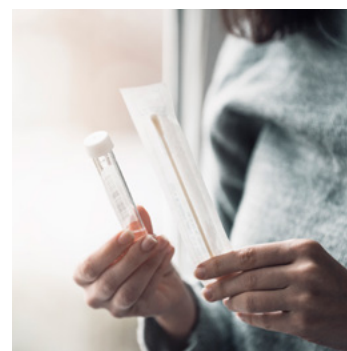
- ▶ Indirect effects: at what potential levels of fatality averted in the community would testing in schools be cost-effective?
- ▶ Direct effects: at what potential levels of fatality averted in school-aged children would the schools testing service be cost effective and what additional work would be needed to further ascertain these assumptions?

What were the behavioural barriers and facilitators to taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?

## 3.3 To evaluate whether the above aims were achieved, it is important to understand the context of the schools testing service between October 2020 and March 2022; we explored test volumes, overall cost, and set up and policy timelines, as well as the differences between distributed and reported tests

This contextual summary was developed through reviewing NHSTT and UKHSA documentation and via a participatory approach with UKHSA and DfE stakeholders who were involved in the schools testing service.

A ToC for the schools testing service and a ToC overlaid with a process map of how the testing worked can be found in appendix 3.2.



### Summary of key findings

- ▶ The schools testing service made up 25% of the total volume of LFD tests distributed and 16% of the total spend of the testing programme in England.
- ▶ The testing delivery mechanism was voluntary and for pupils initially began as an onsite model, with the use of LFDs to test all pupils, moving to home testing in March 2021.
  - ▶ Onsite tests were used at the start of school terms in September 2021 and January 2022.
- ▶ Of the LFD tests that were distributed, 22% were officially reported.
- ▶ The gap between tests distributed and tests reported increased over time as more tests were distributed.
- ▶ The number of tests reported per young person per week was well below both the adjusted and intended targets of the schools testing service; specifically, LTLA that had a larger proportion of people from ethnic minority groups or that were more-deprived reported fewer tests per person per week.

### 3.3.1 The schools testing service made up 25.1% of the total volume of LFD tests distributed and 15.5% of the total testing spend

There were 500 million LFD tests distributed for the schools testing service over the 18-month period from October 2020 to March 2022, representing 25.1% of the total number of LFD tests distributed for England (Table 3-1). Of these, 341 million were distributed for use in secondary schools and colleges. The average unit cost of an LFD distributed for the testing service in secondary schools and colleges was GBP 7.54 (compared with GBP 6.06 for the full national testing programme and GBP 11.68 for healthcare worker testing). Unit costs were calculated for the entire evaluation period. Unit costs include the purchase price of tests, as well as all other direct, indirect and overhead costs associated with the testing service, including the logistics, human resources and other costs to deliver a test to the point of care. Unit costs for the three priority services exclude support payment costs and laboratory set-up costs. It is important to note that the total unit costs were not the same for each service. The unit cost for the full evaluation period for each service depended on the point in time when tests were purchased and distributed for that service and the various logistical costs to deliver the tests. As expected, the procurement or purchase price of the tests decreased over time. For example, for LFDs, the purchase price decreased by more than half between September 2020 and March 2022; therefore, services that had a higher proportion of tests distributed later in the evaluation period (such as schools) would have benefited from lower purchase prices and increased technical efficiencies accrued. The average unit cost of LFD tests was higher for schools than for the whole testing programme, as the latter had greater volumes distributed later compared with the schools testing service. More details on unit cost calculations and comparisons of costs across services can be found in appendix 2.3.

The total financial cost of the schools testing service for the evaluation period was GBP 3.64 billion, of which GBP 2.59 billion was spent on testing in secondary schools and colleges (Table 3-2). The average total cost per pupil for the full duration of testing in secondary schools and colleges was calculated to be about GBP 600. As the intensity of testing fluctuated over time due to changes in guidance and periods of vacation, this value is an average total for the fourteen months that the schools testing service was operational (January 2021 to February 2022), including vacation periods.

Table 3-1. Number of LFDs distributed and PCR tests registered in England as part of the schools testing service (during the evaluation period).

Service	Description	Total number	Percentage of total (England)
<b>Schools (staff and pupils)</b>	Number of LFD tests distributed	500,091,900	25.1% (of all LFDs distributed in England)
	Number of PCR tests registered*	388,200	<0.5% (of all PCR tests registered in England under Pillar 2)
<b>Secondary schools and colleges (staff and pupils)**</b>	Number of LFD tests distributed	340,715,600	17.1% (of all LFDs distributed in England)
	Number of PCR tests registered*	321,400	<0.5% (of all PCR tests registered in England under Pillar 2)

\*Registered volume is estimated based on reporting proportions (see appendix 2.3 for details). For PCR, the volume of tests refers to those that were registered in order for an individual's result to be linked following laboratory analysis.

\*\*Secondary schools and colleges are a subset of the total schools testing service (see 'Definitions' section for details).

Table 3-2. Total financial cost of the schools testing service for England (during the evaluation period).

Service	Test type	Total cost (GBP)*	Percentage of total spend (England)†
<b>Schools (staff and pupils)</b>	LFD	3,619,753,000	15.43%
	PCR	20,472,500	0.09%
	Total	3,640,225,500	15.52%
<b>Secondary schools and colleges (staff and pupils)**</b>	LFD	2,569,634,700	10.95%
	PCR	16,091,800	0.07%
	Total	2,585,726,500	11.02%

\* Total financial costs for the schools testing service excluding isolation-related support and COMF (Containment Outbreak Management Fund).

\*\*Secondary schools and colleges are a subset of the total schools testing service (see 'Definitions' section for details).

† Percentage of the total is calculated against the total expenditure of testing in England, excluding isolation-related support.

Rapid asymptomatic testing was introduced onsite in secondary schools and colleges on 4 January 2021 [13]. The onsite asymptomatic testing service for schools was initiated in March 2021 over two weeks during the return of all pupils to schools following the end of the third national lockdown. Onsite asymptomatic testing was also implemented on return to schools in September 2021, following the summer holidays and in January 2022. Home self-testing was undertaken for the remainder of each term following the initial onsite tests. The overall schools testing service ended on 21 February 2022; exceptions after this end date included testing during outbreaks of COVID-19 and testing in SEND settings, which ended on 31 March 2022. Local health protection teams may still advise some targeted outbreak testing in residential SEND settings [14].

Initially, the service was planned for rollout across schools in January 2021, when it was assumed that pupils would return for the start of term; however, due to high rates of COVID-19 infection at the time and national lockdowns imposed, the wider service was pushed back to 8 March 2021. In January 2021, testing was available, through schools, for children of essential workers and vulnerable young people (see appendix 3.1 for a detailed policy timeline).

Secondary schools are allocated an average of GBP 5569 per child per annum by the DfE [15]. Therefore, to keep schools open, the testing service was the equivalent of approximately 9% of the average total DfE annual expenditure per pupil.



### 3.3.2 The testing delivery mechanism was voluntary and for pupils initially began as an onsite model, with the use of LFDs to test all pupils, moving to home testing in March 2021

Stakeholder interviews confirmed that the initial objective of the onsite testing model, rolled out in January 2021, was to remove as many positive cases as possible and reduce onward transmission and outbreaks in schools [13, 16]. Although this objective was still relevant throughout the testing service timeline (see appendix 3.1 for school-specific and general timelines), the objective to increase confidence among pupils, staff and parents to attend education settings became more of a focus, as restrictions on the wider population were eased.

Guidance for pupils advised that testing should be performed on the morning of a school day, with two tests spaced out over the course of the school week to ensure adequate coverage. In January 2021, staff were offered the option to begin twice-weekly testing at home and were encouraged to continue with this throughout the schools testing service timeline [13].

Confirmatory PCR tests for positive LFD tests were required throughout except for tests conducted onsite during March 2021, when they were temporarily suspended [17]. The decision to suspend confirmatory PCR tests after receiving a positive LFD test result at an ATS was justified by DfE (on DHSC's/UKHSA's behalf) as being because tests conducted under supervision usually have a minimal chance of being incorrect and so there is minimal need to further confirm the result [17]. Those testing at home who received a positive LFD result were still required to obtain a confirmatory PCR test within two days of receiving their positive LFD result [18]. Confirmatory PCR tests were later suspended for the general population, from 11 January 2022, due to the high prevalence of COVID-19 [19]. A press release from UKHSA at the time explained the decision as follows: 'during periods of high prevalence, it is very likely that a positive LFD test means you have COVID-19' [19].

Initial guidance in December 2020 [6] set out a weekly testing regimen for the school and college workforce. Additionally, pupils and the school/college workforce who were identified as having been in close contact with someone who had tested positive for COVID-19 within a school/college were required to take an LFD test at the start of each day for 7 days instead of self-isolating. If the LFD test returned a positive result, a confirmatory PCR test and isolation was necessary [20]. This guidance was based on initial suggestions by the Public Health Clinical Oversight (PHCO) team and results from modelling studies that showed an alternative to compulsory isolation of contacts [21-23]. A further pilot study of testing in schools in October 2020, funded by DHSC, illustrated the potential benefit of daily contact testing in secondary school and college settings [24]. This guidance was due to come into effect in January 2021. However, updated guidance was released on 20 January 2021, pausing daily contact testing due to the emergence of the new Alpha variant and the higher rates of secondary attack from this variant [25]. The pause was to allow experts to investigate whether daily testing was effective in the context of a new strain of the virus.

Daily contact testing was subsequently investigated later in 2021 for its efficacy versus that of self-isolation; this involved a large-scale, cluster-randomised controlled trial [26]. More than 200 schools participated in the trial. Overall, daily contact testing was found to be 'non inferior to self-isolation', with similar rates of symptomatic infections among pupils and staff seen with each approach. Daily contact testing was deemed a safe alternative to home isolation following a school-based exposure, in an attempt to reduce school absences [26]. In October 2021, following the publication of this study, schools were given the option of using this approach instead of sending close contacts home for isolation (see appendix 3.3 for further details).



### 3.3.3 Special schools, other specialist settings and primary schools

Separate guidance was published for special schools and other specialist settings, which included special schools, special academies, alternative provision settings, specialist units in mainstream schools and pupil referral units. This was broadly similar to the guidance for mainstream schools; however, greater flexibility was advised for these settings to allow schools to choose the most appropriate way for pupils and their families to participate in onsite and home testing [27]. Alternative testing methods were explored for pupils with SEND, to identify whether there was an easier or more acceptable form of testing, such as LAMP (loop-mediated isothermal amplification) tests that involved collecting saliva samples instead of swabbing; however, according to a DHSC technical report on COVID-19, it was deemed challenging to deploy LAMP testing at scale and so it was not rolled out on a wider basis [28].

Asymptomatic testing of primary school-aged children was not advised due to the limited public health benefits attached to testing primary pupils at the time. It was considered that such young children may have found the sampling process too invasive or unpleasant to tolerate regular testing [29]; however, symptomatic testing may have been performed if a child's parent/carer was comfortable taking the sample. Staff in primary school-based nurseries and maintained nursery schools were given the opportunity to participate in self-testing through the distribution of home testing kits to their educational site.

#### Case study: Alternative testing methods for younger pupils or pupils with special educational needs can increase acceptability, as demonstrated in Germany

Germany utilised 'lollipop' PCR tests for young children and children attending special schools, which involved children having to suck on a swab for at least 30 seconds without the need for throat or nasopharyngeal swabbing. The method was rolled out among young children at the end of January 2022, as testing was mandatory for day care and school children [30]. Prior to this, a pilot feasibility study conducted in German primary and special schools found high levels of acceptance among stakeholders for the lollipop method, and respondents considered it to be simpler and more child-friendly compared with the anterior nasal antigen rapid test [31].

Schools in England most commonly used rapid LFD tests for the testing service; however, for some pupils with special educational needs or for smaller/younger pupils, there were difficulties in administering these tests due to the discomfort experienced or the dexterity needed by the pupil [32]. Although alternative testing methods were explored, e.g., LAMP tests, these were also deemed challenging for pupils with SEND and, as mentioned above, deemed challenging to deploy at scale [28].

The example of alternative testing methods demonstrated in Germany and the difficulties in testing young people with SEND may warrant further research to identify the most acceptable and effective testing method in this population. It is recognised that between countries there may be differences in laboratory performance testing and approval processes, which would need to be taken into consideration when comparing testing methods.

CASE STUDY

### 3.3.4 Of the LFD tests that were distributed, 22% were officially reported, with potential reasons for this low level of reporting highlighted in appendix 3.3

The volume of tests reported may reflect changes in the volume of tests conducted over time within the schools testing service. However, the volume of tests conducted cannot be measured directly and there are likely to be multiple factors that influence changing reporting rates over time. Figure 3-1 and Figure 3-2 show the volumes of LFD and PCR tests, respectively, reported in English schools throughout the evaluation time period.

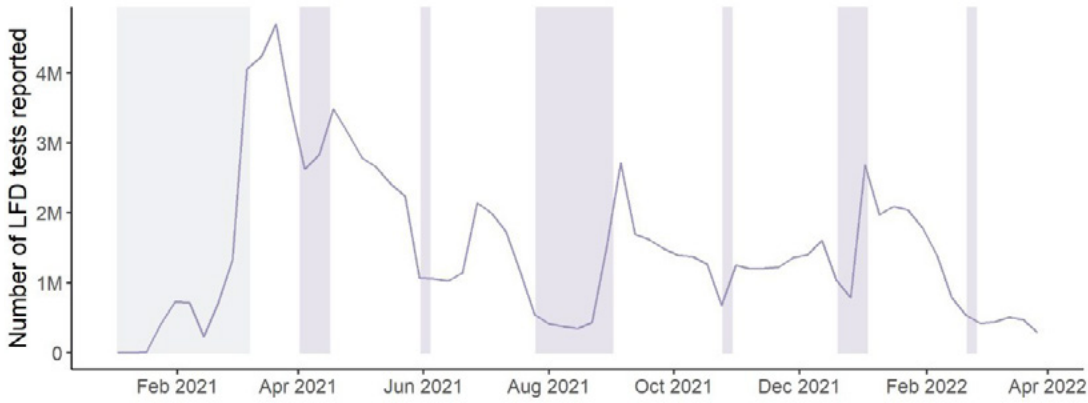


Figure 3-1. Volume of LFD tests reported as part of educational testing programmes in England by week (millions).

School holidays and restrictions on face to face education are indicated by the vertical purple and grey bars, respectively.

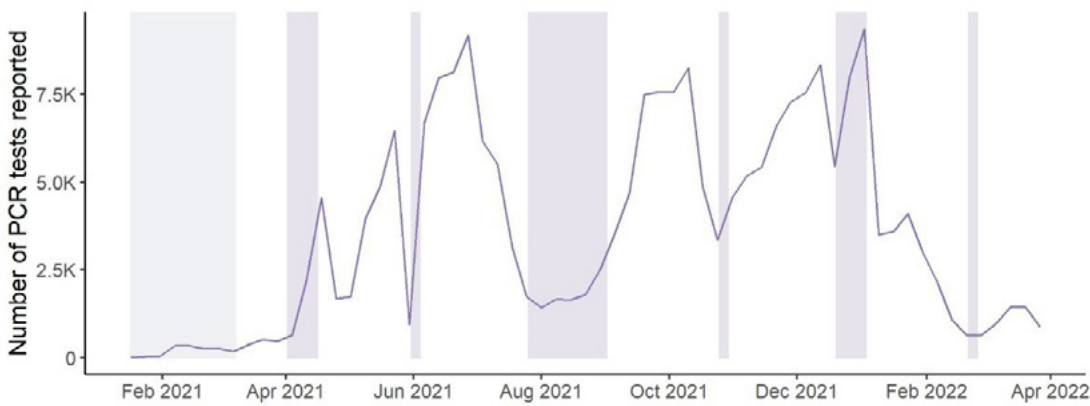


Figure 3-2. Volume of PCR tests reported as part of educational testing programmes in England by week (thousands).

School holidays and restrictions on face to face education are indicated by the vertical purple and grey bars, respectively.

The gap between tests distributed and tests reported increased over time as more tests were distributed, with 22.2% of all distributed LFD tests reported. It was not possible to compare the number of LFD kits dispatched with the number of LFD tests conducted in educational settings, because tests were counted when they were sent out rather than when they were registered by the user [33].

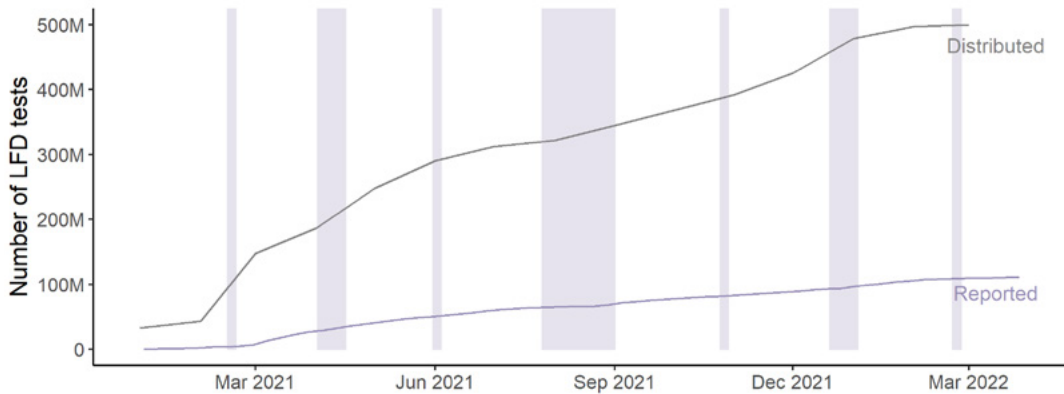


Figure 3-3. Cumulative volume of LFD tests distributed and reported as part of educational testing programmes over time. School holidays are indicated by the vertical purple bars.

The number of LFD tests reported for schools was a small proportion of the total distributed, reflecting a combination of tests distributed but not taken, tests taken that were not reported, or tests taken that were reported but they were not reported as relating to the schools testing service (Figure 3-3).

The cumulative volume of PCR tests registered and reported for schools has not been included in this report, as the vast majority of the schools testing service was conducted using LFD testing. Symptomatic testing using PCR tests was available to the general population. While some PCR testing was conducted in the schools testing service, the volumes were comparatively extremely small (just 366,500 PCR tests were reported through the schools service) and only intended for use in exceptional circumstances, such as a pupil or staff member experiencing barriers to accessing a PCR test elsewhere [34]. Furthermore, it was difficult to match the PCR tests reported to those registered due to a lack of appropriately detailed data categories. It should be noted that, in general, those experiencing symptoms would access PCR testing through the general public testing scheme.

### **3.3.5 The number of tests reported per young person per week was well below both the adjusted and intended targets of the schools testing service; specifically, lower-tier local authorities (LTLAs) that had a larger proportion of people from ethnic minority groups or that were more deprived reported fewer tests per person per week**

The number of tests reported relative to the number of school-aged young people in each LTLA (Figure 3-4) varied substantially between LTLAs and was highest in late March 2021, when pupils returned to schools and the schools testing service began. The target testing rate for young people at school was set at two tests per pupil per week [35]. The two-tests-per-week target related to young people in school at the time and has been adjusted down to account for the proportion of attendance in schools each week, shown as a dashed line in Figure 3-4. Data for attendance in schools were not available for every week for every LTLA; only data from a sub-sample of schools were available during the evaluation period covered in this report. The rate of test reporting per young person per week in each LTLA was approximately 1.0 at the highest point, in April 2021 (Figure 3-4) and was lower than the adjusted weekly target rate (target adjusted for potential absenteeism) for all time periods shown. Following a peak at the beginning of each term (partly due to onsite testing), reporting rates steadily decreased over time, decreasing by approximately two thirds between the beginning and the end of terms. Similar patterns were observed in Figure 3-1 and Figure 3-2 for the numbers of LFD and PCR tests reported, respectively, which suggests either a decrease in participation in testing among pupils as term-time progressed or a decrease in reporting of test results as term-time progressed.

While tests reported remained consistently below the target, the gap between the target and actual testing decreased immediately following a school holiday period (Figure 3-4). As already mentioned, this could be a result of onsite testing on return from holidays, with higher rates of participation and reporting rates.

The analysis of testing in school-aged young people was performed at the LTLA level<sup>2</sup>, as a proportion of the reported test volume came from records that had school names missing and because school-level data for attendance (required to calculate coverage at school level) were not available. Thus, we were unable to explore any schools-related characteristics associated with test coverage (reported number of tests per week per young person per LTLA), as it was not possible to link the data at the school level with testing data, which were available at the LTLA level. Therefore, we explored the variation in test coverage by LTLA characteristics only. The median test coverage was lower in local authorities with higher proportions of people from ethnic minority groups (see appendix 3.4). Similarly, the median test coverage was lower in areas with a high-deprivation index (lower IDACI (Income Deprivation Affecting Children Index) deciles). Both relationships were consistent across the time period evaluated.

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<sup>2</sup> The calculation of a key metric of interest, test coverage (number of tests taken per young person per week), required information regarding school size (number of young people per school) and pupils' attendance. It was not possible to estimate this at the individual school level, because linking data reported in Pillar 2 (that included site names and school names) to other databases with specific school characteristics was deemed not feasible as the site ID was either null/not recorded in a proportion of rows of the testing data, although the individual was recorded to be of school age. We were therefore concerned that calculating testing coverages at school level (if this were possible via matching) could substantially under-represent true coverages. Further key covariates that needed to be adjusted, such as REACT prevalence, vaccination coverage among 11-18-year-olds, and the proportion of different variants in circulation were also available at the LTLA level. For all of these reasons, the schools analyses were carried out at the LTLA level rather than the individual school level.

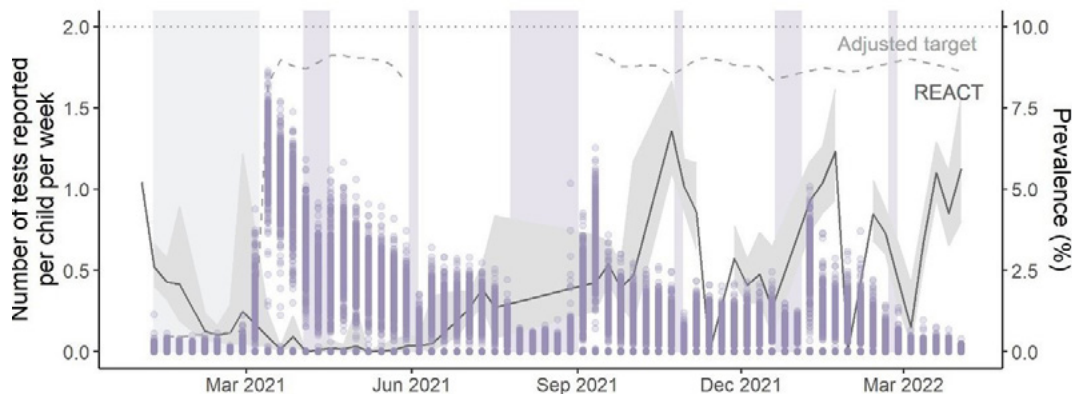


Figure 3-4. Number of LFD tests reported per week relative to the number of school-aged young people in each English lower-tier local authority (LTLA).

Denominator: number of young people aged 11 to 18 years resident in each LTLA. School holidays and restrictions on face to face education are indicated by the vertical purple and grey bars, respectively. The grey solid line and the shaded area around it show the estimated prevalence of COVID-19 infection in young people aged 12 to 17 years in England, based on REACT study data, with an associated 95% credible interval (right-hand y-axis). The adjusted target number of tests per young person per week, taking into consideration the average proportion of school attendance each week, is shown as a dashed line. The crude target was two tests per young person per week. Each of the mauve dots represents data from an LTLA aggregated on a weekly basis.

### 3.4 Results of the evaluation

#### Summary of key findings

Did the schools testing service fulfil its UKHSA intended aims? Was the schools testing service a cost-effective intervention?

Despite the gap between distributed and reported tests, the schools testing service did achieve its UKHSA intended aims and purposes in the following areas:

- ▶ The aim of increasing confidence in returning to face to face education settings was achieved, according to observations reported in the behavioural and qualitative literature.
- ▶ Schools testing is associated with enhanced case-finding.

Inconclusive results were observed in the following areas, predominantly due to the limitations with the schools data (see 'Data limitations' section above):

- ▶ Our statistical results relating to whether the schools testing service led to a reduction in hospitalisations and deaths in the general population are inconclusive; more data would need to be captured to conduct real-time studies to be able to analyse this statistically.
- ▶ We were not able to evaluate whether the schools testing service reduced face to face days lost due to self-isolation.
- ▶ Linked to this, we were unable to provide robust evidence for causal effects but we have conducted some modelling on the impact of false-positive results on unnecessary self-isolation.

We were unable to ascertain cost-effectiveness in the schools setting in the way that we were able to for other settings (explained further in section 3.4.2.5).

We conducted two uncertainty analyses of key drivers of potential indirect and direct effects of the schools testing service:

- ▶ Indirect effects: we predict that the testing service in secondary schools and colleges would be cost-effective in terms of QALYs gained if it reduced new infections by more than 3% (at a willingness to pay threshold of GBP 70,000); we assess 3% to be within a plausible range for transmission reduction.

SUMMARY



- ▶ Direct effects: our crude/indicative analysis suggests that the testing service in secondary schools and colleges would be cost-effective in terms of QALYs gained at an assumed incidence of 85 per 1000 population, an IFR of approximately 0.06% and a direct reduction in new cases of 25% through asymptomatic testing in schools.

What are the behavioural barriers and facilitators to taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?

**We determined from retrospective data that:**

- ▶ Support provided to the education sector, specifically in relation to training and guidance, was useful for reassuring pupils, parents and staff.
- ▶ Setting up and running an ATS within schools was resource-intensive; therefore, financial and logistical support was crucial for ATS rollout.
- ▶ Taking a test at home increased between March 2021 and July 2021, while at-school testing decreased; however, a minority of pupils felt concerned about self-testing at home.
- ▶ Establishing stronger partnerships between local health authority teams and schools enabled systems for reporting outbreaks and receiving support to be set up.
- ▶ Reporting results via both school and NHSTT platforms was burdensome for some parents and pupils.
  - ▶ Consequences following a potential positive test result were a barrier to testing for some families.
  - ▶ Pupils from more-deprived areas may need more support to test in any future pandemic [3, 4].

### 3.4.1 The schools testing service did achieve its UKHSA intended aims and purposes in the following areas

Synthesised qualitative evidence (see appendix 3.3) supports the assertion that the schools testing service increased confidence in returning to face to face education settings. Generally speaking, parents considered the schools testing service to be a valuable tool to provide reassurance, highlighting the value that carers placed on testing as an intervention. However, it appears that this opinion waned over time, which could have been due to a number of factors, including the vaccine rollout, increased immunity through prior infection and increased concern about missed education.

Parents considered the value of testing to include the reassurance that they were not infected and so would not infect others [36]. A survey of approximately 2100 adults per epidemic wave in England highlighted that the lowest point of confidence among parents in relation to whether face to face education was safe was at the start of the December 2020 national lockdown, with just 25% of adults stating that they felt it was safe for their children to return to school. An upward trajectory in the perception of safety in schools was observed from early January 2021, coinciding with the announcement of the asymptomatic testing rollout in schools [37].

Staff also agreed that testing reduced the risk of school closures [3]. Furthermore, school stakeholder interviews conducted by the evaluation consortium highlighted the importance of the testing service as a point of reassurance for staff returning to face to face education, especially for those who may have been at higher risk or had family members who were high-risk individuals.

**Case study: The focus on keeping schools open without a targeted schools testing service may come at a cost for staff reassurance, ultimately impacting attendance – an example from France**

According to UNESCO data on global school closures, France had one of the lowest, if not the lowest, total durations of their schools closed (12 weeks) when compared globally [38]. Testing among school-aged young people in France relied upon accessing universal mass testing programmes rather than setting up a school-specific testing service. This approach became particularly burdensome for pharmacies and testing laboratories during periods of high prevalence in the community and schools [39]. Later in the pandemic, the focus turned instead to vaccinating young people, with different testing and isolation procedures dependent on the young person's vaccination status [40].

In January 2022, it was reported that schools in France were under pressure, with discontent among staff and teachers who felt their safety had not been considered due to inadequate measures in place within schools [39]. This ultimately led to strike action from teachers and school closures, in protest against the handling of the COVID-19 crisis [41].

Consideration: A key factor for the asymptomatic testing service in English schools was to ensure that not only pupils and parents felt safe and reassured to return to schools but also that teachers and staff felt protected, to enable them to teach pupils face to face. Qualitative insights, both from user research and external stakeholder conversations, suggest that the schools testing service achieved this goal of reassurance while also keeping rates of transmission low in schools. A study conducted in the US went further, suggesting that the use of 'test to stay' strategies, much like that of the English strategy, led to a dramatic reduction in the numbers of missed days of school while also keeping the risk of in-school transmission at low levels [42].

**3.4.1.1 Schools testing is associated with enhanced case-finding**

A series of analyses were performed to determine the estimated association between test coverage and the identification of asymptomatic cases (the green line in Figure 3-5). Potential confounders were adjusted in the regression models (either through stratification or adding as a covariate in the models), for all of the variables indicated by the pink dots in the causal diagram (Figure 3-5), to obtain a debiased estimate of testing as an intervention from all of these other influencing factors.

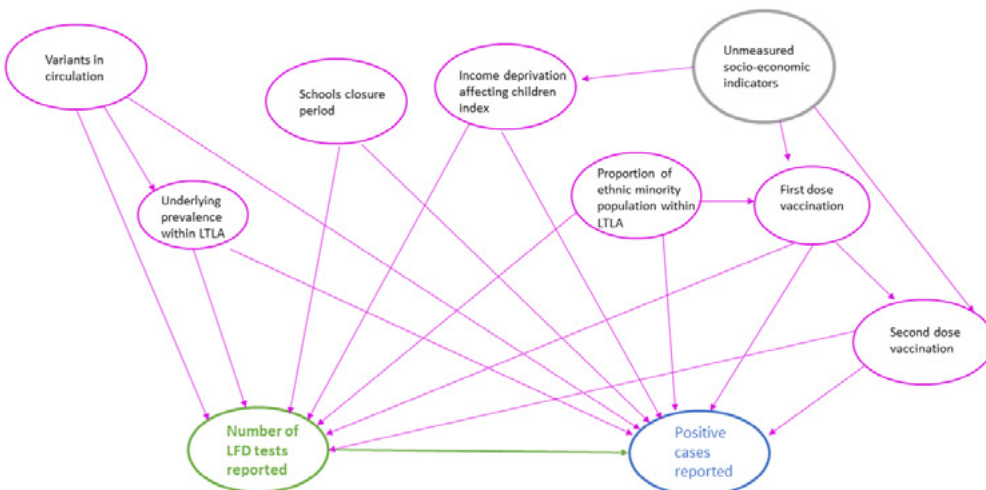


Figure 3-5. A diagram depicting assumed causal pathways that can lead to biased associations between the reported number of LFD tests and the reported number of positive cases is presented here for replication: <http://dagitty.net/mBrv8SI>.

The pink pathways represent the biasing pathways/backdoor pathways that could lead to a biased association between the reported number of LFD tests in a given LTLA per week and positive cases reported. The biased pathways were blocked using the regression model presented in Table 3-3. The main exposure of interest (reported number of LFD tests in a given LTLA per week) is shown in green, the outcome

(number of positive cases reported) is shown in blue, and grey represents unmeasured variables (or unavailable variables). The green arrow represents the causal pathway of interest.

The analysis was also split into four distinct time blocks to enable the observation of changes between key underlying policy changes in the schools testing service or school calendar and to account for periods of restrictions on face to face education (also see appendix 3.1 for general and school-specific policy changes):

- ▶ **Time period 1:** onsite testing during March 2021
- ▶ **Time period 2:** start of the schools testing service until the summer holiday, April to July 2021
- ▶ **Time period 3:** return from the school summer holiday until the Christmas holiday, September to December 2021
- ▶ **Time period 4:** pupils return to school until the end of the evaluation period, January to March 2022

Table 3-3 shows the results of the analysis.

**Table 3-3. Regression analysis of the number of positive LFD tests reported, with regression coefficients from hierarchical linear models across the four time periods.**

	Time period 1	Time period 2	Time period 3	Time period 4
<b>Variable</b>	Estimate [95% CI] <sup>a</sup>	Estimate [95% CI] <sup>a</sup>	Estimate [95% CI] <sup>a</sup>	Estimate [95% CI] <sup>a</sup>
<b>Test volume of reported LFDs per week</b> (% change in positive tests for every 1% increase in reported test volume)	0.756*** [0.686 to 0.828]	0.838*** [0.784 to 0.89]	0.758*** [0.724 to 0.794]	0.848*** [0.823 to 0.872]
<b>Community prevalence</b> (% change in positive tests for every 1% increase in prevalence)	0.405*** [0.343 to 0.466]	0.536*** [0.504 to 0.568]	0.833*** [0.794 to 0.87]	0.500*** [0.455 to 0.543]
<b>IDACI</b> (% change in positive tests for each 1-decile increase in IDACI)	-0.095*** [-0.119 to -0.071]	-0.086*** [-0.103 to -0.068]	-0.031*** [-0.044 to -0.019]	-0.080*** [-0.092 to -0.068]
<b>Proportion of cases of the Alpha variant</b> (% change in positive tests for each 0.1-unit increase in proportion)	<sup>b</sup>	<sup>b</sup>	0.058* [-0.01 to 0.126]	0.589** [0.032 to 1.147]
<b>Proportion of cases of the Delta variant</b> (% change in positive tests for each 0.1-unit increase in proportion)	0.050 [-0.006 to 0.106]	-0.007 [0.007 to 0.035]	0.02 [-0.096 to 0.023]	0.576** [0.009 to 1.124]
<b>Percentage of BAME population</b> (% change in positive tests for each 10 percentage point increase)	-0.015 [-0.049 to 0.019]	-0.0001 [-0.025 to 0.025]	-0.018** [-0.035 to -0.001]	-0.026*** [-0.092 to -0.067]
<b>Cumulative first dose vaccination coverage</b> (% change in positive tests for each 0.1 unit increase in the proportion of the 11-18-year-old population vaccinated)	-0.258 [-2.931 to 2.498]	0.842** [0.181 to 1.506]	-0.104*** [-0.129 to -0.078]	0.043** [0.005 to 0.081]
<b>Cumulative second dose vaccination coverage</b> (% change in positive tests for each 0.1 unit increase in the proportion of the 11-18-year-old population vaccinated)	-	-1.422 [-3.226 to 0.413]	-0.714*** [-0.908 to -0.518]	0.052** [0.009 to 0.095]

<sup>\*</sup>p < 0.1; <sup>\*\*</sup>p < 0.05; <sup>\*\*\*</sup>p < 0.01

Dependent variable: log (number of positive tests reported).

BAME: black, Asian and minority ethnic.

IDACI: Income Deprivation Affecting Children Index. Decile 1 represents the most deprived 10% of lower-layer super-output areas (LSOAs) nationally, and decile 10 represents the least deprived 10% of LSOAs nationally. As the unit of analysis was LTLA per week and IDACI was available at LSOA levels, the median value of this index across the LSOAs within each LTLA was used for the analysis.

Model 1: asymptomatic testing site (ATS) testing phase, March 2021; Model 2: April-July 2021; Model 3: September-December 2021; Model 4: January-March 2022.

<sup>a</sup>95% confidence interval (CI) computed based on profile likelihood using the "confint" R function.

<sup>b</sup> Proportion of the Alpha variant was 0 or missing during periods 1 and 2, leading to rank deficiency and hence was dropped from these models.

The key messages from this regression analysis are as follows:

**There was a positive association between test coverage and identification of positive cases for all time-periods observed**

Overall, the regression coefficients for the test coverage variable (test volume) were positive, meaning that a higher number of tests reported was associated with increased numbers of positive LFD results reported, as one would expect. Overall, the associations between the reported volume of LFD tests and the number of positive cases reported across the time periods of the evaluation were statistically significant and represented a consistent effect size with relatively small standard errors (Table 3-3).

During the ATS testing phase, each 1% increase in test volume was associated with a 0.756% (95% confidence interval (CI): 0.686%-0.828%) increase in the number of positive tests reported.

Similarly, during the second time period, each 1% increase in test volume was associated with a 0.838% (95% CI: 0.784%-0.890%) increase in the number of positive tests reported; during the third time period this was 0.758% (95% CI: 0.724%-0.794%); and during the fourth time period this was 0.848% (95% CI: 0.823%-0.872%).

Although testing was associated with enhanced case-finding, it is difficult to say whether more testing (at or closer to target levels) would have led to greater benefits. This is because we cannot definitively say whether testing targets were achieved, as the data currently show the numbers of tests reported were lower than the numbers of tests distributed, and it may be that testing rates were higher but just not reported. Therefore, we have been able to describe what we were able to confidently observe in the data, i.e., that within the range of test volumes reported, we saw greater case detection with greater reporting. We cannot extrapolate beyond that range and say, for example, what the impact might have been had daily testing been performed and all tests reported.

**Community prevalence was significantly associated with increased numbers of positive cases in all four time periods**

The community prevalence (defined using the REACT prevalence data [39]) was found to be significantly associated with increased numbers of positive cases reported during each of the four time periods modelled. On average, each 1% increase in community prevalence was associated with an increase in positive LFDs reported of between 0.41% and 0.83%.

**There was an association between the Income Deprivation Affecting Children Index (IDACI) and the reported number of positive LFD results, with areas of higher deprivation showing more positive results**

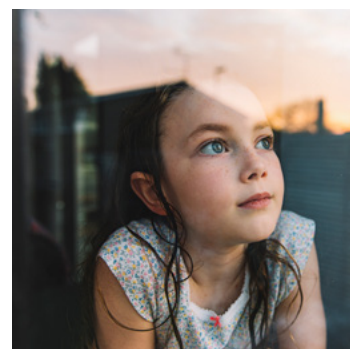
IDACI deciles were consistently and significantly negatively associated with the identification of positive cases, showing that in areas of greater deprivation (lower IDACI deciles) more positive cases were reported.

Associations between other covariates and the reported numbers of positive LFD test results were not consistent across the four time periods

The association between the proportion of individuals from ethnic minorities in a population and the number of positive cases reported was not consistently significant across the four models (i.e., the association was non-significant across the first three periods and was negative in the fourth period, with a negative coefficient that was statistically significant). Similarly, the effect of cumulative doses of vaccination was not clear.

**3.4.2 Inconclusive results were observed in the following areas; we provide reasons for this and explain the supplementary analyses we conducted**

3.4.2.1 Our statistical results relating to whether the schools testing service led to a reduction in hospitalisations and deaths in the general population are inconclusive; more data would need to be captured to conduct real-time studies to be able to analyse this statistically



Enhanced case-finding is effective if those cases are isolated and their downstream impact is mitigated. However, this observed relationship (presented above) between community prevalence and increased detection of positive LFDs cannot necessarily be interpreted as a causal effect. The estimation of indirect effects of testing in schools on hospitalisations and deaths in high-risk groups requires a detailed knowledge of the causal chain of effects. For example, we would need a causal effect of schools testing on preventing further transmission of COVID-19 to vulnerable relatives. This would require rich data at a household level, along with data on test positivity results in elderly relatives. Such estimation would require an appropriate characterisation of the causal chain of events, i.e., the assertion that young people at school are drivers of onward transmission of infection within each household. Reverse causation cannot be ruled out, as parents and other elderly relatives might have passed the infection to their children. Assessment of such temporality of the sequence of events was beyond the scope of this work, due to a lack of such data which would have needed to be collected at the time; furthermore, such assessments are best conducted in real-time as part of a prospective study, when data relating to the sequence of events can be gauged. Therefore, our evaluation cannot provide any causal links regarding the reduction of hospitalisations and deaths in the general population as a result of the schools testing service. We have instead explored an uncertainty analysis in section 3.4.2.5.

### **3.4.2.2 We were unable to evaluate whether the schools testing service reduced face to face days lost due to self-isolation**

Absenteeism data were only available for a subset of schools in England and not accessible at the granularity required (e.g., by school, by week) within the timeframe of the evaluation, to measure impact. The primary research question was to determine how many face to face school days were lost through self-isolation as a result of schools testing. Attendance data available at LTLA level were deemed not suitable for modelling this, as assessing the direct impact of test results on absenteeism required the number of positive tests reported at the level of individual schools. Aggregate data at the LTLA-level would have masked the (likely large) inter-school variation. Furthermore, a proportion of the reported test volume came from records with missing school names. Therefore, the available absenteeism data could only be used to estimate a revised target for testing within schools, with no further analysis possible. However, while complete absenteeism data were not available in time for this evaluation, the evaluation consortium did conduct an analysis of the estimated number of false-positive LFD test results, using sub-sample data on LFD positive results with a subsequent confirmatory PCR test result available (Table 3-4), as false-positive results may have resulted in unnecessary self-isolation. The sub-sample dataset was used to estimate the conditional probability of testing positive by PCR if receiving a positive LFD test result, and this was used to estimate the number of false-positive results. Further descriptions of these paired data are provided in section 3.4.2.3 and appendix 3.4. The weekly estimate of the false-positive proportion provided in appendix 3.4 was applied to the Pillar 2 data to estimate the proportion of reported LFD positives that were likely to be false-positive results. Overall, this analysis suggested that an estimated 35.8% of all the positive LFD tests among young people aged 11 to 18 years returned false-positive results during time period 1. The corresponding estimates for time periods 2, 3 and 4 were 17.6%, 11.9% and 12.7%, respectively (Table 3-5).





Table 3-4. Paired data for cases positive by LFD with a confirmatory PCR test taken within 3 days of the LFD test among young people aged 12 to 17 years.

Time period	Total LFD positive cases with confirmatory PCR tests performed	LFD positives that were also positive by PCR	Proportion of LFD positives that were also positive by PCR	Proportion of positive LFDs that were false-positive by PCR
<b>Prior to ATS period</b> (Jan-Feb 2021)	26	20	76.9%	23.1%
<b>Time period 1</b> (March 2021)	3968	2645	66.7%	33.3%
<b>Time period 2</b> (April-July 2021)	27,927	23,747	85.0%	15.0%
<b>Summer break</b> (Aug 2021)	2974	2794	93.9%	6.1%
<b>Time period 3</b> (Sep-Dec 2021)	142,657	125,111	87.7%	12.3%
<b>Christmas break</b>	20,367	17,629	86.6%	13.4%
<b>Time period 4</b> (Jan-Mar 2022)	34,742	30,460	87.7%	12.3%

Table 3-5. Estimated number of false-positive LFD test results among school-aged young people (11-18 years) in England.

Period	Reported number of LFD positives	Estimated number of LFD positives that were likely to be false-positives	Estimated number of LFD positives that were likely to be false-positives (lower bound)	Estimated number of LFD positives that were likely to be false-positives (upper bound)
<b>Time period 1</b> (March 2021)	18,291	6543 (35.8%)	5852 (32.0%)	7236 (39.6%)
<b>Time period 2</b> (April-July 2021)	127,466	22,400 (17.6%)	19,308 (15.1%)	25,733 (20.2%)
<b>Time period 3</b> (Sep-Dec 2021)	403,722	48,008 (11.9%)	45,322 (11.2%)	50,946 (12.6%)
<b>Time period 4</b> (Jan-Mar 2022)	757,256	96,357 (12.7%)	87,838 (11.6%)	105,771 (14.0%)

Table 3-5 includes data from Pillar 2 testing of any young person aged 11 to 18 years; it also includes anyone within this age band regardless of missing channel indicator. Data on staff and household bubble groups were not included in this evaluation. Data from weeks during which the correction factor was not available were excluded from this table. The lower (upper) bound represents the 2.5% (97.5%) posterior quantile.

### 3.4.2.3 Linked to this, we were able to review how much unnecessary self-isolation took place as a result of false-positive results, based on the data made available to us

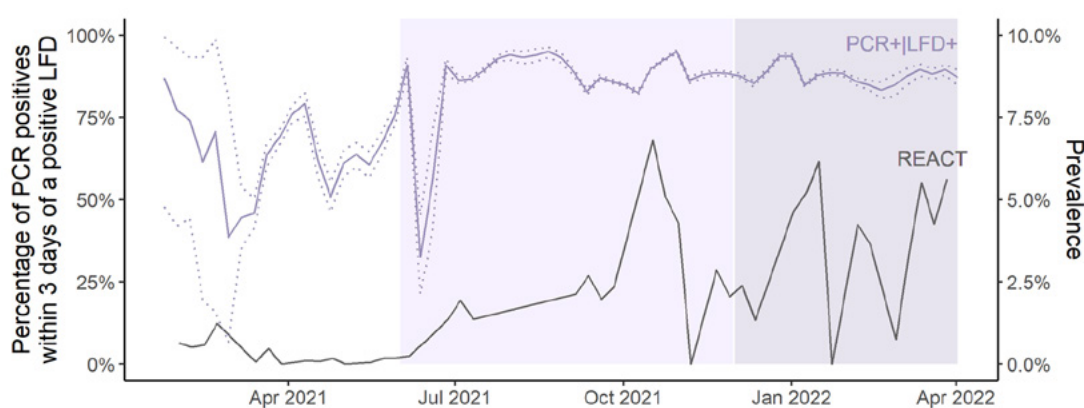
A sub-sample of data was available for analysis, comprising details of young people aged 12 to 17 years who tested positive by LFD and who had taken a PCR test within three days of receiving their positive LFD result. These paired data were available for 232,661 cases positive by LFD (Table 3-4).

The age range for this analysis was chosen to align with the age range for the REACT prevalence estimates, which include a 12- to 17-year-old age group. This dataset was used to estimate the conditional probability of testing positive by PCR if a young person reported a positive LFD test result (referred to as the positive proportion). This positive proportion is presented in Figure 3-6, along with the overall prevalence estimates among 12- to 17-year-olds from the REACT study. The complement of the

positive proportion was used as a correction factor to estimate the number of false-positive LFD test results (referred to as the false positivity rate). A summary of the data is presented with further weekly details in appendix 3.4.

Overall, there was initially a wide variation in the positive proportion (from January 2021 until August 2021); after August 2021, the positive proportion remained relatively stable, at approximately 80% (Figure 3-6). When aggregating these data separately across the four time periods considered in this evaluation, during time period 1, 33.3% of the positive LFD results were confirmed to be false-positive results by PCR (Table 3-4). A previous estimation among secondary school pupils who had tested positive by LFD found that 38% (4-10 March 2021) and 45% (11-17 March 2021) were false-positives, based on their PCR results [44]. Compared with time period 1, the proportions of LFDs that were confirmed by PCR to be false-positives were lower for the subsequent time periods, with false-positive proportions of 15.0%, 12.3% and 12.3% during time periods 2, 3 and 4, respectively (Table 3-4). We were not able to identify the reasons for the difference as the estimation of false positivity will be affected by the sensitivity and specificity of available diagnostic tests, the viral concentration, the symptomatic status of the infection [45] and the underlying disease prevalence. On average, during periods of low community prevalence, e.g., between April and June 2021, the probability of a young person aged 12 to 17 years testing positive by PCR was relatively low compared with periods of high community prevalence, e.g., July to October 2021. This follows algebraically that during periods of low prevalence, a larger proportion of positive LFD tests will be false-positive results compared with the proportion of false-positive test results obtained during periods of high community prevalence. These findings can be compared against theoretically expected positive proportions (positive predictive values) for a given value of sensitivity and specificity of LFDs. If the LFD sensitivity and specificity are assumed to be 40% and 99.8%, respectively, then at a disease prevalence of 5%, one would expect the positive predictive values to be 91.3%. For the same sensitivity and specificity, at 0.5% and 1% disease prevalence, the expected positive proportions would be 50.1% and 66.9%, respectively.

We understand that the range reported for LFD specificity can vary from 100% to 99.72%.<sup>3</sup> Further to this and based on real world analysis and post-market surveillance, UKHSA has published and has referenced an estimate of LFD specificity of 99.97% along with estimates of PPV at varying rates of disease prevalence.<sup>3</sup> However, for the purposes of this evaluation a conservative figure of 99.8% was used.<sup>4</sup> It is worth noting that if a higher specificity was used (e.g. 99.97%), the Positive Predictive Value (PPV) would have increased as indicated in the UKHSA post-market report,<sup>3</sup> potentially increasing the cost effectiveness overall.



**Figure 3-6. The probability of testing positive with a confirmatory PCR test, among young people aged 12 to 17 years, conditional on testing positive with an LFD. The shaded bands represent phases during which different variants were dominant. The solid line for PCR+|LFD+ represents the median value, and the dotted lines represent 2.5% to 97.5% posterior intervals.**

The false-positive rate presented in Figure 3-6 was applied to aggregated numbers of positive LFD results reported each week by a given LTLA. The estimated number of positive LFD results that were subsequently found to be false-positives by PCR is

<sup>3</sup> Lateral flow device specificity in phase 4 (post-marketing) surveillance – GOV.UK ([www.gov.uk](http://www.gov.uk))

<sup>4</sup> Sheila M. Bird, Covid Tests in Secondary Schools: A Statistical Cause Célèbre, Significance, Volume 18, Issue 3, June 2021, Pages 42–45, <https://doi.org/10.1111/1740-9713.01535>

presented separately across the four time periods (Table 3-5). During time period I (ATS testing phase), 35.8% (32.0% to 39.6%) of the positive LFD results were estimated to be false-positives. The corresponding estimates for the subsequent time periods were 17.6%, 11.9% and 12.7% (Table 3-5). An economic evaluation was performed based on these estimates of false-positive LFD results and is discussed in the next section.

#### 3.4.2.4 Economic impact of positive and false-positive tests

We were unable to evaluate whether the schools testing service reduced face to face days lost due to self-isolation (see the 'Data limitations' section at start of this chapter) and hence did not compute the economic impact of reduced parent absenteeism due to the testing service.

We considered the economic impact of false-positive LFD results, as reported above. Among 11- to 18-year-olds, 743,500 school days were lost due to false-positive results during the entire evaluation period (Table 3-5). This represents 0.06% of the total number of school days in a typical 18-month period. The number of days lost to false-positive results equated to a loss of productivity among parents of GBP 42 million over the 18-month period. This used a weighted average number of isolation days based on the guidance over time, assuming 65% of those testing positive by LFD would take a confirmatory PCR test and correcting for isolation periods falling over weekends. However, the schools testing service covering 11- to 18-year-olds also identified 1.2 million true-positive cases, at a total cost of GBP 2.59 billion. Therefore, the cost for each true-positive case identified was GBP 2100 per case identified. While these costs appear high, it should be noted that the identification of these positive cases would have had a greater impact than simply the immediate outcome of the cases found, as teenagers represent a high-contact group and would have led to a higher number of infections in the community. Assumptions and calculations are presented in appendices 2.3 and 3.5. The economic impact of false-positive results has been built into the economic analysis below.

It is also worth noting, as outlined in the previous section above, that if a higher specificity was used, the PPV would have increased, impacting the cost effectiveness analysis.

#### 3.4.2.5 Due to insufficient data, it was not possible to conduct a cost-effectiveness analysis of the schools testing service in a way that was consistent with the cost-effectiveness analyses we conducted for the other services. Instead, we chose to explore an uncertainty model, which has predicted that the schools testing service would have been cost-effective in terms of indirectly averting hospitalisations and deaths in the community if it had reduced community transmission by more than 3%

While there was a lack of data available to enable a statistical evaluation of the indirect connection between schools testing and reductions in wider community transmission, we conducted an uncertainty analysis to explore the potential indirect effects of testing secondary school children on new cases in the community, by modelling the impact of a series of hypothetical scenarios of reductions in new cases in the community (explored in Table 3-6).

**Table 3-6. Uncertainty analysis of the cost-effectiveness of the testing service in secondary schools and colleges, at various assumptions of testing effectiveness on reducing new infections.**

Potential reductions in new infections in the community due to testing in schools	1%	2%	3%	4%	5%
Number of infections averted	520,700	1,041,300	1,562,000	2,082,600	2,603,300
Number of hospitalisations averted	5600	11,100	16,700	22,300	27,900
Number of ICU admissions averted	600	1200	1800	2500	3100
Number of deaths averted	1100	2200	3400	4500	5600
Number of life years saved	11,800	23,600	35,300	47,100	58,900
Number of QALYs gained	12,000	24,000	35,900	47,900	59,900
Cost savings from hospitalisations and ICU admissions averted (GBP)	16,526,400	33,052,800	49,579,200	66,105,600	82,632,000

<b>Potential reductions in new infections in the community due to testing in schools</b>	<b>1%</b>	<b>2%</b>	<b>3%</b>	<b>4%</b>	<b>5%</b>
<b>Cost-effectiveness (full cost: using complete allocation of direct, indirect and overhead costs)</b>					
Cost per hospitalisation averted (GBP)	464,100	232,100	154,700	116,000	92,800
Cost per death averted (GBP)	2,290,500	1,137,900	753,700	561,600	446,300
Cost per QALY gained (GBP)*	214,600 [180,400-258,100]	106,600 [89,600-128,200]	70,600 [59,400-84,900]	52,600 [44,200-63,300]	41,800 [35,200-50,300]
<b>Cost-effectiveness (marginal cost: using volume driven costs only)</b>					
Cost per hospitalisation averted (GBP)	250,800	125,400	83,600	62,700	50,000
Cost per death averted (GBP)	1,230,700	608,000	400,400	296,600	234,400
Cost per QALY gained (GBP)*	115,300 [96,900-138,700]	57,000 [47,900-68,500]	37,500 [31,500-45,100]	27,800 [23,400-33,400]	22,000 [18,500-26,400]

\*Cost per QALY gained using a value of 6.78 QALYs per death averted (range: 4.98-8.8).

Hospitalisation fatality ratio (HFR) = 20.13; infection fatality ratio (IFR) = 1.07; false-positivity of LFDs: 14%; QALY, quality-adjusted life-year (calculated over the 18-month period).

Note, these are using the provider perspective only (not societal).

Modelled incidence rates from actual prevalence data and actual hospitalisations and deaths data for the evaluation period (October 2020 to March 2022) were used to calculate the actual infection hospitalisation ratios (IHRs) and hospitalisation fatality ratios (HFRs) during the 18-month period [46]. A sensitivity analysis was developed, assuming reductions in new cases of 1% to 5% due to testing in secondary schools and colleges. Infections, hospitalisations and deaths averted were modelled at these various potential reduction levels. Cost savings from hospitalisations and intensive care unit (ICU) admissions averted were estimated. Combined with the total cost of the testing service, these were used to estimate the cost per infection averted, cost per hospitalisation averted, cost per death averted and cost per QALY gained. Table 3-6 summarises the parameters, and Figure 3-7 illustrates the sensitivity analysis. The cost per QALY gained was computed using the full cost of the testing service as well as the marginal cost using only the direct and direct overhead costs (not using indirect and overhead costs) as this service began in January 2021, after the initial set-up costs had been incurred. The darker shaded area reflects the minimum and maximum values for QALYs for deaths found in the literature [47-49]. (See appendix 3.5 for further details on the methods and assumptions used).

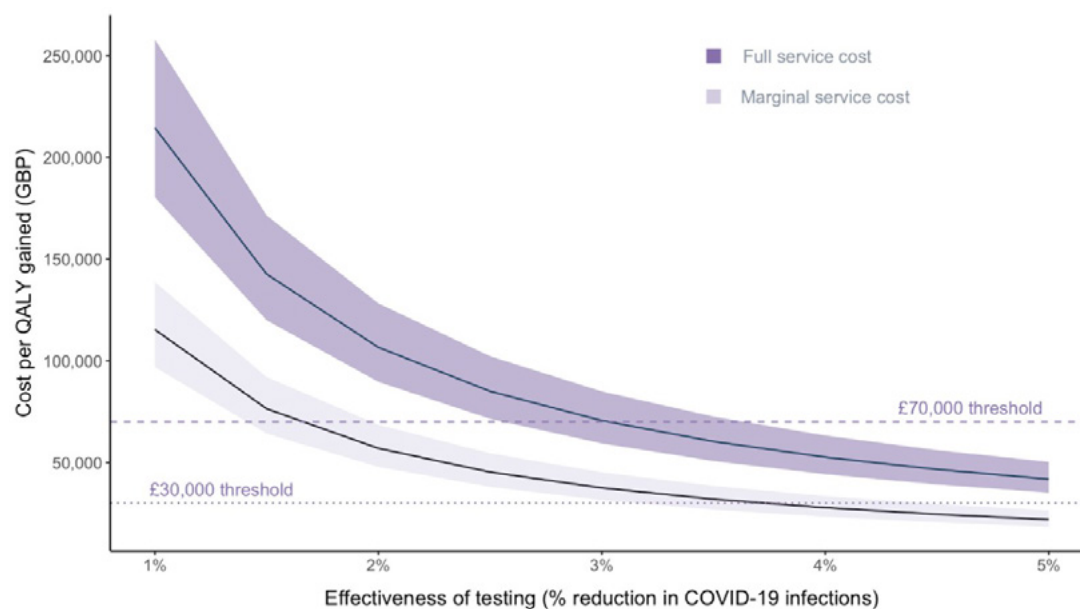
Figure 3-7 shows that the schools testing service was cost-effective in terms of cost per QALYs gained at a testing effectiveness of 3% or more at reducing new infections (using the Green Book willingness to pay threshold of GBP 70,000) [50]. At a testing effectiveness of reducing new infections by 3%, more than 16,000 hospitalisations were averted, an excess volume that the NHS may have had difficulty in absorbing. The cost per hospitalisation averted was GBP 154,700, cost per death averted was GBP 768,400 and cost per QALY gained was GBP 70,600 (59,400-84,900). When considering only the marginal costs of the testing service, the service would have been cost-effective if it reduced new infections in the community by 1.65% or more.

In comparison, the Covid-SMART study, conducted in Liverpool, analysed the impact of voluntary rapid asymptomatic community testing for the SARS-CoV-2 antigen on COVID-19-related hospital admissions from November 2020 to January 2021. It found that testing led to a 25% (11% to 35%) reduction in COVID-19-related hospitalisations [46]. Given that reductions in this study were observed in a smaller, controlled, quasi-clinical trial of community-wide testing, where the intensive testing was conducted with military assistance, a reduction in hospitalisations of 3% by testing only schoolchildren (actual hospitalisations during the evaluation period were 556,900) is not implausible, implying that the schools testing service was likely to have been cost-effective in terms of cost per QALY gained at a willingness to pay threshold of GBP 70,000 [50].

Indirect effects at various levels have also been reported for other interventions, such as vaccines [51, 52]. A systematic review of SARS-CoV-2 vaccine effectiveness against infection found that mean efficacy was 83% in the first month after

completion of the original vaccination schedule and decreased to 22% at 5 months [53]. While testing is likely to have a far lower effect size than vaccination, it could be considered to be an effective strategy in reducing new infections before vaccinations become available and after the effects of the vaccine have waned, before receiving boosters. While several studies on the cost-effectiveness of vaccination have been published, none were identified that specifically explored the cost-effectiveness of vaccination against infection in England, particularly in schoolchildren [51, 52].

Our analysis included the indirect effects of testing in schools to protect the wider community including high-risk populations. The impact was measured only in terms of QALYs gained and is therefore likely to be an underestimate.



**Figure 3-7. Cost-effectiveness of testing in secondary schools and colleges at different levels of testing effectiveness on reducing new cases in England.**

The shaded area is the cost per QALY gained at an upper level of 8.8 QALYs per death averted and a lower level of 4.98 QALYs per death averted. The line shows the analysis conducted at 6.78 QALYs per death averted.

The above analysis only considered cost-effectiveness in terms of QALYs gained due to the indirect effects of testing in schools on community transmission, given the knowledge that the direct impact of testing in schools on hospitalisations and mortality is likely to be minimal due to the low levels of severe disease in younger age groups. However, a future pandemic with a different epidemiological profile, or even a new COVID-19 variant with a greater disease impact in younger populations, may indeed justify intense testing in these age groups and lead to more favourable costs per QALY gained.

A very crude calculation suggests that at an assumed incidence of 85 per 1000 population and a direct reduction in new cases of 25% through asymptomatic testing in schools [46], this service would have been cost-effective in reducing deaths at an IFR of approximately 0.06%, representing approximately more than ten times the IFR observed in this age group during the evaluation period. Therefore, the inherent uncertainty when the schools testing service was being planned could be seen as preparing to mitigate these potential risks had they occurred. However, the crude analysis above should be treated with caution and warrants further analysis using actual data on incidence in this age group at different time periods associated with the numerous variants of concern and using various IFR and incidence pairings to determine at which levels the schools testing service may have been cost-effective in terms of QALYs gained from direct effects.

There was inherent uncertainty when the schools testing service was being planned and policymakers had to allow (at least implicitly) for circumstances being different and potentially worse. Had a dangerous new variant emerged, the cost per QALY gained could have been substantially lower, but it was not possible to have known that when the decision was taken to pursue the testing service. Therefore, although



in retrospect the schools testing service may not have been cost-effective in terms of QALYs gained through indirect effects on community transmission, this could not have been predicted in advance and the testing service represented an insurance policy against potentially more severe scenarios.

Until recently, little was known about the long-term impact of pupils missing school, with few studies providing causal evidence of the impact of pupil absence on academic performance. However, results from global simulations of the effect of school closures on learning are now being corroborated by country estimates of actual learning losses experienced by pupils. Evidence from Brazil, India, Mexico, Pakistan, South Africa, Sweden and others show substantial losses in pupils' mathematical and reading ability. In some low- and middle-income countries, learning losses have, on average, been found to be approximately proportional to the length of school closures.

This translates as meaning that each month of school closures led to a full month of learning losses, despite the best efforts of decision makers, educators and families to maintain continuity of learning during the pandemic. Younger pupils who had less access to age-appropriate remote learning opportunities were more affected by these learning losses than older pupils; economically disadvantaged pupils were also more affected by these learning losses than their economically advantaged counterparts. A study in Sweden showed that ten days of absence from elementary school over a school year leads to a reduction in grade point average of 3.3% of a standard deviation; this immediate impact on school performance can spill over into secondary school performance and final educational attainment, culminating in considerable human capital losses over time, leading to worse labour market performance and earnings [54]. Another study in the United States estimated that pandemic learning losses led to a median reduction in mathematics grades of 9% to 11% and English grades of 3% to 7% in elementary school pupils [55]. The economic impact of this is estimated to be USD 2 trillion in lifetime earnings [56]. On an individual level, a 9% to 11% decline in mathematics achievement, if allowed to become permanent, would represent a loss in expected lifetime earnings of USD 16,000 to 43,800. For England, this would mean a loss of up to GBP 146 billion for secondary pupils alone or 294 billion for the 8.3 million state school pupils. Although we were unable to estimate whether the schools testing service reduced face to face days lost due to self-isolations averted, if 30% of absenteeism was averted, this would equate to an economic gain of more than GBP 40 billion in secondary school pupils alone.

The economic analysis presented in this section does not consider other, broader societal impacts, such as confidence for pupils to return to school; the short- and long-term cognitive impacts of school days missed and potential future earnings lost, as described above; the mental health impacts of social exclusion; the ability of parents to return to work; and other impacts that are challenging to quantify. Our economic impact is therefore likely to be an underestimate. We have flagged these additional impacts in the next section (section 3.4.3) through our behavioural research.

### **3.4.3 Should testing in schools be rolled out again there are key learnings that could be applied in the future**

Assuming young people remain at low-risk of harm from COVID-19, the role of testing should not be to seek indirect effects but, via a lower-intensity testing strategy, should be to instil confidence in keeping schools open while minimising disruption.

The aim of reducing disruption, both in terms of face to face school days lost and parent/guardian days lost due to caring for a self-isolating pupil, aligns with the need for a low-intensity testing strategy. However, this is in conflict with the high-intensity strategy (which may lead to higher rates of pupils and potentially their contacts having to isolate) that would be required to reduce community transmission and thereby reduce pressure on healthcare settings and ultimately reduce the number of deaths.

This conflict was also observed in the behavioural analysis, relating to the aims of increasing pupil/parent/teacher confidence, detailed in the subsequent section. There were positive views about returning to face to face education, and staff, parents and pupils were reassured that the schools testing service was adding a layer of protection. However, a small proportion of parents/school stakeholders did not see



the value in testing at the scale it was delivered, and some expressed concern that it would lead to more pupils isolating due to being identified as close contacts (prior to daily contact testing options being introduced).

To explore the potential for a testing intervention to reduce disruption, a comparator intervention must first be defined. The reduction in disruption would then be relative to the chosen comparator. For example, the schools testing service, as delivered during the period of this evaluation, could be considered to have reduced disruption compared with the continuation of home schooling. However, the same service could be considered to have increased disruption compared with a low-intensity testing regimen that involved testing once per month.

For a schools testing intervention to propagate through transmission pathways to the groups at high risk of hospitalisation and death, pupils would need to be responsible for a sufficiently high proportion of population transmission and the testing and self-isolation of young people would need to reduce this proportion to impact the force of infection acting on high-risk groups. Although data were available on the number of tests reported and the numbers of positive tests reported per child per month, it is not known how many positive results led to the isolation of pupils. The effectiveness of isolation in reducing contacts with other pupils or its effect on contact with high-risk groups, such as the over-65s, is also unknown.

Indirect effects at various levels have been reported for other interventions, such as vaccines [51, 52], but it is unclear whether such effects could occur for testing interventions, which are likely to have a far lower direct effect-size than vaccination. If there are insufficient direct effects expected for an intervention, then the ethics of indirect effects (see for example [57]) and the necessity for an evidence base [58] should be explored in advance, recognising it is more challenging to do so in the midst of a pandemic. It should be noted, however, that the nature and level of direct effects are also uncertain and variable. For example, confidence in face to face education is a direct effect but is not associated with a quantifiable metric suitable for estimating an incremental cost-effectiveness ratio. Estimating an incremental cost-effectiveness ratio using QALYs gained through the avoidance of severe COVID-19 cases in pupils is a feasible analysis, but hedging against the potential for a future variant with higher severity is a subjective choice.

When exploring uncertainty about the severity of infection in pupils, our analysis indicates that testing at the frequency achieved by the schools testing service may have been cost-effective under some hypothetical scenarios. However, unless pupils are classified or likely to be classified as a high-risk group, testing strategies for schools should by default be of low intensity, low cost and cause minimal disruption. Strategies aiming for indirect effects in schools or other low-risk-high-contact populations should be assessed in real time, as has been done for paediatric influenza vaccines [59, 60], and through pilot studies, before being implemented at scale, to avoid efficiency losses and unnecessary costs.

To determine the 'optimal' level of testing, we were not able to investigate whether the presence of the existing testing regimen in itself led to confidence, whether any level of testing would feel credible to parents/guardians or whether there would be an 'optimal' level of testing. Further work is necessary to clearly understand the level and impact of testing and required self-isolation that would lead to the instilling of confidence.

If, in the future, testing in schools needed to be prioritised, we have developed a series of learnings, observed as part of this evaluation, relating to the schools testing service.

### **What are the behavioural barriers and facilitators to taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?**

The schools testing service went from inception to full rollout in 3 months, despite operational, epidemiological and supply chain challenges. Therefore, it is rich with operational and behavioural insights that the evaluation team have obtained from UKHSA reports and an extensive academic literature search, which are summarised in the following section. Detailed findings can also be found in appendix 3.3.

### 3.4.3.1 Taking a test

#### **Support provided to the education sector, specifically in relation to training and guidance, was useful for reassuring pupils, parents, and staff**

While participants expressed their enthusiasm for the schools testing service, studies also reported that pupils, staff and parents had concerns around tests being an uncomfortable or painful experience [4, 24, 61, 62]. However, for others, repeated testing and gaining confidence in the schools testing service led to nearly 60% of pupils stating they would be willing to get tested again [24]. Furthermore, media coverage about the return to face to face education in schools, involving Dr Ranj Singh and Dr Amir Khan (both NHS doctors and TV presenters), helped reassure pupils and parents about the testing process [7].

Various types of support were noted by parents and teachers that helped to ease their concerns, including tutorials; specific, detailed information about the schools testing service for pupils and staff; and training given to staff responsible for administering tests [4]. Ensuring that pupils and staff had sufficient time to review relevant information was also deemed important, particularly for consenting to take part in the schools testing service [62].

A further facilitator to testing was knowing that although participating in testing was strongly encouraged, it remained optional, so being able to withdraw from testing at any point removed this potential barrier to participating [62].

#### **Case study: Variations in mandating versus strongly encouraging school testing seen across different regions in Germany**

The timing of testing within schools in Germany was similar to that of England, starting before or after the Easter holidays in March/April 2021 [63]. The target rate for testing was also similar, with reports of German schools asking pupils to take tests twice a week. Tests were carried out under the supervision of teachers or nursery staff. If a pupil tested positive, they were sent home and required to take a confirmatory PCR test and quarantine, while the rest of their class remained at school. The variation between schools in different areas was seen in the voluntary or mandated nature of testing. For example, in Bremen, tests were voluntary, whereas in other areas, such as North Rhine-Westphalia, schools required pupils to self-test as a prerequisite for participation in lessons [63].

In England, government guidance stipulated that testing within schools and continued home testing was voluntary albeit strongly recommended; however, it should be noted that schools had control over the way this guidance was communicated and may not have presented it as an option apart from obtaining consent from parents to test their child.

Consideration: A detailed evaluation of testing programmes in other countries was outside the scope of this evaluation; however, the issue of whether to mandate testing or have voluntary testing is an area that could benefit from further investigation. It could be assumed that mandating testing may depend on cultural differences in a given country, whereby parents and pupils feel more compelled to test and conform to rules and regulations and therefore higher participation rates are observed. On the other hand, if there are barriers to testing, with parents or pupils not feeling engaged or seeing it as necessary to test, then mandating testing may exacerbate absenteeism within schools at a time when maintaining attendance is the aim.

#### **Setting up and running an ATS within schools was resource-intensive, so financial and logistical support was crucial for ATS rollout**

Schools valued support (financial and logistical) when setting up an ATS, as an ATS was perceived to increase staff workload and required time, effort and substantial resources (both for mainstream schools and special schools) [3, 36, 62, 64, 65]. School staff were instrumental in managing the process of arranging for pupils and staff to be tested, including the registration process and data management [24]. However, staff resourcing to oversee the testing process was often cited as a challenge [7].

## CASE STUDY



This support also included ensuring that schools had sufficient kits to be able to comply with the recommended testing regimen [65] as well as during times of outbreak management. Some schools felt under pressure; in such cases, council staff or mobile testing units would sometimes be deployed to schools to ensure testing was easily accessible and available [66].

### **Taking a test at home increased between March 2021 and July 2021, while at school testing decreased; however, a minority of pupils felt concerned about selftesting at home**

As may be expected, the location where a test was taken was predominantly within school settings during March 2021 (69% onsite) [67]. However, with the move to home testing after this period the proportion testing at home increased, to 81% in May 2021 [68] and 72% in July 2021 [69]. Parents' reporting on their child's participation in testing was very similar to that of their children.

It should be noted that moving from onsite testing to home testing elicited some concern from a minority of pupils; this tended to be more prevalent among some subgroups, including white pupils, pupils eligible for free school meals, pupils with special educational needs, and pupils who reported they were exempt from wearing a face covering [7]. Parents also shared some concerns around home testing and whether they would be able to perform the test accurately, when they should expect to receive results and how to register results [7].

#### **3.4.3.2 Reporting the results**

##### **Establishing stronger partnerships between local health authority teams and schools enabled systems for reporting outbreaks and receiving support to be set up**

Logistical issues with the schools testing service were raised around the initial communication between DfE, health protection teams, local authority public health teams, and schools, and a lack of understanding of roles and responsibilities created difficulties for decision-making, as mentioned in a report from the Institute for Government [70]. However, conversations held with school stakeholders suggested that relations improved with local authority public health teams and in fact became a vital support network, particularly for school leadership teams (see appendix 3.3). School leaders were able to establish a system to report outbreaks (positive test results) to their local authority public health teams and receive support and advice rather than relying on DfE or UKHSA (see appendix 3.3). Comments were made about the additional burden and time needed to manage test results and issues with the system itself for uploading results, which increased during times of bubble testing [24, 65]. It was also mentioned within stakeholder discussions that, due to limited resources or capacity within schools, negative results that were not reported to the school by pupils or parents were not followed up (see appendix 3.3).

##### **Reporting results on both school and NHSTT platforms were burdensome for some parents and pupils**

Prior to and during the early rollout of the schools testing service, parents and carers found reporting results to be an additional burden, especially when having to report positive results for multiple children in the same household, which would subsequently result in multiple calls for contact tracing [4]. Households in which only parents were testing or with one child were more likely to express having a positive experience [65]:

“

Once results were announced we received countless phone calls asking the same information. Can there not be a cross-reference for phone calls? I know it's important, but it was repetitive at a time my children were very poorly and I was very unwell. (NHS survey respondent) [4].

“

When a whole household test positive, the household members should be able to be linked somehow to prevent having to go through a 20–30-minute phone call for each household member for track and trace (especially children). (NHS survey respondent) [4].

It should be noted that during stakeholder conversations, it was mentioned that contact tracing teams moved to models where efforts were made to contact households just once rather than multiple times.

It was also mentioned that the use of different platforms to report results was cited as confusing and time-consuming by some parents of secondary school pupils [65].

Although the expectation within the schools testing service was that each pupil would receive notification of their LFD test result, some pupils and staff interviewed as part of pilot studies (for the schools testing service) mentioned that their result was not always communicated to them [55, 58]. Although they understood the school's rationale to only communicate positive test results, they would still want confirmation of their LFD test result, whatever the result, for reassurance and to know for certain if they were negative (it should be noted that a school's process of communicating results may vary depending on capacity); they also wished to receive information and guidance on what to do with their result [62, 65].

### **Consequences following a potential positive test result were a barrier to testing for some families**

For families and staff asked about the prospect of reporting a test to schools or NHSTT, many of them anticipated that there would be an element of under-reporting [3]. At the time that study was conducted (July to September 2020), some participants, especially individuals who were members of an ethnic minority, felt there was a stigma around contracting COVID-19, and they anticipated negative comments from others. A lack of reporting results could also have been due to a fear of missing out on work or school [3, 4]. Parents surveyed in a different study also felt that schools might not want to admit that COVID-19 was in their schools and would be reluctant to communicate this type of data [71].

Conversely, from a school staff perspective, the same level of stigma was not anticipated due to the understanding of COVID-19 among a diverse school population; however, it was appreciated that there may be individuals within a school who may pass comments or judgement [3].

### **Pupils from more-deprived areas may need more support to test in any future pandemic [3, 4]**

Our literature review found that certain groups were more likely to report not taking a test in the previous seven days, such as older pupils (19% versus 12% for younger pupils), particularly pupils in years 11 to 13; pupils from ethnic minorities compared with white pupils (21% versus 12%); young people with SEND (20% versus young people without SEND, 13%); and pupils eligible for free school meals (FSM) (25% versus non-FSM pupils, 12%) [68]. These findings regarding differences between ethnic groups should be treated with some caution because they may also reflect aspects of differential test administration among schools with higher proportions of pupils from ethnic minorities, rather than differential uptake of testing between different demographic groups of pupils per se. Differences between groups of pupils remained approximately the same in July 2021 [69] as reported in May and March 2021.

As was the case with the demographic sub-trends, differences across geographic regions remained broadly similar across the survey timepoints. In July, parents of secondary school children in the East and South East regions of England were the most likely to report their child had taken a COVID-19 test in the previous seven days (87% and 82% respectively), with those in London the least likely to report this (73%) [69].

Young people at secondary school who were from affluent households were more likely to test regularly. Furthermore, if the young person attended a school where testing was encouraged, and their parents tested themselves regularly, this increased the likelihood that the young person would test regularly compared with testing among young people who were in 'urban adversity' households, had parents who did not test or whose school did not actively encourage testing [72].





## 3.5 Conclusions

The schools testing service was set up and mobilised under huge urgency to support young people's return to school following a lockdown. It is important to recognise the effort and dedication made by all those involved in setting up and running the schools testing service at a time of great uncertainty and with the responsibility to keep pupils' education on track. The testing service achieved its aims of instilling confidence in the return to school and was associated with identifying more asymptomatic cases than would have been possible without it.

Due to the limitations of the schools data at the time of the evaluation process (please see 'Data limitations' section), the evaluation consortium was unable to measure whether the schools testing service reduced face to face school days lost due to self-isolation. Furthermore, it remains inconclusive whether the schools testing service saw broader downstream impacts in community transmission, hospitalisations and deaths. In any future pandemic, it is highly likely that young people will again need to be tested, for a variety of reasons: 1) as a mechanism to distribute tests to the wider population, as needed; 2) as a measure to instil confidence; or 3) as a protective measure if different groups in society, for example children and young people, were at higher risk than they were during the COVID-19 pandemic. Therefore, considerations and recommendations are made relating to simplifying the reporting process, policy and guidance, through a more streamlined and low-intensity testing strategy. Data collection and sharing should also be streamlined, while the role of local authority public health teams and local education leads should be strengthened in the future.

## 3.6 Key considerations and service-level recommendations for future testing strategies

### Summary of key considerations and recommendations

We present the overall testing programme recommendations in chapter 6 of this report, with recommendations referring to testing services for high-contact groups being particularly relevant to schools. Additional considerations and recommendations specific to the schools testing service are as follows:

#### Considerations:

- ▶ Data limitations prevented a holistic analysis of the impact of schools testing
- ▶ Reporting test results to schools and NHSTT platforms was seen as time-consuming and confusing at times
- ▶ Partnerships between schools, local authority public health teams and local education leads was seen as integral for the success of managing testing services within schools and the community

#### Recommendations:

- ▶ Timely and efficient dissemination of guidance, or updates to guidance, to enable school and local health protection teams to mobilise and operationalise actions

SUMMARY

### 3.6.1 Considerations

#### 3.6.1.1 Data limitations prevented a holistic analysis of the impact of schools testing

To conduct the range of analyses required, the evaluation consortium required access to various data, some of which were not available due to the reasons outlined in the 'Data limitations' section and can be summarised as:

- ▶ Data being unavailable due to the way they were collected at the time/the way the services were implemented - we explore considerations relating to this point in chapter 6.
- ▶ Data being unavailable due to the long lead-time required to provide these data to the evaluation consortium (ONS and attendance data).

Regarding absenteeism data, our understanding following conversations with school stakeholders is that each school used their own database or software of choice to manage attendance data and often had designated individuals or teams whose role it was to collect, record and update attendance on a daily basis. DfE requested attendance data from schools, with specific details or timeframes needed, and schools then sent the required information back to DfE.

Although from a school perspective the recording of attendance was not seen as an issue or particularly burdensome (see appendix 3.3), and attendance data are collected at a granular level, the lead time and data governance issues meant that the evaluation consortium could not receive the required data within the evaluation timeframe to be able to perform the relevant analyses and thus evaluate the full impact of the schools testing service. Stakeholders noted that DfE are already undertaking work to improve the capture of attendance data [73].

Similar limitations were experienced with the testing coverage data, in that the evaluation consortium were only able to view data at an LTLA level rather than at a school level, which would have enabled an exploration of possible associations between school-related characteristics and test coverage. Better visibility of school-associated positivity rates and the use of real-time data by region would have also benefited other schools or local authorities, by enabling them to be more prepared for potential increases in cases within their own schools (as mentioned by school stakeholders).

The reliance on indirect effects suggests that a consideration for any future intervention or evaluation should be for clear, measurable endpoints to be defined at an early stage, so that high-quality data can be collected. Furthermore, data-sharing agreements and improved data governance should be set up in advance to ensure data are easily accessible to partner departments or stakeholders. Improved data collection and data sharing among schools, DfE and UKHSA are important considerations for policymaking, similar evaluations and for the wider benefit of the public, especially in a pandemic situation. In the absence of data, uncertainty analyses could provide additional insights and support for decision-making in the presence of unknown factors at the time of service set up.

### **3.6.1.2 Reporting test results to schools and NHSTT platforms was seen as time consuming and confusing at times**

Stakeholder conversations and qualitative insights indicated that having separate platforms (e.g., NHSTT and a school's own platform) for staff, pupils and parents to report LFD results was burdensome and at times confusing [62, 65]. If such a method to record results is warranted in a future pandemic, consideration could be made to streamline platforms to simplify and incentivise pupils, staff and parents to report their test results.

More rapid registration of multiple test results via user accounts could be explored and potentially facilitated, suitable for use in schools but also at home. Parents would like to be able to upload test results from more than one child under one username; this would help to reduce multiple calls from contact tracing teams, if they can ascertain results are from a single household.

### **3.6.1.3 Partnerships between schools, local authority public health teams and local education leads was seen as integral for the success of managing testing services within schools and the community**

As discussed with stakeholders, one of the most important factors enabling schools to manage COVID-19 was the collaboration and support of local authority public health teams and educational leads from the local authority. A technical report published in December 2022 [74] highlighted the importance of viewing schools as integrated parts of the community rather than isolated settings.

With available funding passed down from central government, local authorities were able to create teams who could better support the schools in their local area. This involved support during outbreaks, interpreting and implementing guidance and providing reassurance to the school leadership team. Feedback from school stakeholder interviews suggested that the support offered by DfE via helplines or email was often limited or delayed due to the immense pressure and scale of queries DfE were receiving from schools at the time.



Although the majority of the stakeholders we spoke to felt well supported by their local authority public health teams, one cannot assume this was the case for the majority of schools across England, due to the small sample size of stakeholders involved in the evaluation. For schools which may have felt less well supported by their local authorities, considerations could be made to provide both schools and local authority teams with best practice SOPs, case studies and examples of how better relationships or collaborations were formed during the pandemic.

Other considerations for improving partnerships could be to further review what support schools required in different situations in relation to testing and consider the best approach for providing that support in any future pandemics. For example, local authority public health teams and local education leads could work with UKHSA to understand and develop strategies for maintaining testing coverage among pupils throughout term-time, for example by deploying a standalone team to test all pupils in a school at certain time intervals, as was suggested during the school stakeholder interviews.

Lastly, consideration could be given to how best to maintain an appropriate level of upskilled employees, to ensure experience and learnings from previous pandemics are not lost.

## 3.6.2 Recommendations

### 3.6.2.1 Policy and guidance updates

#### **Timely and efficient dissemination of guidance or updates to guidance to enable school and local authority public health teams to mobilise and operationalise actions.**

Although it was appreciated that the guidance at times needed to change at pace to keep up with the changing pandemic landscape, feedback from school stakeholders highlighted the difficulties associated with receiving policy changes or guidance documents out of school hours, late in the evening or on weekends, with little notice to implement the guidance. This was especially the case when public announcements were made by the then prime minister or education secretary prior to the dissemination of guidance by DfE, which put pressure on school leadership teams to amend guidance and reassure staff and their school community.

Consideration should be given to disseminating guidance directly to school leadership and local authority public health teams ahead of public or televised announcements.

Another factor that was noted as a difficulty by school stakeholders was the content of the guidance. Often, multiple pages of information were shared without clearly outlining the changes that had been made since the publication of the previous guidance and, more importantly, why the changes had been made. This was not only a burden for school leaders who had to spend time combing through both the previous and updated guidance to create their own communications materials, but it also made it difficult to communicate and rationalise with the wider school community why the changes had taken place. Ultimately, this can affect the engagement with a testing service.

Clear executive summaries outlining the changes since the previous guidance was published and a clear rationale will aid communication with parents, pupils and staff. Furthermore, if guidance that includes training aspects or an explanation of the rationale behind any changes can be communicated via a video tailored to a specific audience, such as pupils or staff, this may be better received and easier to digest than written documentation [62, 75].

Ultimately, guidance will foster greater compliance and adherence if it is timely, clear and forms part of a considered stakeholder strategy.



# Priority Service 2: Healthcare Workers Testing Service



# Healthcare Workers Testing Service

This chapter on the evaluation of the healthcare workers testing service will cover the following:



## Definitions

This part of the evaluation focused on the asymptomatic testing of healthcare workers, which aimed to enable NHS organisations both nationally and locally to identify asymptomatic cases of COVID-19 and limit the spread of the disease within healthcare settings.

For the purposes of this evaluation, 'healthcare workers' covers all clinical and non-clinical staff working within the health sector. This evaluation did not cover patient testing or symptomatic healthcare worker testing.

## 4.1 Executive summary of the healthcare workers testing service evaluation

Here, we summarise the findings of our evaluation of the healthcare workers testing service and compare them with the intended aims of the service and the key indicators developed during the evaluation process.

### Outline of the hypothesis and research questions

Our evaluation aimed to answer the following questions:

- ▶ Did the healthcare workers testing service fulfil its intended aims, identified through a review of UKHSA documents, other documentation supplied by the secretariat, publicly available documentation and stakeholder interviews, to:
  - ▶ Support the NHS in its infection control risk reduction strategy
  - ▶ Reduce staff absenteeism due to COVID-19
  - ▶ Support both COVID-19 and non-COVID-19 clinical pathways over the winter period and during the second wave of the pandemic
  - ▶ Protect patients<sup>5</sup>
  - ▶ Protect staff<sup>5</sup>

Please note that these were the aims of the service as stated by NHS England (NHSE) [1]; they were also noted to be aims of the service within UKHSA documentation [2]. Additional aims were stated by UKHSA in a Business Justification Template [3], which included:

- ▶ Giving staff workplace confidence in fellow NHS employees, as positive staff will self-isolate
- ▶ Making key workforces more resilient by preventing outbreaks

These additional aims were not specifically evaluated; however, it should be noted that no evidence was uncovered in our behavioural research around the impact of the testing service on staff confidence in the workplace. It should also be noted that the evaluation consortium prioritised those aims that were measurable within this evaluation and have not attempted to amend these aims to make them measurable (further discussion is provided in chapter 6 relating to measurable aims).

This research question also relates to the overall evaluation hypothesis that the evaluation consortium chose to explore, regarding whether testing services aimed at high-risk groups led to a reduction in hospitalisations and deaths in those high-risk groups.

- ▶ Was the service a cost-effective intervention when considering the cost per nosocomial infection (also referred to as healthcare-associated infection) averted, the cost per QALY (quality-adjusted life-year) gained and the cost per absentee day averted in healthcare workers?
- ▶ What were the behavioural barriers and facilitators for taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?

### Description of the context of the evaluation

- ▶ Testing of healthcare workers comprised 7% of the total volume of LFDs distributed, with testing overall in healthcare contributing 7.8% of the total national testing expenditure.

- ▶ The number of tests reported for NHS trusts only represents a fraction of the number distributed, which may have been due to under-reported negative tests.
- ▶ There were large variations in numbers of LFDs and PCR tests reported, with no discernible trend observed.
- ▶ Weekly trends in reported LFD tests were reflective of changes in policy.
- ▶ There was an increase in LFD tests reported by healthcare workers in November 2021, likely as a result of changes in policy brought about in response to the emergence of the Omicron variant.
- ▶ Overall, the total numbers of PCR tests reported were low, with a peak of approximately 600 tests reported in a week for acute care trusts, with a small peak in confirmatory PCR testing across all settings seen during the Omicron period.
- ▶ The move in July 2021 from a 'push' model where trusts were supplied with LFD tests to distribute to healthcare workers, to an individual healthcare worker-initiated 'pull' model where staff ordered their own LFD tests, may have contributed to the decrease seen in the number of tests reported after this time.
- ▶ Increasing levels of vaccination and decreased perceptions of risk may have further contributed to the fluctuations in testing observed following the vaccine rollout in December 2020.
- ▶ The positivity rate of LFD tests followed prevalence estimates, with more irregular trends observed for the PCR positivity rate.

## Results of the evaluation

Did the healthcare testing service fulfil its intended aims? Was the healthcare testing service a cost-effective intervention?

- ▶ Nosocomial infections in hospitalised patients were closely associated with LFD testing coverage, with this association being greatest during the Omicron variant period. Our analysis showed that healthcare worker testing was associated with a 16% reduction in nosocomial infections.
- ▶ Testing would have been cost-effective at reducing nosocomial infections at a testing effectiveness of 5.5% or more. The estimated testing effectiveness was 16.8%, indicating that this service was likely to have been highly cost-effective in terms of averting nosocomial infections.
- ▶ Our analysis suggests that community prevalence was driving full-time equivalent (FTE) days lost due to COVID-19 infection in the healthcare sector. Increases in LFD test coverage were associated with decreases in FTE days lost due to COVID-19, except during the Delta and Omicron periods, when no association with testing coverage was observed.

What were the behavioural barriers and facilitators to taking a COVID-19 test, reporting of a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?

- ▶ The uptake of testing seen throughout the healthcare workers testing service was driven by the perceived value of testing, as evidenced by the qualitative literature.
- ▶ Healthcare workers were motivated to test to keep patients and families safe.
- ▶ The physical experience of taking a test was not flagged as a barrier for healthcare workers, with the barrier perceived to be overcome by the value they ascribed to testing.
- ▶ Healthcare workers needed clearer guidance on when to test, especially in the face of changing testing policy and regimens.
- ▶ The requirement for healthcare workers to self-isolate following a positive test placed a burden on healthcare system resources.

## Key considerations and service-level recommendations for future testing strategies

We summarise the overall testing programme recommendations in chapter 2 of this report, with recommendations referring to testing services for high-risk groups and their contacts being particularly relevant to healthcare. Additional considerations and recommendations specific to the healthcare workers testing service are as follows:



## Considerations

- ▶ Reporting complexity was experienced at both national and local levels, and there was a discrepancy between the numbers of LFD tests distributed and reported. The move to enable reporting of LFD test results by individual healthcare workers via the gov.uk website reportedly made it more challenging for trusts to understand the performance of their individual testing services. As testing and test reporting is likely to be critical in the management of any potential future pandemic, it is important that any future reporting system involves reporting at a local level.
- ▶ Stakeholders noted that, while it was challenging to find an approach to incentives or penalties to encourage testing compliance that could be successfully applied at a national level, there were some local initiatives in place, such as prize draws, for full compliance with reporting. UKHSA may wish to further explore a system of penalties and incentives to encourage staff compliance.
- ▶ The principle of local determination for defining 'patient-facing' healthcare workers led to confusion and local variation in testing eligibility.

## Recommendations

- ▶ Policies should be communicated clearly to avoid staff confusion. This should include a transparent justification, reliable evidence and the management of expectations for future policy and guidance updates.
- ▶ Assess healthcare testing interventions in real time to support a responsive strategy, noting there is a trade-off between a responsive strategy and the challenges posed by rapidly changing guidance.

## 4.2 The healthcare workers testing service evaluation sought to answer the following research questions and overall evaluation hypothesis

Did the healthcare workers testing service fulfil its intended aims, identified through a review of UKHSA documents, other documentation made available through the secretariat, publicly available documentation and stakeholder interviews, to:

- ▶ Support the NHS in its infection control risk reduction strategy
- ▶ Reduce staff absenteeism due to COVID-19
- ▶ Support both COVID-19 and non-COVID-19 clinical pathways over the winter period and during the second wave of the pandemic
- ▶ Protect patients<sup>5</sup>
- ▶ Protect staff<sup>5</sup>

Please note that these were the aims of the service as stated by NHSE [1]; they were also noted to be aims of the service within UKHSA documentation [2]. Additional aims were stated by UKHSA in a Business Justification Template [3], which included:

- ▶ Giving staff workplace confidence in fellow NHS employees, as positive staff will self-isolate
- ▶ Making key workforces more resilient by preventing outbreaks

These additional aims were not evaluated; however, it should be noted that no evidence was uncovered in our behavioural research around the impact of the testing programme on staff confidence in the workplace. It should also be noted that the evaluation consortium prioritised those aims that were measurable within this evaluation and have not attempted to amend these aims to make them measurable.

This research question also relates to the overall evaluation hypothesis that the evaluation consortium chose to explore, regarding whether testing services aimed at high-risk groups led to a reduction in hospitalisations and deaths in those high-risk groups.

- ▶ Was the service a cost-effective intervention when considering the cost per nosocomial infection (also referred to as healthcare-associated infection) averted, the cost per QALY (quality-adjusted life-year) gained and the cost per absentee day averted in healthcare workers?

- ▶ What were the behavioural barriers and facilitators for taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?

### 4.3 To evaluate whether the above aims were achieved, it is important to understand the context of the healthcare workers testing service between October 2020 and March 2022; we explored testing volumes, overall cost, and set up and policy timelines, as well as the differences between the numbers of distributed and reported LFD tests

A Theory of Change (ToC) for the healthcare workers testing service and a ToC overlaid with a process map of how the testing worked can be found in appendix 4.2.

#### Summary of key findings

- ▶ Testing of healthcare workers comprised 7% of the total volume of LFDs distributed, with testing overall in healthcare contributing 7.8% of the total national testing expenditure.
- ▶ The number of tests reported for NHS trusts only represents a fraction of the number distributed, which may have been due to under-reported negative tests.
- ▶ There were large variations in numbers of LFDs and PCR tests reported, with no discernible trend observed.
- ▶ Weekly trends of reported LFD tests were reflective of changes in policy.
- ▶ There was an increase in LFD tests reported by healthcare workers in November 2021, likely as a result of changes in policy brought about in response to the emergence of the Omicron variant.
- ▶ Overall, the total numbers of PCR tests reported were low, with a peak of approximately 600 tests reported in a week for acute care trusts, with a small peak in confirmatory PCR testing across all settings seen during the Omicron period.
- ▶ The move in July 2021 to an individual healthcare worker-initiated 'pull' model for LFD supply may have contributed to the decrease seen in the number of tests reported after this time.
- ▶ Increasing levels of vaccination and decreased perceptions of risk may have further contributed to the fluctuations in testing observed following the vaccine rollout in December 2020.
- ▶ The positivity rate of LFD tests followed prevalence estimates, with more irregular trends observed for the PCR positivity rate.

SUMMARY

#### 4.3.1 Testing of healthcare workers comprised 7% of the total volume of LFDs distributed, with testing overall in healthcare contributing 7.6% of the total national testing expenditure

There were 140 million LFD tests distributed over the 18-month period from October 2020 to March 2022 for the healthcare worker testing service, representing 7% of the total number of LFDs distributed for England (Table 4-1). There were 4 million PCR tests registered for healthcare workers through Pillar 1 (estimated to be 9.5% of the total number of Pillar 1 PCR tests registered). The total financial cost of the healthcare worker testing service for this period was GBP 1.77 billion, representing 7.6% of the total testing expenditure in England (Table 4-2). These estimated costs included laboratory costs but did not include payments made to healthcare workers for isolating following a contact with a positive COVID-19 case. PCR tests accounted for 7.5% of the total costs (GBP 132 million), while LFDs comprised about 92.5% (GBP 1.64 billion) of the total costs of the healthcare worker testing service. Of the

<sup>5</sup>Added as aims for NHS trusts in September 2021 [4].

total costs during the evaluation period (October 2020 to March 2022), 55% and 19% were direct and indirect costs, respectively, with the remainder being overhead costs. Overhead and indirect costs were marginally higher in FY21 than FY22 due to the initial costs of setting up the testing service.

The average unit cost of an LFD and PCR test was GBP 11.68 and GBP 32.64, respectively. Unit costs were calculated for the full evaluation period and capture the purchase price of tests, as well as all other direct, indirect and overhead costs associated with the programme, including the logistics, human resources and other costs to deliver the test to the point of care. As unit costs decreased over time, the average cost differed by service depending on the relative timing of purchasing and distribution. The unit cost of LFDs over the evaluation period in hospitals was higher than for other testing services, at GBP 11.68 per test compared with GBP 7.24 for testing in schools, as the testing service started earlier and more intensively in healthcare settings, when the cost of tests was higher. In contrast, the unit costs for PCR tests in the healthcare testing service were substantially lower than for other services, as these costs came from Pillar 1, which excluded overheads. Overhead costs were only attributed to Pillar 2 testing. More details can be found in appendix 2.3.

**Table 4-1. Number of LFDs distributed, and PCR tests registered in England as part of the healthcare testing service, for staff only (during the evaluation period).**

Service	Test type	Total number	Percentage of total
Healthcare (staff only)	LFD	140,357,000	7% (of all LFDs distributed in England)
	PCR	4,047,000	9.5% (of all PCR tests registered in England Pillar 1)

**Table 4-2. Total financial cost of the healthcare testing service for England (during the evaluation period).**

Service	Test type	Total cost (GBP)*	Percentage of total spend (England)**
Healthcare (staff only)	LFD	1,639,522,000	7%
	PCR	132,083,800	0.6%
<b>Total</b>		<b>1,771,605,800</b>	<b>7.6%</b>

\* Total financial costs for the testing service excluding isolation-related support and COMF (Containment Outbreak Management Fund).

\*\* Percentage of total is calculated against the total spend of testing in England excluding isolation-related support.

### 4.3.2 The healthcare workers testing service in England initially involved regular asymptomatic testing of patient-facing staff of NHS trusts in November 2020, followed by primary care and independent healthcare providers shortly after

The healthcare workers testing service in England started with the rollout of the regular asymptomatic testing service for patient-facing staff of NHS trusts, which began in November 2020 [1], followed by primary care in January 2021 and independent healthcare providers in April 2021. Various technologies were explored as part of the effort to increase testing capacity, including LAMP (loop-mediated isothermal amplification) testing of saliva samples. The rollout of asymptomatic healthcare worker testing followed a pilot study involving 1200 staff members from five NHS trusts, which demonstrated that regular LAMP testing of saliva samples from asymptomatic staff was both feasible and acceptable [1]. Asymptomatic testing in healthcare settings was implemented in secondary care, primary care, the independent sector, maternity wards, emergency departments and end-of-life services [2]. Interviews with healthcare testing service stakeholders showed that once the first satisfactory results about the sensitivity and specificity of LFDs were available, LFDs became the main tests for the asymptomatic testing service. They offered a rapid result and enabled home testing. LAMP tests were only used in a limited number of trusts.





LFD tests were initially distributed to the NHS based on an on-demand 'push' model to trusts. With this model, trusts received a stock of tests and were responsible for test distribution among sites, storage, recording of orders and reporting of aggregated test results shared by their staff. This was later followed by a 'pull' model, driven by individual staff orders via a gov.uk website, with tests delivered directly to the homes of staff from July 2021. Staff were required to input the name of the trust where they worked to ensure the tests were registered as belonging to an NHS staff member. In parallel with the deployment of LFDs, LAMP tests were used on saliva samples. LAMP tests were recommended for staff members who were unable to perform an LFD test, for whatever reason, when they were available to the local NHS organisation.

Organisations and regions received management information from NHS Test and Trace to help them to understand what proportion of their staff had ordered and reported tests. However, trusts continued to receive a supply of LFDs for patient use as per existing use cases (emergency departments, maternity and neonatal departments, and end-of-life-care visitors) [5].

The general policies relating to asymptomatic testing and isolation were established by various teams within UKHSA, the Department of Health and Social Care (DHSC) and NHSE and were made available on the gov.uk website. Every health organisation was then responsible for clear communication of these policies to their staff members through their local organisations.

There was a single national standard operating procedure (SOP) and frequently asked questions (FAQs) document for twice-weekly asymptomatic testing with LFDs in NHS trusts, an SOP and FAQs for primary care, and an SOP for independent healthcare providers. In many instances, NHS staff were required to follow the general guidance for self-isolation. Testing and self-isolation guidance for close contacts of COVID-19 cases varied during the period covered by this evaluation (see appendix 4.3 for more details).

#### **4.3.2.1 Site set-up**

For asymptomatic testing, where LAMP tests were piloted, healthcare workers were advised to conduct Direct LAMP tests on-site or LFD tests (if available and required) at home, ideally before attending work. From November 2020 until the updated SOP in July/August 2021, NHS trusts were required to set up an 'internal distribution location for the issue of devices to eligible staff members, reporting template, printed copy of the instruction guide and any other written instructions including local information' [1]. Stakeholder feedback has highlighted that tests may have been made available in staffrooms and similar communal spaces for staff to take home. Confirmatory PCR tests were to be arranged in line with an organisation's existing processes or through NHSTT. From July 2021 onwards, the updated SOP allowed all NHS staff to order testing kits via the universal testing service; these were then delivered to their homes so they could continue to self-test at home (see appendix 4.3 for more details).

#### **4.3.2.2 Staff training**

An instructional video [6] and written instructions [7], including how to interpret test results, were available for staff to learn how to self-administer their test. As noted by a stakeholder involved in the healthcare worker testing service, the original tests arrived with a very long set of instructions from the manufacturer (many of which were in Chinese) that needed to be translated and presented in more user-friendly language. Each trust was required to provide a support package that also included staff access to a helpline for further training and, if deemed necessary, onsite training arrangements [1]. NHS staff were advised to follow a special guide for self-testing that differed from the manufacturers' guidance, as NHS staff were using the tests in a slightly different way [7]. These instructions were agreed among relevant experts and discussed with the Medicines and Healthcare products Regulatory Agency (MHRA) (see appendix 4.3 for more details).

The general recommendation for healthcare workers was to conduct their tests at home. It was recommended that healthcare workers be observed by a trained colleague the first time they took a test [1]. To facilitate this, NHS organisations were required to identify staff trainers and facilities to enable healthcare workers to be observed when they collected and used a device for the first time.

NHS organisations were expected to provide practical support, with hands-on demonstrations/training, for staff for whom English was not their first language or who had problems with dexterity or other issues. Self-test instructions in various formats and languages were available [8]; translations and British Sign Language services were also available by calling the 119 helpline.

For the purposes of this evaluation, the statistical and economic evaluation focused on secondary care only; primary and independent healthcare settings were excluded due to a lack of available data and difficulty in accessing existing data within the evaluation timeframe. In addition, these other settings had a smaller staff population size (the NHS Hospital and Community Health Service workforce comprised 1,355,780 people as of September 2021, whereas the primary care workforce was smaller, at approximately 400,000 people) [9]. However, operational insights within this chapter aimed to establish the intended and actual design of the testing service across both primary and secondary care. Due to the limited number of existing behavioural studies relating to asymptomatic testing, the observations about asymptomatic testing were drawn from a wide range of peer-reviewed publications describing various types of testing, such as daily contact testing and symptomatic testing.

### 4.3.3 The number of tests reported for NHS trusts represented just a fraction of the number distributed, which may have been due to under-reporting of negative tests

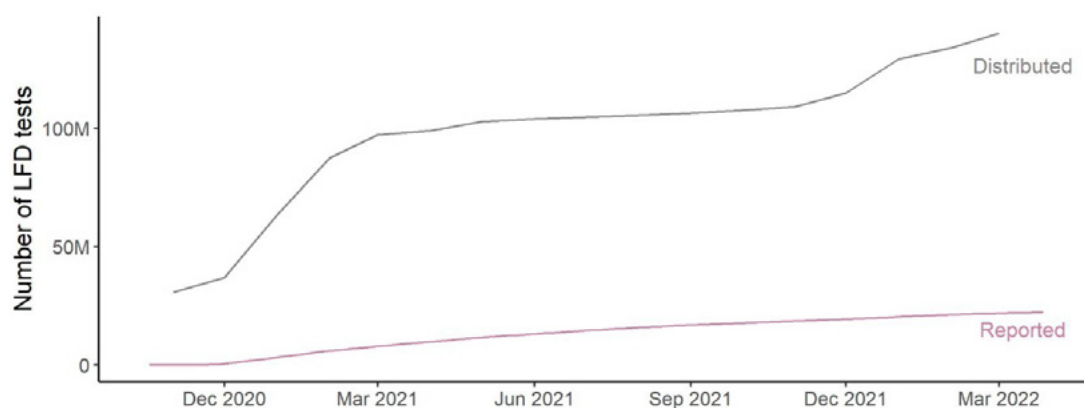
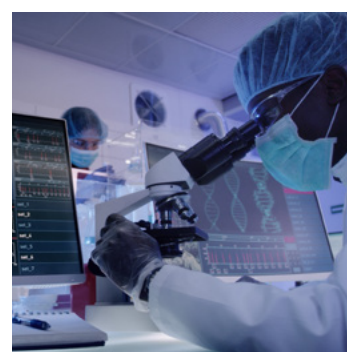


Figure 4-1 Cumulative volume of LFD tests distributed and reported across all English healthcare settings.

As shown in Figure 4-1, much lower numbers of LFD tests were reported by NHS trusts in England than the numbers distributed. This is likely to reflect tests taken but not reported, influenced by changes in reporting systems over time and the lack of a consistent, centralised reporting system. The speed of the testing rollout was such that no central reporting system for results of LFD tests was initially available, so each individual trust developed their own reporting system for results and uploaded the data to Public Health England (PHE). Furthermore, and based on findings from our healthcare stakeholder conversations, organisations used a wide range of solutions for reporting LFD results, with some developing their own mobile apps for reporting, some uploading their collated results via Excel spreadsheets and others reporting via emails that included data tables and lists of surnames.

Stakeholders suggested that a possible explanation for the discrepancy between the number of LFD tests distributed and reported could be that there was no rationale stated for reporting negative results, despite this being mandatory and required for the NHS to be able to carry out performance management. Stakeholders also noted that healthcare workers had not associated recording a negative test result with the normal standards required for health-record keeping, where reporting all tests results is required. Therefore, healthcare workers may have viewed reporting a negative COVID-19 test result as being a burden and that they were being required to report something that did not have any impact. It is worth noting that it was unclear from our literature review whether there were evaluated healthcare worker training materials that detailed when and how to report, which may also have impacted reporting rates.

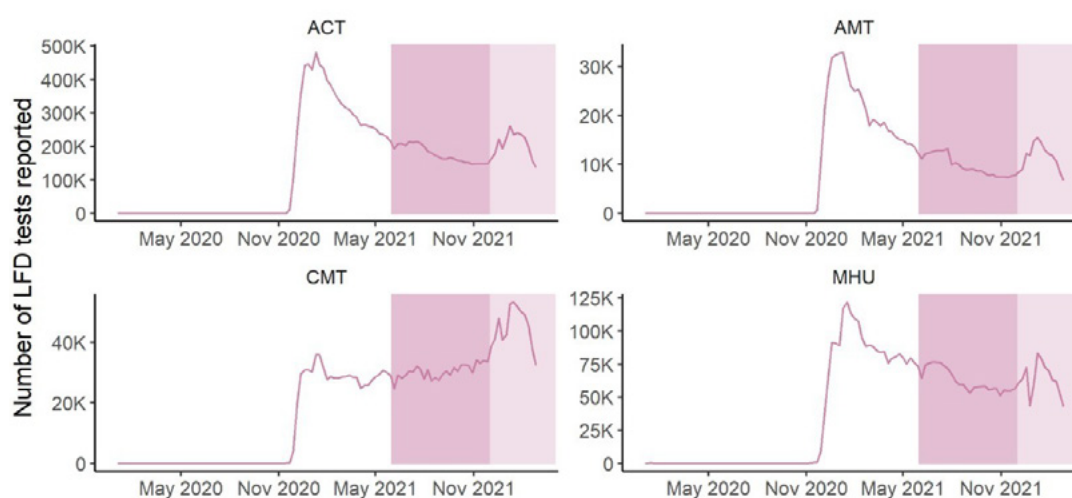


The cumulative volume of PCR tests registered and reported has not been included here as, due to a change in the approach to data collection, there was no differentiation by use case (patients versus healthcare workers) for reported PCR tests. Furthermore, the majority of the healthcare workers testing service was conducted using LFD tests. Healthcare workers comprised 95.2% of total LFDs distributed to the NHS and just 9.5% of registered Pillar 1 PCR tests.

An SOP published in September 2021, by NHSE, for primary care and acute trusts, noted that it was important to instruct healthcare workers to report results via a single route, to avoid duplication [10]. Duplicate reporting may have led to additional work pressures on PHE to remove any duplicates from the data. Duplicates were likely to have been reported by healthcare workers who worked for trusts, as they could have double-reported their test results, via both the gov.uk website and the existing reporting route in their trust.

#### 4.3.4 There were large variations in the numbers of LFDs and PCR tests reported, with no discernible trend observed

##### 4.3.4.1 Weekly volumes of reported LFD and PCR tests followed similar trends across all healthcare settings except for community trusts



**Figure 4-2. Weekly volume of LFD tests reported by NHS trust type.** ACT = acute trusts, AMT = ambulance trusts, CMT = community trusts, MHU = mental health trusts. The shaded areas correspond to time periods when the Delta (dark pink) or Omicron (light pink) variants were predominant. Note that the y-axis scales are different for each panel.

The changes in weekly testing volumes reported shown in Figure 4-2 and Figure 4-3 align with changes in healthcare worker testing protocols and variants over time. The number of LFDs reported peaked in all healthcare settings in the week of 9 January 2021, with 667,791 LFDs, likely coinciding with the third national lockdown, which began on 6 January 2021 (Figure 4-3 and Figure 4-4). The highest weekly number of LFDs was reported in acute trusts, with 481,415 tests in the week of 9 January 2021. After this time, reporting decreased. The lowest number of LFDs reported was in ambulance trusts, with 6217 tests in the week of 5 March 2022. With the data that were received it was not possible to point to a potential hypothesis that might explain why a different trend was observed for community trusts.

4.3.4.2 There was an increase in LFD tests reported by healthcare workers in November 2021, likely as a result of changes in policy brought about in response to the emergence of the Omicron variant

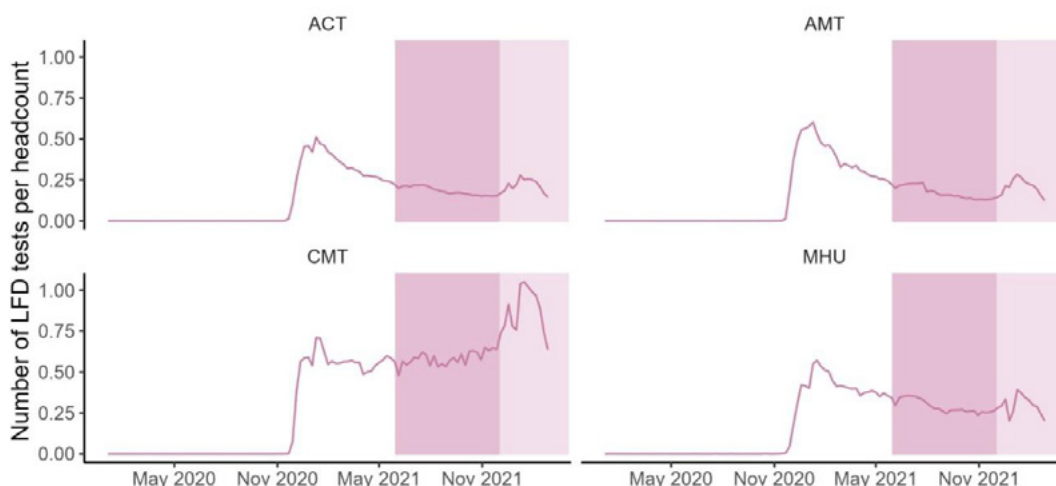


Figure 4-3. Weekly volume of LFD tests reported per worker by trust type (Pillar 1 and 2). ACT = acute trusts, AMT = ambulance trusts, CMT = community trusts, MHU = mental health trusts. The shaded areas correspond to time periods when the Delta (dark pink) or Omicron (light pink) variants were predominant.

The average number of LFD tests was approximately 0.5 tests per worker per week in December 2020 (Figure 4-3). This decreased to approximately 0.25 tests reported per worker per week over time in all trust types, except for community trusts where it remained at this level until the Omicron variant period, when it increased considerably (up to one test per worker per week). In other trust types, the increase seen during the Omicron period was not so pronounced, although reported LFD tests per worker still increased. The increase in test reporting seen after November 2021 could have been due to the arrival of the more transmissible and increasingly prevalent Omicron variant and a national drive for contacts to test for seven days, irrespective of vaccination status [11].

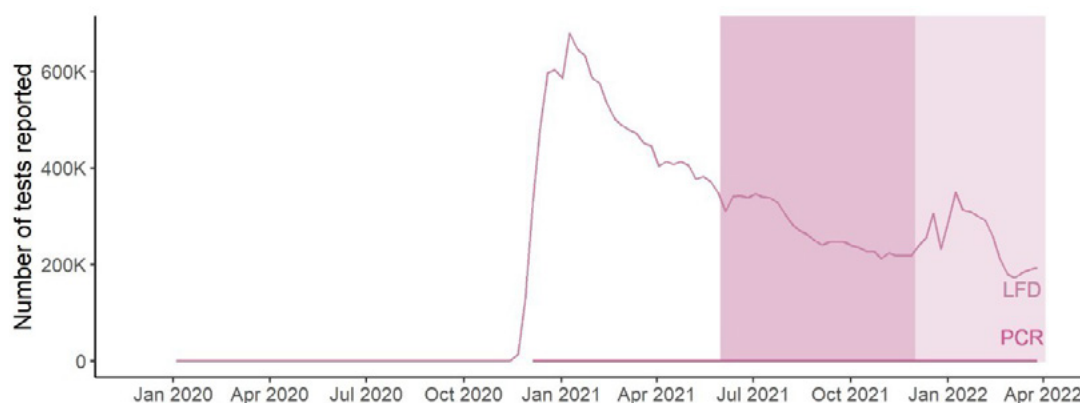


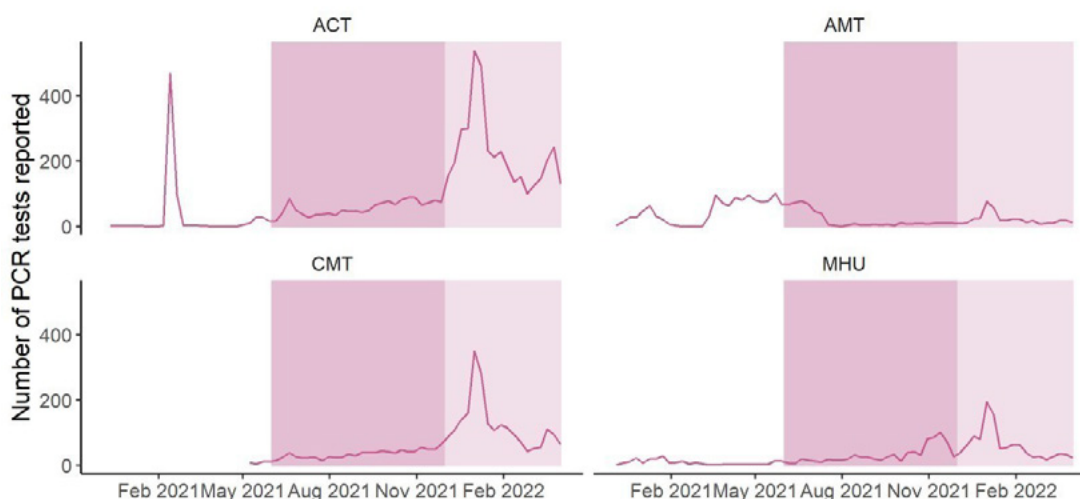
Figure 4-4. Weekly volume of PCR tests reported by trust type. ACT = acute trusts, AMT = ambulance trusts, CMT = community trusts, MHU = mental health trusts. The shaded areas correspond to time periods when the Delta (dark pink) or Omicron (light pink) variants were prevalent.

The number of tests reported increased from November 2020 to January 2021 (Figure 4-4), as the rollout of asymptomatic testing for patient-facing healthcare workers began in 34 trusts, benefiting more than 250,000 staff, with the full rollout following soon after. Eligible patient-facing healthcare workers were required to undertake twice-weekly, at-home testing with a self-administered LFD or LAMP test with a confirmatory PCR, ideally before attending work. The rapid acceptance and increase in the use of LFD tests may have been due to the fact that LFDs enabled

testing at home, which was described by healthcare workers as preferable to testing at work [12]. A spike in testing was seen around January 2022, coinciding with the Omicron variant period.

There is an inherent tension between local risk-assessment and national guidance. Due to the flexible approach to defining which healthcare workers were eligible for testing, it was challenging to understand the effectiveness of service implementation, as who was included in the specific target population eligible for testing was not reported. Therefore, for this evaluation we had to rely on assumptions related to the total population of the workforce eligible for testing.

**4.3.4.3 Overall, the total numbers of PCR tests reported were low, with a peak of approximately 600 tests reported in a week for acute care trusts, with a small peak in confirmatory PCR testing across all settings seen during the Omicron period**



**Figure 4-5. Weekly volume of PCR tests reported by trust type.** ACT = acute trusts, AMT = ambulance trusts, CMT = community trusts, MHU = mental health trusts. The shaded areas correspond to time periods when the Delta (dark pink) or Omicron (light pink) variants were prevalent.

PCR testing data were sparser than LFD testing data (Figure 4-5). All PCR tests (both symptomatic and confirmatory) were initially reported in Pillar 1 (total number of tests, n = 2696; overall median number of tests reported in Pillar 1 per week = 7). However, from spring 2021, PCR tests were primarily reported in Pillar 2 (n = 25,043; overall median number of tests reported in Pillar 2 per week = 125). Across all trust settings, PCR tests were seen to peak during the Omicron variant period, although total test numbers were still very low.

PCR tests were not always used consistently by healthcare workers. There were cases of healthcare workers using LFDs for symptomatic testing, in breach of the guidance to use PCR tests [13], but it was not clear whether this was a lack of understanding or a choice. Furthermore, before LFDs were widely available, the PCR testing process itself was perceived as a potential driver of infection, as individuals were ‘worried that the test kit drop-off points were sites of potential infection’; this may have affected the number of PCR tests reported [14]. In addition to this, our stakeholder interviews confirmed that in the Pillar 1 data there was no differentiation of PCR results of patients versus healthcare workers; therefore, it was difficult to distinguish test results associated with healthcare workers from those of patients.

**4.3.4.4 The move, in July 2021, to an individual healthcare worker-initiated pull model for LFD supply may have contributed to the decrease seen in the number of tests reported after this time**

According to the November 2020 SOP for asymptomatic testing of healthcare workers in NHS trusts [1], Innova LFDs were supplied to NHS organisations in England to meet the requirements of the staff population to be tested. This was achieved through an agreed ordering schedule with NHSE and constituted a ‘push’ system for ordering tests.



From 5 July 2021, the NHS moved from this push model to an individual staff member-initiated 'pull' model for the supply of LFDs [5]. Healthcare workers were now required to order kits for self-testing at home, via the universal testing service, while LFDs for staff were no longer distributed to trusts. Staff were advised to follow this system once they had used up their supply of Innova LFDs. Staff were required to order their own tests online and input the name of the trust where they worked to ensure the tests were registered as belonging to an NHS member of staff. A box of tests was posted to staff at their home address. Although the responsibility for requesting tests moved to NHS staff members, this did not alter the trend in the number of tests distributed and reported.

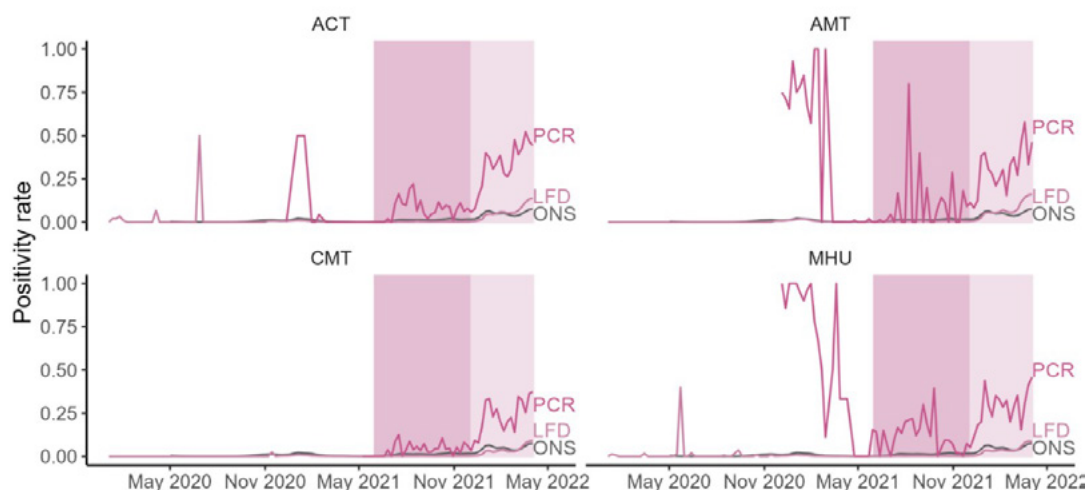
As noted in our stakeholder interviews, the move to a pull model was implemented to reduce the burden on trusts; however, a major issue was the time needed to build new IT infrastructure within the context of other IT priorities for the government. While the shift to the individual pull model was beneficial from an operational point of view, it removed access to data at the granular level needed for the effective surveillance of nosocomial infections and the corresponding management of staffing. The data that were shared back from UKHSA to trusts were not sufficiently granular for this purpose, due to data sharing constraints and the limitations of the IT capacity.

When universal testing was made available to the entire population in April 2021, there may have been instances when healthcare workers ordered their tests via gov.uk as a member of the public, before this way of ordering and reporting was officially launched for healthcare workers in the summer of 2021. Similarly, healthcare workers with children may have likely utilised the schools testing supply route. As noted in the stakeholder interviews, there is only anecdotal evidence to support this assumption; however, it is likely that this may have been happening when trusts were running out of stock and the new mass supply of tests had not yet arrived. It could also have happened among those groups of healthcare workers who were not eligible for testing as per localised definitions of eligibility (see appendix 4.3 for more details). Additionally, where healthcare workers were eligible for testing, the test kits allocated to healthcare workers may have been used by other household members.

#### 4.3.4.5 Increasing levels of vaccination and decreased perceptions of risk may have further contributed to the fluctuations in testing observed following the vaccine rollout in December 2020

Healthcare workers were among the four priority groups to receive COVID-19 vaccinations [15], starting in early December 2020, and this may have been one of the contributing factors that drove the uptake of testing and reporting after this period. Healthcare workers, as well as the general population, shared the perception that vaccination alongside falling prevalence decreased the risk of contracting and spreading SARS-CoV-2. An Italian study demonstrated that the perception of COVID-19 risk decreased after vaccination [16], thus the vaccine rollout may have reduced the perceived value of testing.

#### 4.3.4.6 The positivity rate of LFD tests followed prevalence estimates, with more irregular trends observed for the PCR positivity rate



**Figure 4-6. Weekly proportion of all reported tests that were positive for COVID-19 in English NHS trusts, by type of trust and test type (LFD or PCR).** ACT = acute trusts, AMT = ambulance trusts, CMT = community trusts, MHU = mental health trusts. Grey line: estimated prevalence of COVID-19 in the population, from ONS data. The shaded areas correspond to time periods when the Delta (dark pink) or Omicron (light pink) variants were predominant.

The positivity rate of LFD tests generally followed COVID-19 prevalence estimates (Figure 4-6), while the PCR positivity rate was more erratic, with much higher positivity rates observed, likely due to the small sample size and selection bias. In ambulance and acute trusts, between January and March 2022, LFD positivity was much higher than the population prevalence, indicating possible bias in reporting and higher prevalence in healthcare workers due to the Omicron variant. In addition to declining prevalence, intermittent decreases seen in PCR test reporting were potentially driven by the recommendation to cease home testing for 90 days after any positive result was confirmed by PCR [1].

PCR positivity rates were high in early 2021, before decreasing rapidly, followed by further increases during each of the Delta and Omicron periods of dominance. Only one of these periods, during the dominance of Omicron, reflected prevalence. In January 2022, the requirement for confirmatory PCR tests was suspended [17]. Therefore, the increase in positive PCR test results seen in Figure 4-6 represents only symptomatic PCR testing, with a much smaller population denominator, likely driven by Omicron prevalence.

## 4.4 We explored whether the healthcare workers testing service supported the hypothesis of the evaluation and whether it achieved UKHSA's intended objectives and purpose

### Summary of key findings

Did the healthcare testing service fulfil its UKHSA intended aims? Was the healthcare testing service a cost-effective intervention?

- ▶ Nosocomial infections in hospitalised patients were closely associated with LFD testing coverage, with this association being greatest during the Omicron variant period. Our analysis showed that healthcare worker testing was associated with a 16.8% reduction in nosocomial infections.
- ▶ Our models indicate testing would have been cost-effective in reducing nosocomial infections at a testing effectiveness of 5.5% or more. We estimated the effect size to be 16.8%, indicating that this service was likely to have been highly cost-effective.
- ▶ Our analysis suggests that community prevalence was driving full-time equivalent (FTE) days lost due to COVID-19 infection in the healthcare sector. Increases in LFD test coverage were associated with decreases in FTE days lost due to COVID-19, except during the Delta and Omicron periods when no association with testing coverage was observed. It was not possible to quantify the impact of testing on economic productivity.

What were the behavioural barriers and facilitators to taking a COVID-19 test, reporting of a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?

We synthesised from retrospective data that:

- ▶ The uptake of testing seen throughout the healthcare workers testing service was driven by the perceived value of testing, as evidenced by the qualitative literature.
- ▶ Healthcare workers were motivated to test to keep patients and families safe.
- ▶ The physical experience of taking a test was not flagged as a barrier for healthcare workers, with the barrier perceived to be overcome by the value they ascribed to testing.
- ▶ Healthcare workers needed clearer guidance on when to test, especially in the face of changing testing policy and regimens.
- ▶ The requirement for healthcare workers to self-isolate following a positive test placed a burden on healthcare system resources.

SUMMARY

#### 4.4.1 Did the healthcare workers testing service fulfil its intended aims? Was the healthcare workers testing service a cost-effective intervention?

4.4.1.1 Nosocomial infections in hospitalised patients were closely associated with LFD testing coverage, with this association being greatest during the Omicron variant period. Our analysis showed that healthcare worker testing was associated with a 16% reduction in nosocomial infections

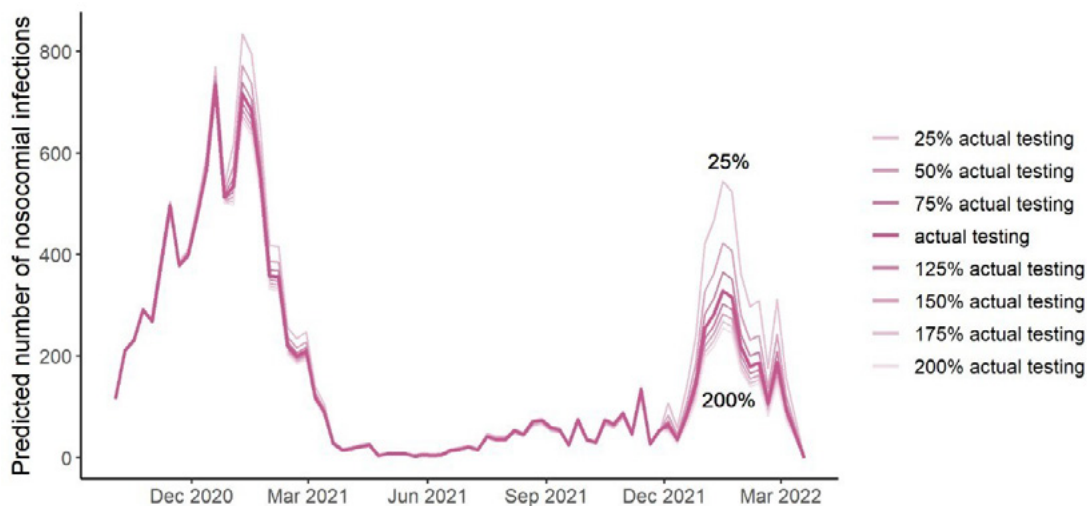


Figure 4-7. Weekly number of nosocomial infections predicted for different testing scenarios, for 136 trusts included in the analysis.

Our analysis showed that the proportion of nosocomial infections among new weekly cases in hospitalised patients (which included new admissions and cases diagnosed in hospital) was negatively associated with reported LFD testing levels (Figure 4-7). Overall, the analysis predicted that healthcare worker testing was associated with a 16.8% (95% confidence interval (CI) 8.2%-18.8%) reduction in nosocomial infections compared with a testing scenario at 25% of actual levels. Models were based on the fitted data, which represented 100% of reported tests. As extrapolations to zero (no testing) are not statistically robust, fractions of testing were considered with the lower limit of 25% of actual levels. However, the strength of this association varied over time and was estimated to be highest during the Omicron period, with a doubling of testing coverage (number of tests reported per person per week) associated with a 22% (95% CI 4%-47%) decrease in the risk of the COVID-19 infection being nosocomial (see appendix 4.4 for the full analysis). It is worth noting that testing is effective when implemented alongside additional infection control measures, such as isolation.

#### 4.4.1.2 Testing would have been cost-effective in reducing nosocomial infections at a testing effectiveness of 5.5% or more. The estimated testing effectiveness was 16.8%, indicating that this service was likely to have been highly cost-effective in terms of averting nosocomial infections

The statistical analysis in section 4.4.1.1 estimated that healthcare worker testing was associated with a 16.8% (95% CI 8.2%-18.8%) reduction in nosocomial infections compared with a testing scenario at 25% of actual levels. This was in line with a modelling exercise carried out by UKHSA in 2022, which estimated that the reduction in nosocomial infections due to weekly testing of staff was 16%, and the reduction due to daily testing of staff was 25.4% [18]. However, given the increased resources needed for daily testing, the level of cost-effectiveness was lower under this scenario.

Using actual hospitalisation data from during the evaluation period (October 2020 to March 2022), and the range of values obtained from the statistical analysis, we conducted a sensitivity analysis assuming reductions in nosocomial infections of 8%-20% due to weekly testing of staff and 15%-30% due to daily testing of staff, to assess the potential impact of testing on the number of deaths averted and QALYs gained, and the corresponding cost-effectiveness (Table 4-3). Nosocomial infections and deaths averted were modelled at these various potential reduction levels, and

cost savings from infections averted and intensive care unit (ICU) admissions averted were estimated. The costs per nosocomial infection averted, per death averted and per QALY gained were estimated. Summary results of the sensitivity analyses for weekly and daily testing are shown in Table 4-3 and Table 4-4, respectively. The costs per QALY gained at various rates of reduction in nosocomial infections due to weekly testing (the actual UKHSA testing strategy) were plotted (Figure 4-8) to determine the threshold of testing effectiveness for weekly testing to be cost-effective (see appendix 4.5 for the detailed methodology).

**Table 4-3. Summary of the cost-effectiveness of weekly testing with respect to nosocomial infections averted during the evaluation period (October 2020 to March 2022).**

	Reduction in nosocomial infections due to testing		
	8%	16%*	20%
Number of nosocomial infections averted	17,500	35,000	43,800
Number of deaths averted	5500	11,000	13,800
Cost per nosocomial infection averted (GBP)	101,100	50,600	40,5500
Cost per death averted (GBP)	320,800	160,000	127,900
Number of QALYs gained	38,000	76,100	95,100
Cost per QALY gained (GBP)	46,400	23,200	18,500

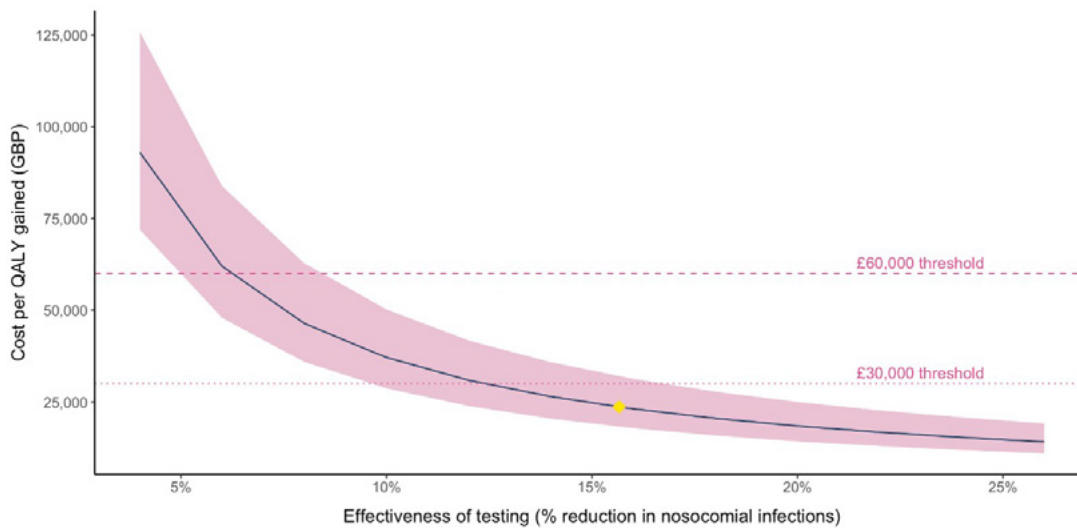
\*The statistical analysis above estimated that healthcare worker testing was associated with a 16.8% (95% CI 8.2%-18.8%) reduction in nosocomial infections compared with a testing scenario at 25% of actual levels.

At an effectiveness of 8% to 20%, between 17,500 and 43,800 nosocomial infections were averted during weekly testing of healthcare workers. The number of deaths averted ranged from 5500 to 13,800, with a cost per death averted of GBP 127,900-320,800. Between 38,100 and 95,100 QALYs were gained, translating to a cost per QALY gained of GBP 18,500-46,400. A sensitivity analysis of the QALY values for deaths generated a cost of GBP 25,000-62,800 per QALY gained at a value of 4.98 QALYs per death averted and GBP 14,300-35,900 per QALY gained at a value of 8.8 QALYs per death averted at a testing effectiveness rate of 4%-26% (Table 4-3).

**Table 4-4. Summary of cost-effectiveness of daily testing with respect to nosocomial infections averted during the evaluation period (October 2020 to March 2022).**

	Reduction in nosocomial infections due to testing		
	15%	25%	30%
Number of nosocomial infections averted	32,800	50,400	65,700
Number of deaths averted	10,300	15,800	20,700
Cost per nosocomial infection averted (GBP)	53,900	35,200	27,000
Cost per death averted (GBP)	630,300	410,800	314,800
Number of QALYs gained	71,400	109,400	142,700
Cost per QALY gained (GBP)	91,300	59,500	45,600

At a daily testing effectiveness of 15% to 30%, between 32,800 and 65,700 nosocomial infections were averted due to testing of healthcare workers. The number of deaths averted ranged from 10,300 to 20,700 with a cost per death averted of GBP 314,800-630,300. The cost per QALY gained was GBP 45,600-91,300. A sensitivity analysis of the QALY values for deaths cost GBP 61,600-123,400 per QALY gained at a value of 4.98 QALYs per death averted and GBP 35,300-70,600 per QALY gained at a value of 8.8 QALYs per death averted (Table 4-4).



**Figure 4-8. Cost-effectiveness of weekly testing at different levels of testing effectiveness with respect to averting nosocomial COVID-19 infections in England.** The shaded area indicates the cost per QALY gained at an upper value of 8.8 QALYs per death averted and a lower value of 4.98 QALYs per death averted. The line shows the analysis conducted at a value of 6.78 QALYs per death averted. The yellow point at 16.8% represents the statistically modelled level of testing effectiveness in reducing nosocomial infections.

Figure 4-8 illustrates the cost-effectiveness (cost per QALY gained) for various assumptions of testing effectiveness with respect to reducing nosocomial infections of COVID-19 in acute care trusts in England. The range (shaded area) shown in the plot indicates the cost per QALY gained at an upper value of 8.8 QALYs per death averted and a lower value of 4.98 QALYs per death averted.

The healthcare worker testing service was cost-effective at reducing nosocomial infections at values of effectiveness of 5.5% or more, at a willingness to pay threshold of GBP 70,000. The statistical analysis in section 4.4.1.1 estimated that healthcare worker testing was associated with a 16.8% (95% CI 8.2%-18.8%) reduction in nosocomial infections compared with a testing scenario at 25% of actual levels. This suggests that for all values of effectiveness predicted in the 95% CI, the healthcare worker testing service was cost-effective. The yellow dot in Figure 4-8 illustrates that at an overall 16.8% decrease in nosocomial infections, the healthcare worker testing service was cost-effective, at a cost of GBP 22,100 per QALY gained, which is well below the Green Book willingness to pay threshold of GBP 70,000 [19]. The healthcare worker testing service was cost-effective at reducing nosocomial infections at values of effectiveness of 12.5% or more at the National Institute for Health and Care Excellence (NICE) threshold of GBP 30,000.

Compared with a hypothetical scenario of no testing, the healthcare worker testing service was likely to have contributed to an even greater reduction in nosocomial infections and hence would have been highly cost-effective.

#### **4.4.1.3 Our analysis suggests that community prevalence was driving full-time equivalent (FTE) days lost due to COVID-19 infection in the healthcare sector. Increases in LFD test coverage were associated with decreases in FTE days lost due to COVID-19, except during the Delta and Omicron periods, when no association with testing coverage was observed**

In this section, we explore the impact of testing coverage on FTE absenteeism. The results in this section should be interpreted with caution, as testing had two effects on absenteeism, which worked in opposite directions. Testing meant more cases would be identified and would need to isolate (both necessary isolation of asymptomatic cases and unnecessary isolation of individuals who received false-positive results), leading to an increase in absenteeism. The isolation of individuals with true-positive results would reduce onward transmission and subsequent isolations, leading to a reduction in staff absenteeism. The balance of these two dynamics changed over time and at different comparator levels of testing. It should be noted that we were unable to distinguish between symptomatic and asymptomatic tests in this analysis, because this was not recorded in Pillar 1 data.





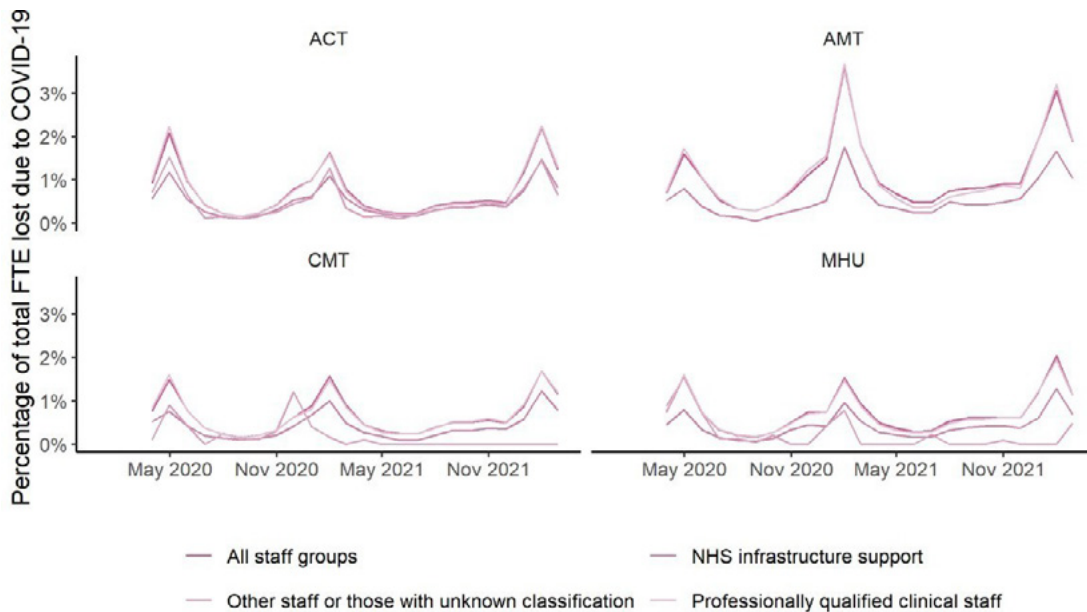


Figure 4-9. Monthly absenteeism data over time, by trust type and staff group. ACT = acute trust; AMT = ambulance trust; CMT = community trust, MHU = mental health trust.

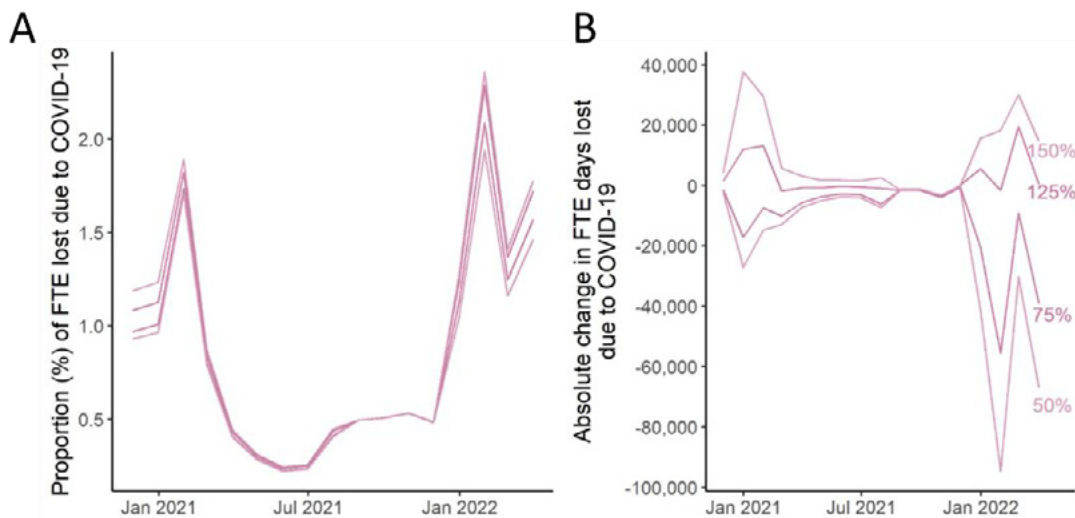


Figure 4-10. Predicted FTE days lost due to COVID-19 in all acute trusts, associated with increased (125%-150%) or decreased (50%-75%) coverage of testing and reporting, shown as percentage of total FTE days available (A) and as the number of additional FTE days lost (B).

FTE days lost due to COVID-19 varied over time, by trust type and by staff group (Figure 4-9) and ranged between 0% and 4% of the total corresponding FTE days available. Our analysis suggested that community prevalence was driving FTE days lost due to COVID-19 infection in the healthcare sector but that at times testing seemed to mitigate this.

Before and during the vaccine rollout, higher levels of healthcare worker testing was associated with reductions in FTE days lost due to COVID-19. Conversely, there were no association between healthcare worker testing and FTE days lost due to COVID-19 during the Delta and Omicron phases, which were periods of high community prevalence. The increase in LFD test coverage was associated with decreases in FTE days lost due to COVID-19 during the first two time periods (models 1 and 2, Table 1 in appendix 4.4). Higher levels of COVID-19 prevalence in the community were associated with significant increases in FTE days lost due to COVID-19 in all periods except for the pre-vaccination period. Effect sizes ranged from 0.23% to 0.46% increases in FTE days lost for each relative 1% increase in community prevalence of COVID-19. Similarly, the LFD positivity rate in healthcare workers was positively

associated with FTE days lost due to COVID-19. The average income deprivation score was not associated with FTE days lost. Our model predicted that changes in testing levels (50% to 150%) would have resulted in modest changes in FTE days lost due to COVID-19 for all time periods (Figure 4-10).

Due to testing having two effects on absenteeism, which worked in opposite directions, the impact of testing on economic productivity was difficult to quantify.

#### **4.4.1.4 Nosocomial infections being released into the community**

We did not quantify the impact of patients with undetected COVID-19 being released into the community and potentially infecting others through secondary transmission. We therefore believe that the actual community impact of the intervention was likely to have been greater, making it more cost-effective.

#### **4.4.1.5 Impact of long-COVID**

We did not quantify the impact of early detection on the cost of long-COVID, including the cost to the healthcare system and patients' quality of life.

### **4.4.2 What were the behavioural barriers and facilitators to taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?**

In any future pandemic, healthcare workers will likely be a target group for testing. This, combined with the efficacy of testing highlighted in this evaluation, makes it important to determine the barriers and facilitators healthcare workers identified in relation to testing.

#### **4.4.2.1 The uptake of testing seen throughout the healthcare workers testing service was driven by the perceived value of testing, as evidenced by the qualitative literature**

##### **Healthcare workers were motivated to test to keep patients and families safe**

The consistent level of LFD test reporting across all trust types could in part be due to the perception of COVID-19 risk, which appeared to influence the value healthcare workers placed on testing [20]. A major driver of value was the perceived benefit that testing represented to keeping others safe [12-14]. For healthcare workers, the value of point of care (POC) testing was associated with its ability to influence the 'risk of contagion' [21] and the 'motivation to protect their communities' [14], which outweighed any individual benefits arising from testing [13]. Healthcare workers described the security they felt that they would not be transmitting COVID-19, either to patients ('I feel safe seeing my elderly/vulnerable patients') or to their loved ones ('Assures me I'm not a silent spreader, keeps my family safe') [13].

##### **The physical experience of taking a test was not flagged as a barrier for healthcare workers, with the barrier perceived to be overcome by the value they ascribed to testing**

Throat and nose swab sample collection for testing was generally an uncomfortable experience, which was raised as more of an issue when it was recommended that testing be conducted more regularly. However, it appears that for healthcare workers this physical discomfort was not a barrier to engaging with testing. This seemed to be because the barrier of physical discomfort was overcome by the value ascribed to testing. Despite 60.1% (1187/1976) of respondents reporting the procedure to be 'fairly uncomfortable' or 'very uncomfortable', 94.5% (1829/1935) stated they would continue the twice-weekly LFD testing process during the pandemic; respondents felt it to be 'a negligible inconvenience if it helps save lives and livelihoods' [13]. Saliva sampling for LAMP testing was perceived to be much easier to perform than sampling using throat and nose swabs [14].

#### 4.4.2.2 Clearer guidance was needed on when to test

##### **Healthcare workers needed clearer guidance on when to test, especially in the face of changing testing policy and regimens**

The guidance for healthcare workers on reporting and testing could have been clearer. While healthcare workers understood how to test, some flagged confusion around when to test [12, 22], and stakeholder interviews identified that confusion also existed regarding how long to self-isolate for. There were cases of healthcare workers using LFDs for symptomatic testing, in breach of the guidance to use PCR tests [13], but it was not clear whether this was a lack of understanding or a choice. Early experiences of testing (before the launch of repeat asymptomatic testing for healthcare workers) were characterised by a lack of knowledge of the POC testing landscape [21] and reflected 'emerging knowledge on the nature of the virus, its symptoms and transmission routes' [20].

Not all healthcare workers understood the testing guidance. A lack of understanding of the requirement to test was described as negatively affecting healthcare worker attitudes to the implementation of testing. This 'negatively affected their willingness to adopt the tests', while this 'limited knowledge acted as a barrier as they were unable to identify the advantages or disadvantages of implementing POC tests into practice' [21]. Some healthcare workers were confused by the guidance, which acted as a barrier to testing as per requirements. Some primary care physicians also expressed uncertainty about when one should be tested and found the guidance confusing, while some sought clarification and advice from colleagues, which at times led to them not getting tested [20].

There was also confusion around the reporting of results: who was responsible for reporting results within an organisation and to whom should the results be reported [23]. Furthermore, early in the pandemic, issues were raised regarding PCR results around who the test results should be given to and which clinical records they should go on:

“

... does it go to your GP? Does it go to occupational health or ... does it go purely to the individual? (Clinical director) [23].

However, despite confusing guidance, there appeared to be a better understanding of how to test than when to test. This was not unexpected, as many healthcare workers, especially clinical staff, have experience with sample collection and POC testing through the management of other diseases, which may have contributed to their confidence in performing LFD tests for COVID-19 [21]. Additionally, the regular and routine performance of LFD testing meant staff reported being 'familiar with how to test and report LFD results' [12].

“

All the people that work in the practice can take blood and do swabs, and quite a lot of us do respiratory stuff, spirometry and other breathing things. With simple training, we should be able to manage a point of care test that is simple, and it's making sure it can be done repeatedly and accurately. (GP 16) [21].

The level of understanding and confidence to facilitate testing could be enhanced through the communication of educational materials and through training [21]. While accepting that this extra work was for a good cause, some suggested a 'toolkit' of instructions and tips for those implementing the testing service, to help manage the expectations of both staff and participants [14].

Overall, however, most healthcare workers had no technical problems with the use of LFDs [13], and most felt that the instructions for testing were clear [14]. In one survey, all participants (n = 58) reported being at least 'fairly confident' that they conducted the test correctly [12]. This confidence extended to swabbing, mixing samples with the buffer, cartridge inoculation, and reading a test result [12, 13], with 98% (of 1937 healthcare workers surveyed) performing LFD testing unassisted and preferring to do so [13] (see appendix 4.3 for more details).

#### 4.4.2.3 The requirement for healthcare workers to self-isolate following a positive test placed a burden on healthcare system resources

Requiring staff to self-isolate following a positive test result placed demands on healthcare system resources. Healthcare workloads were already increased due to the demands of the pandemic; this situation was exacerbated by the requirement for staff to self-isolate and resulted in staff shortages [24]. This loss of workforce had organisational implications for healthcare services [23], as it meant 'putting extra pressure on the remaining staff' [25] and threatened the ability of healthcare units to function. As isolation was a core part of infection control, this highlights the need for mitigation strategies to be in place to alleviate the issue of a reduced workforce.

“

One of the key vulnerabilities in this is the sustainability of the general practice service. You know, what we want to do is make sure that we don't lose people, we don't have to self-isolate...So, we're losing manpower, and therefore productivity and sustainability. (GP 21) [21].

This reduction of workforce was described as an 'ethical dilemma', because of the impact on health service provision [23]. Stakeholders noted that this was interesting, as the issue causing the dilemma was which approach would cause the least harm. It also resulted in feelings of guilt for those who were isolating and not contributing to the work of a team that was already running at reduced capacity, especially when they needed to contact these team members for information:

“

...for 14 days I had to work from home without remote access. So, I only had access to my emails, I couldn't get remote access to the electronic medical records system, so I had to do telephone reviews or do anything to help the team in the hospital...I was feeling bad being at home, pestering my colleagues. (Registered dietician) [23].

## 4.5 Conclusions

In any future pandemic, healthcare workers will inevitably be a target cohort that will benefit from testing.

Our evaluation has shown that the testing of healthcare workers supported the NHS in its infection control risk-reduction strategy, as it led to a reduction in nosocomial infections, thereby protecting patients and staff.

Furthermore, testing supported reductions in staff absenteeism, except during the Delta and Omicron periods.

These factors made healthcare worker testing a highly cost-effective intervention when viewed in the context of QALYs gained and the cost per nosocomial infection averted.

We were unable to measure support to clinical pathways, for the winter period in particular, as this aim was too broad and specific data necessary to enable this evaluation were not collected.



## 4.6 Key considerations and service-level recommendations for future testing strategies

### Summary of key considerations and recommendations

We present the overall testing programme recommendations in chapter 6 of this report, with recommendations referring to testing services for high-risk groups and their contacts being particularly relevant to healthcare. Additional recommendations specific to the healthcare testing service are as follows:

#### Considerations

- ▶ Complexity in reporting results was experienced at both national and local levels
- ▶ Incentivisation approaches may drive testing and reporting
- ▶ The principle of local determination for defining 'patient-facing' healthcare workers led to confusion and local variation in testing eligibility

#### Recommendations

- ▶ Policies should be communicated clearly to avoid healthcare worker confusion. This should include a transparent justification, reliable evidence and the management of expectations for future policy and guidance updates
- ▶ Assess healthcare testing interventions in real time to support a responsive strategy, noting there is a trade-off between a responsive strategy and the challenges posed by rapidly changing guidance

SUMMARY

### 4.6.1 Considerations

#### 4.6.1.1 Reporting complexity was experienced at a national and local level

Our stakeholder workshops and rapid literature review of relevant behavioural research noted that healthcare workers (particularly clinical staff) follow protocols and guidance well, as they understand the impact of their non-compliance on public health and the health of their patients. Our evaluation also showed that there was a discrepancy between the numbers of LFD tests distributed and reported. Therefore, if reporting is designated as a duty that must be adhered to, NHS organisations need to ensure their staff comply with this requirement. Stakeholders highlighted that moving reporting to gov.uk made it more challenging for trusts to understand the performance of their individual testing services, as there was a perception that in most cases the responsibility for reporting and data collection moved to UKHSA.

Testing and test reporting is likely to be critical in the management of any potential future pandemic; it is important therefore that any new reporting system involves reporting at a local level. Our rapid literature review of relevant behavioural research and our stakeholder interviews demonstrated that healthcare workers trust the government less than they trust the NHS, and they trust local NHS organisations the most [21]. Also, some individuals declined to take part in a testing programme, as they did not trust the government with their data [14]. Another important point is that having access to data about the prevalence of infections allowed trusts to more efficiently manage outbreaks and staffing.

Stakeholders have suggested that for future pandemics:

- ▶ There is a need within healthcare trusts for IT functionality that brings together reporting processes that can provide data to assist in outbreak management and which can also be used for reporting centrally.
- ▶ There should be national-level reporting of test results, with the NHS feeding into this reporting system.
- ▶ IT infrastructure planning in NHS trusts should consider the need to capture self-testing results for patients and staff, along with the need for standardised application programming interfaces (APIs) that are able to connect with digital test-readers and other reporting structures.
- ▶ NHS trusts should have systems that allow self-test results to be inputted to their laboratory information management system (LIMS); this information could then be reported centrally via the laboratory reporting process for notifiable diseases.



- ▶ We encourage UKHSA, in collaboration with DHSC and NHSE, to explore what technology it may be sensible to invest in now, given that technology is likely to progress between now and any future pandemic.

As part of broader pandemic preparedness, NHSE and UKHSA must also establish clear roles and responsibilities for analysing and sharing data. It was unclear from our stakeholder interviews whose responsibility it was to analyse test reporting data for performance management purposes and with which stakeholder network the results of such analyses would need to be shared. Therefore, establishing these roles is crucial.

#### **4.6.1.2 Incentivisation approaches could drive testing and reporting**

UKHSA may also wish to further explore a system of penalties and incentives to encourage healthcare worker compliance. This approach would only be feasible where local NHS organisations have access to sufficiently detailed data that allow them to understand which sections of their workforce are under-reporting. However, there should be recognition and consideration of the level of pressure that healthcare workers were facing and the reasons why people actually tested, i.e., to protect themselves, their loved ones and their patients. Stakeholders noted that, while it was challenging to find an approach to incentives or penalties that could be successfully applied at a national level, there were some local initiatives in place, such as prize draws, for full compliance with reporting. As noted in our stakeholder conversations, developing a sense of community and peer support is an alternative way of incentivising while easing the pain of operationalisation. A tool that allows a comparison of reporting among peers could also act as a tool to connect with well-performing sites and their infection control teams, to enable learning from best practices.

#### **4.6.1.3 The principle of local determination for defining 'patient-facing' healthcare workers led to confusion and local variation in testing eligibility**

It is important to find the correct balance when defining the target population eligible for testing, between giving agency/autonomy at the local NHS level to define the target population and defining it from the top down.

According to the guidance for NHS trusts and primary care settings, the healthcare workers testing service targeted 'all patient-facing staff'; however, there was no definition of 'patient-facing staff' in the guidance. No-one knows their workforce, and who is patient-facing and who is not, better than each individual health organisation. Therefore, who was 'patient-facing' was best defined by local trusts. However, stakeholders noted that without a set of principles for defining 'patient-facing staff', there may be considerable variation in how this is defined among different trusts. This can lead to the perception of a lack of equity of access, where some people are kept safer than others, as well as confusion in instances where healthcare workers are employed by different providers. Stakeholder feedback has highlighted that the purpose of healthcare worker testing was for patient safety as opposed to healthcare worker safety, and therefore notions of equity were for equity of the safety of patients. This confusion further highlights the need to establish clear principles at a national level about who is eligible for testing, along with local level definitions and implementation. The stakeholders also noted that the lack of definitions and parameters made the implementation of the testing service particularly challenging when dealing with contractors or bank and agency staff.

One stakeholder noted that, initially, defining the eligible population among healthcare workers was based on the number of LFDs available, and the guidance prioritised access to these available tests. As the availability of tests improved and more healthcare workers could be tested, it was decided to keep this autonomy at the level of NHS trusts. However, reporting the total number of healthcare workers eligible for testing did not become a requirement. This decision was motivated by the fact that it was challenging to evaluate the total workforce due to its fluctuating nature, in part driven by the outsourcing of some services to locums and contractors. Additionally, due to increasing healthcare worker absences across the NHS, many people had to change roles, for example, they moved from management positions to clinical roles.

Our evaluation showed that, because accountability for implementation sat at the local level, eligibility for testing was locally defined. This approach meant it was a challenge to understand how efficiently the testing service was implemented, as the tests reported were not differentiated by the eligible target population. Therefore, for this evaluation we had to rely on assumptions related to the population of the eligible workforce instead of actual data. If the agency to decide on whom is eligible for testing remains at the level of the local organisation, then it is important that these organisations are required to report data relating to their total eligible target population, to enable a more accurate evaluation.

## 4.6.2 Recommendations

### 4.6.2.1 Policies should be communicated clearly to avoid healthcare worker confusion. This should include a transparent justification, reliable evidence and the management of expectations for future policy and guidance updates

Our literature review showed that, although there was clear guidance on how to test, healthcare workers needed clearer guidance on when to test, especially in the face of changing testing policy and regimens. As stakeholders noted in our conversations, the greatest cause of confusion was the continuously changing guidance on actions to take following a positive test and the length of self-isolation required.



The rate at which the guidance changed and reviewed was at times really challenging, especially in early days, when changes sometimes happened several times a day. You just think you understand, get something to share with everybody and it's changed. And that was really challenging to implement. (Interviewee, stakeholder workshop).

Stakeholders also noted that the reasons and justifications for policy updates were not always clear, in particular reasons related to changes to the guidance on the length of self-isolation.

Stakeholders noted that the guidance did not specify a deadline by which tests needed to be reported. This could have had a negative impact on the data recorded when tests were reported, as well as on staffing. A benefit that trusts experienced was that when they were collecting test results, they could use these data to manage their workforce. Adding more clarity around maximum reporting delays would be beneficial both for post-intervention evaluation as well as for real-time workforce management by health organisations. However, stakeholders also noted that the desire for very detailed guidance was not consistently expressed across settings, meaning there is a balance to be struck between the desire for local autonomy and for national instructions.

Our review of the relevant behavioural literature as well as our stakeholder interviews showed that healthcare workers trust the government less than they trust the NHS, and that they trust local NHS organisations the most [14, 21]. Moreover, some healthcare workers sought clarification and advice on the guidance from colleagues. There should be a clear system for the dissemination of communications from UKHSA, to the NHS nationally and locally, and then to employees. Consistent communication about updates to the guidance could be achieved through local champions, selected to explain the changing nature of the narrative and guidance to specific cohorts. Effective training is also required to support policy implementation, with systems in place to ensure required tests are completed. Education materials (e.g., videos) could be localised by using local healthcare workers; this could empower people to test and stay up-to-date with their knowledge of the testing policies in place. It is recognised that this approach may only be feasible for large organisations.

We recognise that the testing management strategy for COVID-19 required multiple updates to the testing service guidance due to the increasing knowledge base, epidemiological developments, and changes in human behaviour. Additionally, policy changes were not only related to testing but also to many other interventions implemented at the same time. As noted by the stakeholders, it would be helpful to have advance notice of any revisions to guidance; the likely frequency of revisions should also be clearly indicated, to manage expectations.



It is incumbent on all parties within the healthcare sector to share their views, requirements, capabilities and capacities. Facilitating continuous feedback from local NHS organisations and testing service participants on their experiences of a testing service can enable real-time modifications of the service. Such involvement could take the form of advisory meetings, workshops, focus groups or interviews.

Closer working of public health departments with local health organisations should be supported, to ensure sustained testing of healthcare workers. This would enable local NHS organisations and public health departments to rapidly identify particular pressure points and act in a timely manner.

#### **4.6.2.2 Assess healthcare worker testing interventions in real-time to support a responsive strategy, noting there is a trade-off between a responsive strategy and the challenges posed by rapidly changing guidance**

Our analysis of the available data indicated that healthcare worker testing interventions had varying impacts (on both nosocomial infections and healthcare worker FTE days lost) throughout the pandemic, possibly influenced by external factors such as community prevalence and vaccination. The rollout of healthcare worker testing interventions through pilot studies with collection of and/or timely access to data relating to suitable endpoints (healthcare worker absenteeism, routine test results, community prevalence, hospitalisations and mortality) could be used by UKHSA to support the real-time assessment of a testing service and adjustment of testing interventions. It is noted that there is an inherent trade-off between implementing a responsive strategy and the challenges posed by rapidly changing testing guidance (as highlighted in recommendation 2).



# Priority Service 3: Adult Social Care Testing Service

# Adult Social Care Testing Service

This chapter, focusing on key features of the adult social care testing service, will cover the following:



## 5.1 Executive summary of the adult social care testing service evaluation

Here, we summarise the findings of our evaluation of the adult social care testing service and compare them with UKHSA's stated purpose of the service and key indicators developed during the evaluation process.

### Outline of the hypothesis and research questions

Our evaluation aimed to answer the following questions<sup>6</sup>:

- ▶ Did the adult social care testing service fulfil its intended objectives and purpose across UKHSA's, the government's and DHSC's respective policies, identified through a review of UKHSA documents and other documentation supplied by the secretariat, publicly available content and stakeholder interviews, to:
  - ▶ Reduce transmission among staff and residents and consequently reduce hospitalisation and mortality rates. This relates to the overall evaluation hypothesis that the evaluation consortium chose to explore, regarding whether testing services aimed at high-risk groups led to a reduction in hospitalisations and deaths in those high-risk groups
  - ▶ Support the workforce
  - ▶ Support individuals' independence, support people at the end of their lives and respond to individuals' needs
  - ▶ Support local authorities and care providers

UKHSA and DHSC stakeholders highlighted that another key objective of testing in care homes was to open up these settings to visitors to both support the residents and reduce the risk of the virus being introduced into care homes. This will be explored along with our discussion of the above aims.

- ▶ Was the adult social care testing service a cost-effective intervention when considering the cost of deaths averted in residents and the cost per QALY (quality-adjusted life-year) gained; was testing still cost-effective following vaccination rollout?
- ▶ What were the behavioural barriers and facilitators for taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why its intended objectives and purpose across UKHSA, the government's and DHSC respective policies may or may not have been met?

For this part of the evaluation, we focused on care homes, which accounted for the majority of the adult social care testing service.

### Description of the context of the evaluation

#### Policy

- ▶ There were 19 changes in testing policy for care homes throughout the evaluation period, across staff, resident, visitor and outbreak testing.

#### Testing volumes

- ▶ Testing in care homes comprised 10% of the total volume of LFDs distributed and 29% of the total volume of Pillar 2 PCR tests registered.
- ▶ Testing overall in care homes and adult social care comprised 17% and 21%, respectively, of the total testing programme spend.
- ▶ For PCR tests, the testing rates per staff member and resident remained consistently at or near the guidance levels of one test per week and one test per month, respectively, while LFD testing reporting rates for staff remained consistently below the target.
- ▶ Testing was often scaled up in response to outbreaks within care homes.
- ▶ PCR reporting volumes were similar to the volumes registered, while LFD reporting volumes were markedly lower than the volumes distributed.

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<sup>6</sup> Please note that the final three of these are the aims of the service as stated by the Department of Health and Social Care (DHSC) [1]. The evaluation consortium prioritised those aims that were measurable within this evaluation and have not attempted to amend these aims to make them measurable. The four objectives outlined above evolved in the winter plan policy papers for 2020/21 [2] and 2021/22 [3].

## Factors associated with testing intensity

- ▶ To understand how the testing service was conducted in care homes, we explored the factors that were associated with resident testing intensity. Positive cases and testing in the previous week, COVID-19 prevalence in the community, and higher Care Quality Commission (CQC) rating were positively associated with testing intensity.
- ▶ To further understand how the testing service was conducted in care homes, we also explored the factors that were associated with staff testing intensity. Staff testing intensity was positively associated with increases in policy defined testing requirements and CQC ratings and negatively associated with the number of positive results in the previous week.

## Results of the evaluation

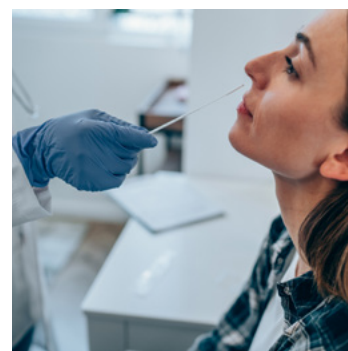
Did the adult social care testing service fulfil its UKHSA intended aims of reducing morbidity and mortality?

- ▶ Testing in care homes was associated with reduced transmission among residents and staff; assuming our associations represented causal effects, we projected that the testing service reduced COVID-19 deaths among care home residents.
  - ▶ Testing was associated with the size of outbreaks when they were discovered and the ability to control outbreaks.
  - ▶ To understand the relationship between testing and mortality in care homes, we explored the factors influencing whether positive COVID-19 cases became deaths. The type of care home had the greatest influence on the association of deaths and positive COVID-19 test results. The number of care workers per resident and the amount of testing had a negative association with mortality.
  - ▶ Increasing staffing levels would have also resulted in increased quality-adjusted life-years (QALYs) gained.
- ▶ Support for the care home workforce was perceived to improve over time, predominantly when testing became available; overall, however, the workforce did not always feel supported, which is explored in detail in section 5.4.6.2.
  - ▶ The workforce was under considerable pressure during the pandemic and the experiences of the first epidemic wave may have impacted the perception of support.
  - ▶ Frequently changing guidance was highlighted as being particularly challenging.
  - ▶ Testing helped to protect staff and residents.
- ▶ The adult social care testing service enabled visitors and essential caregivers to visit care homes and provided a major benefit to support the residents when care homes opened up to such visits.
  - ▶ The restrictions on care home residents did not support their independence nor did they respond to their individual needs for long periods of the pandemic.
  - ▶ Visiting arrangements at the end of life were inconsistently applied by care homes, despite the guidance stating this was allowed.
  - ▶ Lockdowns and visiting restrictions had a negative impact on residents' wellbeing, but testing of visitors enabled care homes to open up, which was seen as a major benefit to the residents.
- ▶ Funding enabled local authorities and providers to operationalise the testing service, and providers involved in pilot studies of testing felt supported.
  - ▶ Local authorities and providers had considerable funding made available to them, some of which was to support the operational delivery of the testing service.
  - ▶ Providers we spoke to who were involved in pilot studies for testing and in policymaking felt supported.

Was the testing conducted in care homes cost-effective?

- ▶ Overall, the testing in care homes can be considered cost-effective throughout the evaluation period.
- ▶ Testing in care homes was 3.5-times more cost-effective prior to the full vaccination rollout.

What were the behavioural barriers and facilitators to taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why UKHSA's intended aims for the testing service may or may not have been met?



- ▶ Factors that impacted testing and reporting behaviours included trust, perceptions of value and the ease of the testing and reporting processes.
- ▶ The switch to home testing was seen as beneficial by care home staff.
- ▶ Concerns about the accuracy of test results (mainly LFDs), alongside individuals' capacity to not suffer financial losses in the event of needing to self-isolate, may have impacted how some staff reported their results or acted following a positive LFD result.
- ▶ Self-reporting of LFD results was viewed positively, but the workload associated with conducting a test and the registering and reporting of results was seen as being time-intensive for a group of staff with an already high workload.
- ▶ Frequent changes in guidance led to variations among care homes in the implementation of testing protocols.

We summarise the overall testing programme recommendations in chapter 6 of this report, with recommendations referring to testing services for high-risk groups and their contacts being particularly relevant to adult social care. Additional considerations and recommendations (see section 5.6 for more details) specific to the adult social care testing service are as follows:

### Considerations

- ▶ Different policies across the adult social care and healthcare settings led to challenges in care homes when healthcare workers did not abide by their regulations; different policies among devolved administrations also led to operational challenges.
- ▶ Changing policies for cohorts outside of care homes caused frustrations among the workforce (e.g., ending of visitor testing when staff testing was still required).
- ▶ Adult social care services that were not part of the initial testing rollout felt forgotten about and left out; clear communication and justification of the timings could improve understanding and acceptance by the various sections of the sector.
- ▶ Inaccurate information led to operational and logistical challenges.
- ▶ Registering and reporting tests (even with an LFD reader) was highly time-consuming, but a more streamlined, automated approach could improve the speed at which high volumes of results are reported.

### Recommendations

- ▶ Ensure the communications around guidance are clear and concise to support effective implementation.
- ▶ Identify and enable targeted support; this could be determined by, for example, CQC rating or type of care home.
- ▶ Employ responsive testing strategies following the rollout of any major new interventions, such as vaccination, that impact the target group; these strategies should be informed by data and evaluated.

## 5.2 The adult social care testing service evaluation sought to answer the following research questions and overall evaluation hypothesis

Did the adult social care testing service fulfil its intended objectives and purpose across UKHSA, the government's and DHSC respective policies<sup>5</sup>, identified through a review of UKHSA documents and other documentation made available through the secretariat and stakeholder interviews, to:

- ▶ Reduce transmission among staff and residents (in care homes) and consequently reduce hospitalisation and mortality rates – this relates to the overall evaluation hypothesis that the evaluation consortium chose to explore, regarding whether testing services aimed at high-risk groups led to a reduction in hospitalisations and deaths in those high-risk groups
- ▶ Support the workforce
- ▶ Support individuals' independence, support people at the end of their lives and respond to individuals' needs
- ▶ Support local authorities and care providers

<sup>5</sup> Please note that the final three of these are the aims of the service as stated by DHSC Policy paper COVID-19: our action plan for adult social care [1]. The evaluation consortium prioritised those aims that were measurable within this evaluation and have not attempted to amend these aims to make them measurable. The four objectives stated above evolved in the winter plan policy papers for 2020/21 [2] and 2021/22 [3].

UKHSA and DHSC stakeholders also highlighted that a key objective of the testing in care homes and other sectors of adult social care (and aligned with the government's Roadmap out of lockdown) was to open up these settings to visitors to both support the residents' wellbeing and reduce the risk of the virus being introduced into care homes. This will be explored within the discussion of the above aims.

In addition, the following questions were explored:

- Was the adult social care testing service a cost-effective intervention?
- What were the behavioural barriers and facilitators to taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why the intended aims were or were not achieved?

### **5.3 To evaluate whether the above aims were achieved, it is important to understand the nature of the testing service, together with the context within which policymaking and implementation took place**

To understand this, we have explored volumes, overall costs, and set up and policy timelines. Details of the set-up and policy timeline, alongside operational findings, can be found in appendix 5.1. We have also explored the differences between distributed and reported tests (largely focused on LFD tests).

A Theory of Change (ToC) for testing in care homes, and a ToC overlaid with a process map of how the testing worked, can be found in appendix 5.2; they provide indicators that could be used to support evaluations of future testing programmes.

#### **Summary of key findings**

##### **Testing volumes**

- Testing in care homes comprised 10% of the total volume of LFDs distributed and 29% of the total volume of Pillar 2 PCR tests registered.
- Testing overall in care homes and adult social care comprised 17% and 21%, respectively, of the total testing programme spend.
- The average unit cost in the adult social care testing service for an LFD and a PCR test was GBP 6.38 and GBP 78.30, respectively.

##### **Policy**

- There were 19 changes in testing policy for care homes throughout the evaluation period, across staff, resident, visitor and outbreak testing.

##### **Testing rates and intensity**

- For PCR tests, the testing rates per staff member and resident remained consistently at or near the guidance levels of one test per week and one test per month, respectively, while LFD testing reporting rates for staff remained consistently below target.
- Testing was often scaled up in response to outbreaks within care homes.
- PCR reporting volumes were similar to the volumes registered, while LFD reporting volumes were markedly lower than the volumes distributed.
- To understand how the testing service was conducted in care homes, we explored the factors that were associated with resident testing intensity. Positive cases and testing in the previous week, COVID-19 prevalence in the community, and higher Care Quality Commission (CQC) rating were positively associated with testing intensity.
- To further understand how the testing service was conducted in care homes, we also explored the factors that were associated with staff testing intensity. Staff testing intensity was positively associated with increases in policy testing rates and CQC ratings and negatively associated with the number of positive results in the previous week.

**SUMMARY**

### **5.3.1 Testing in care homes comprised 9.5% of the total volume of LFDs distributed and 28.7% of the total volume of Pillar 2 PCR tests registered. Testing overall in care homes and adult social care amounted to 16.2% and 20.6%, respectively, of the total testing programme spend.**

Care home residents account for approximately 53% of service users across adult social care. The estimated care home population in England is approximately 360,000 [4]. These residents largely comprise older adults (aged 65 years or more), while approximately 73,000 are aged less than 65 years [5]. It is estimated that 70% of care home residents have dementia or memory problems [4]. Further information about the sector can be found in appendix 5.1.

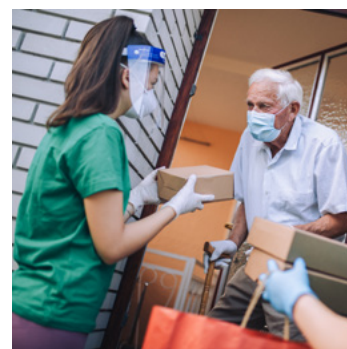
Our review noted that care homes were the first service within the adult social care sector to participate in the mass asymptomatic testing programme (see section 5.3.2 and appendix 5.1. for more details). There were 227 million LFDs distributed over the 18-month period from October 2020 to March 2022 for the adult social care testing service, representing 11.4% of the total number distributed for England (Table 5-1). (Please note that this period is disaggregated in subsequent sections of this chapter.) There were 41 million PCR tests registered for adult social care through Pillar 2, representing 35.5% of total Pillar 2 PCR tests. Care homes comprised the majority (83%) of the testing volume for adult social care. There were 189.5 million LFDs distributed over the 18-month period from October 2020 to March 2022 for testing in care homes, representing 9.5% of the total number distributed for England (Table 5-1). There were 33 million PCR tests registered for care homes through Pillar 2, representing 28.7% of total Pillar 2 PCR tests.

For comparison, over the same time period as that of the evaluation, the total number of tests recorded nationally in Sweden was 17.3 million, in Belgium was 15.5 million and in Italy was 14.2 million [6].

The total financial cost of the adult social care testing service for the full evaluation period was GBP 4.8 billion, representing 20.6% of England's total testing spend (Table 5-2). About 50% of the costs were direct costs and 21% were indirect costs, with the remainder being overheads. The total financial cost of testing in care homes for this time period was GBP 3.8 billion, representing 16.2% of England's total testing spend and 78.7% of the total financial cost for the adult social care testing service (Table 5-2).

The average unit cost in the adult social care testing service for an LFD and a PCR test was GBP 6.38 and GBP 78.30, respectively. Unit costs were calculated for the full evaluation period and capture the purchase price of tests, as well as all other direct, indirect and overhead costs associated with the testing programme, including the logistics, human resources and other costs to deliver a test to the point of care. Unit costs exclude support payment costs and laboratory set-up costs. As unit costs decreased over time, the average cost differs by testing service depending on the relative timing of purchasing and distribution. More details on unit cost calculations can be found in appendix 2.3.

For the reasons noted above (specifically, the volume of tests distributed to the care home sector, and therefore the spend, being greatest in this aspect of adult social care), this evaluation focused on the testing in care homes rather than looking at the whole of adult social care; a technical report on the COVID-19 pandemic in the UK [7] had a similar focus on care homes. Nevertheless, it must be recognised that a considerable number of individuals (service users, carers and staff) would be similarly impacted in future pandemics.





**Table 5-1. Number of LFDs distributed and PCR tests registered in England as part of the adult social care testing service (during the evaluation period).**

Service	Description	Total number of tests	Percentage of total
Adult social care (all services)	Number of LFD tests distributed	227,317,900	11.4% (of all LFDs distributed in England)
	Number of PCR tests registered	40,807,000	35.5% (of all PCR tests registered in England under Pillar 2)
Care homes only	Number of LFD tests distributed	189,541,200	9.5% (of all LFDs distributed in England)
	Number of PCR tests registered	33,056,800	28.7% (of all PCR tests registered in England under Pillar 2)

**Table 5-2. Total financial cost of the adult social care testing service for England (during the evaluation period).**

Service	Test type	Total cost (GBP) <sup>1</sup>	Percentage of total spend (England) <sup>2</sup>
Adult social care (all services)	LFD	1,523,531,300	6.6%
	PCR	3,298,160,200	14.4%
	Total	4,821,691,500	20.6%
Adult social care (care homes only)	LFD	1,208,877,200	5.3%
	PCR	2,588,355,700	11.3%
	Total	3,797,232,900	16.6%

<sup>1</sup> Total financial costs for the testing service excluding isolation-related support and COMF (Contain Outbreak Management Fund).

<sup>2</sup> Percentage of total is calculated against the total spend on testing in England excluding isolation-related support.

### 5.3.2 Tests were deployed throughout the period evaluated, during which there were 19 changes in policy; an overview of the key policy changes is provided below

COVID-19 has a disproportionate impact on older people, especially those in adult social care settings [8]. At the beginning of the pandemic, care home residents were at high risk of infection, disease, outbreaks and deaths caused by COVID-19 [9]. Furthermore, workers in social care were noted to be among the occupational groups at highest risk of COVID-19 mortality [10].

Routine asymptomatic PCR testing was rolled out in July 2020, weekly for staff and monthly for residents in care homes. This started with homes caring for those aged 65 years or more and those with dementia [11], before being rolled out to the remainder of the care home sector by September 2020.

There were numerous policy changes for testing and isolating in care homes throughout the evaluation period, further details of which can be found in appendix 5.1, alongside a policy timeline detailing the key policy changes throughout this time.

The adult social care testing service saw the greatest number of policy changes; we have listed the key updates to these policies below:

#### Staff testing

- ▶ In December 2020, twice-weekly LFD testing for staff (on-site) was introduced [12], in addition to PCR testing, evolving to care home staff being able to self-test at home with LFD tests from February 2021 [13].
- ▶ In December 2021, staff testing with LFDs increased further, to three times a week, in response to the emergence of the Omicron variant [14].

- ▶ A further change to the testing regimen came into effect on 16 February 2022, when staff testing moved to a pre-shift LFD for all staff on days that they were working, with the removal of weekly PCR testing [15].
- ▶ From June 2021, residents could nominate essential caregivers, who were able to attend to the resident in the care home and provide additional support during visits [16]. The testing requirements for essential caregivers were testing in line with staff testing requirements – including rapid and outbreak testing, as noted below [17].

### Resident testing

- ▶ In general, the PCR testing regimen did not change greatly for residents and remained at monthly intervals, except when uplifts in testing (involving both LFD and PCR tests) were undertaken during outbreaks of COVID-19.
- ▶ In February 2021, resident LFD testing was added to the outbreak testing regimen, alongside the existing PCR testing [18]. This involved testing of all residents with LFD and PCR tests on day 1 (known as round one) and a repeat of the LFD and PCR tests (known as round two) undertaken between days 4 and 7.

### Rapid and outbreak testing

- ▶ In addition to asymptomatic testing, additional rapid response testing was needed when there was one or more positive LFD or PCR result from either a resident or staff member.
- ▶ In these circumstances (up until mid-February 2021), staff (only) were required to undertake an LFD test for seven days until no new positive cases were found for five consecutive days [18].
- ▶ From February 2021, rapid testing with an LFD for staff was extended beyond seven days if positive tests were still identified [18].
- ▶ In the case of outbreak testing, additional whole home (staff and resident) testing was required (see resident outbreak testing, above). An outbreak was defined as two or more positive (or clinically suspected), linked cases that occurred in the same setting within a 14-day period; this included PCR or LFD results [19].
- ▶ Staff outbreak testing involved a PCR test on day 1 (round one), which was repeated between days 4 and 7 (round two), with LFD testing daily, as noted above.
- ▶ Recovery testing was undertaken following an outbreak; the timings for this evolved throughout the evaluation period.

### Visitors and visiting professionals testing

- ▶ The purpose of visitor testing was two-fold: i) to enable safe visiting while reducing the risk of introducing the virus into a care home from the community and ii) to support the health and wellbeing of residents through their relationships with friends and family [20].
- ▶ Testing of visitors was in conjunction with other infection prevention and control measures, such as good hand hygiene, wearing of personal protective equipment (PPE) and social distancing [21].
- ▶ At the point that care homes reopened to visitors in the summer of 2020 [22], LFD testing was not yet available.
- ▶ Testing for visitors via care homes was not enabled until December 2020 [23], at which time, and to support one of the aims of the testing service, LFD testing was required for visitors, including visiting professionals. Where required, testing was facilitated by the care home (including PCR testing if required).
- ▶ The results of visitor LFDs (or PCR registration) were required to be reported under a care home's Unique Organisation Number (UON).
- ▶ Visiting during periods when there was an outbreak was permissible for named essential caregivers and for end-of-life visits [17].
- ▶ Generally speaking, visiting professionals (such as community nurses, GPs or ambulance staff) were under their sectors' testing service requirements, but a care home was still able to request that they take a test or demonstrate proof of a recent negative result.



- The Adult Social Care Rapid Testing fund, introduced in January 2021 and extended on several occasions, was used to aid care homes to facilitate visitor testing [24]. This aligned with the Roadmap for easing out of lockdown and for safe visiting to occur, as announced by the government in March 2021 [25].

**5.3.3 For PCR tests, the testing rates per staff member and resident remained consistently at or near the guidance levels of one test per week and one test per month, respectively, while LFD testing reporting rates for staff remained consistently below the target**

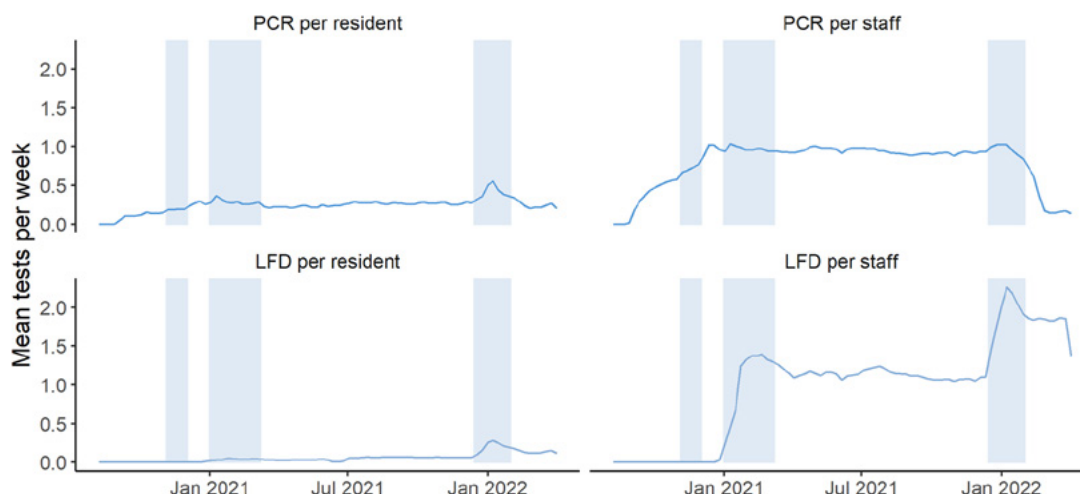


Figure 5-1. Average reported numbers of tests per person per week in English adult care home staff and residents. Blue vertical bars show periods when care homes were closed to visitors (with the exception of visiting for palliative care/end-of-life and named essential caregiver visits) due to government closure policies and community-wide lockdowns.

The weekly PCR testing rate per staff member remained consistently at or close to the guidance level of 1.0 tests per week for asymptomatic staff members (Figure 5-1) until this policy ended in February 2022 [26]. Care homes with more than 1.0 PCR tests per staff member may represent settings with outbreak testing of staff members rather than solely asymptomatic testing. The mean testing rate for residents was close to 0.25 PCR tests per week, near the guidance of one per month (0.25 tests per week).

The mean weekly numbers of LFD test results reported by staff (Figure 5-1) were below the guidance level, which was twice weekly to 15 December 2021 [12, 14]; this increased to three times per week after 15 December 2021 [14], with a further change on 16 February 2022 with pre-shift LFD testing for staff [26]. LFD testing and therefore reported results in residents also increased in response to outbreaks or when individuals were isolating. One plausible factor that could have contributed to the lower than expected reporting of LFD results was that once an individual was known to be positive (by PCR), from February 2021 to December 2021 they were no longer required to undertake an LFD or PCR test for a period of 90 days [18]; we discuss barriers to testing and reporting in appendix 5.3.



### 5.3.4 LFD reporting volumes were markedly lower than the volumes distributed

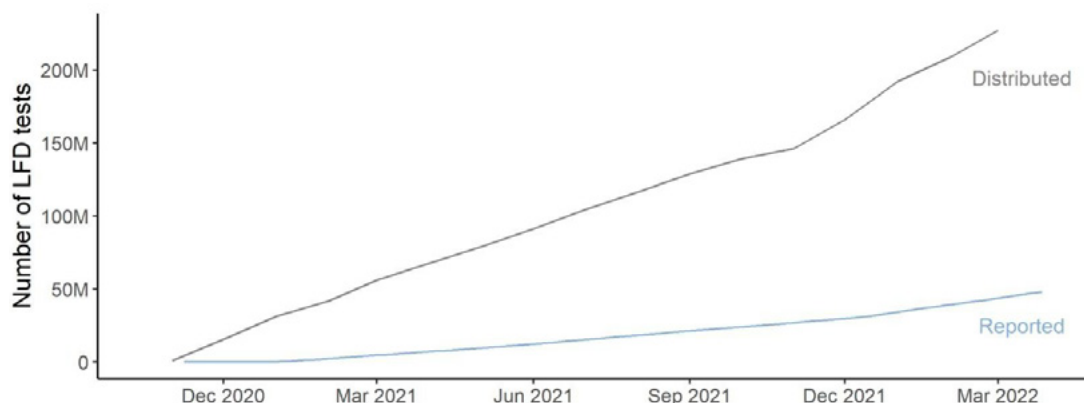


Figure 5-2. Cumulative volume of LFD tests distributed and reported in English adult social care settings over time.

Figure 5-2 shows an increasing disparity over time between LFD tests distributed and reported across adult social care settings, likely indicating low levels of reporting.

The disparity between LFD tests distributed and results reported can be attributed to various factors, including a lack of knowledge/time to report, mistrust of results, financial implications and ease of reporting; these factors are discussed further in section 5.4.6.

Figure 5-3 and Figure 5-4 illustrate how resident and staff testing with both PCR and LFD tests varied throughout the course of the evaluation period for nine of the largest care homes (according to the mean total resident count). An analysis of smaller care homes can be found in appendix 5.4.

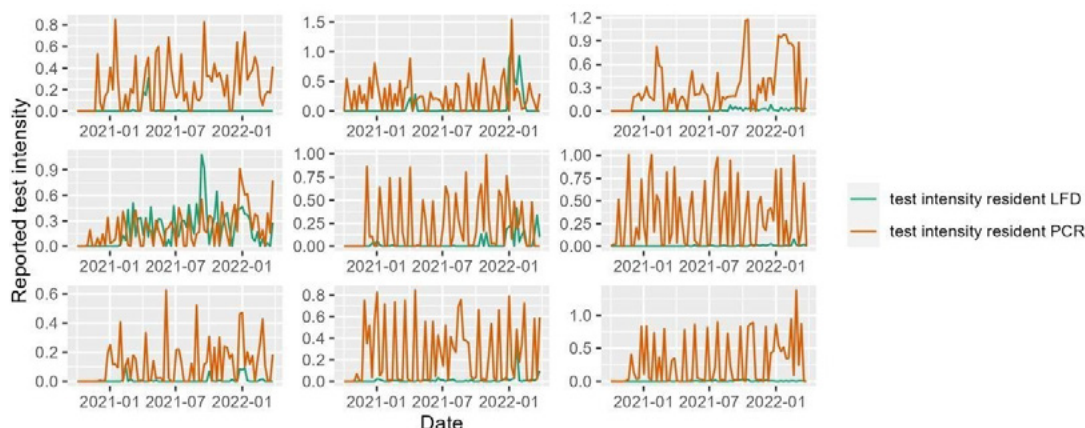


Figure 5-3. Example resident reported test intensity with LFD and PCR tests in large care homes. These nine care homes were the nine largest care homes according to the mean total resident count.

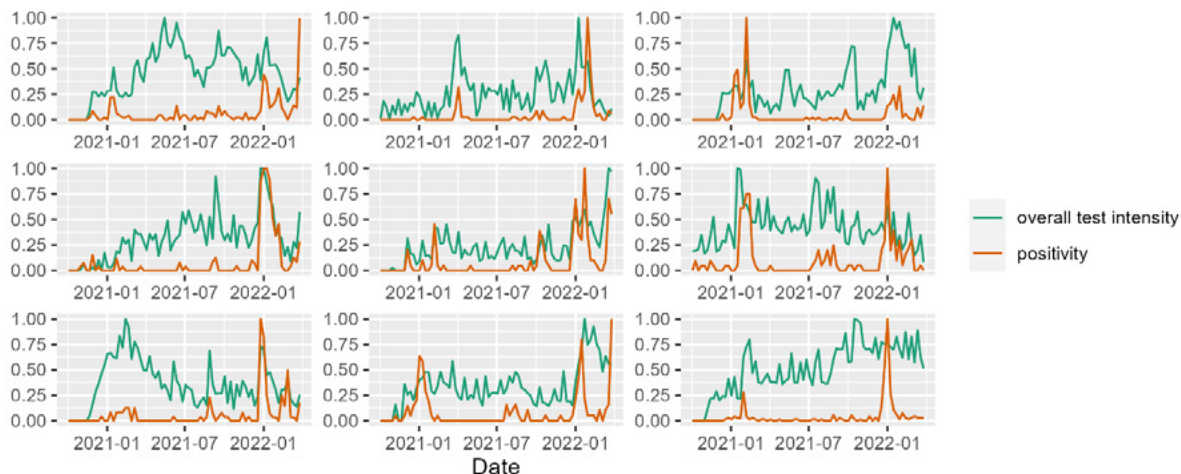
Throughout the statistical analyses, we considered the association between reported (PCR and LFD) testing levels and other factors. Specifically, we defined testing intensity as the number of tests reported per week divided by the population of interest. Further information about the statistical analyses can be found in appendix 5.4.

Figure 5-3 shows that the testing intensity of LFDs was substantially below that of PCRs and more sporadic. This is in line with expectations, as LFD testing in residents was generally in response to outbreaks and was implemented from February 2021 [18].

Reported test results for PCRs (that is PCR tests registered, analysed by a laboratory and with the associated result linked) in residents often displayed a more cyclic pattern of variation, with a monthly periodicity. This presumably represented all/most

residents in a care home being tested in the same week of the month. There were, however, care homes that did not visibly adhere to such a regular testing schedule and, more generally, there was substantial variation in reported resident PCR testing patterns across care homes. From our discussions with stakeholders from care home organisations, it emerged that once the testing regime had been implemented, it became most efficient to test all residents during a single day. These overall trends held when considering care homes of differing sizes (see appendix 5.4).

### 5.3.5 Testing was often scaled up and line with rapid response and outbreak testing



**Figure 5-4. Example overall reported test intensity and test positivity in large care homes.** Overall test intensity represents the sum of test intensities across resident PCR and LFD tests and staff PCR and LFD tests. Test positivity represents overall test positivity across resident PCR and LFD tests and staff PCR and LFD tests. These nine care homes were the nine largest care homes according to the mean total resident count. Note that for each care home, the overall test intensities and positivities have been scaled relative to their maxima to aid visual comparison of the two series.

Figure 5-4 shows overall reported testing intensity overlaid with the test positivity rate (both variables scaled by dividing the series by their maxima for each respective care home). In a number of care homes, testing intensity responded rapidly to increases in testing positivity, likely illustrating the enactment of outbreak or rapid response testing.

In the next two sections, we will explore the factors associated with testing intensity. Following that, we will explore the qualitative insights that offer explanations for the reported testing intensities.

### 5.3.6 To understand how testing was conducted in care homes, we explored the factors that were associated with resident testing intensity. Positive cases and testing in the previous week, COVID-19 prevalence in the community, and higher Care Quality Commission (CQC) rating were positively associated with testing intensity

We examined the factors associated with changes in test reporting intensity, by performing a series of regression analyses for LFD and PCR tests in residents. These regressions contained a range of time-varying (e.g., past test-intensities and positivity rates) and time-invariant characteristics (e.g., CQC rating and whether a care home was a nursing home). These models were linear regressions, with the dependent variable being the reported testing intensity in a week in a given care home. Additional information on the analysis approach and supplementary analysis tables can be found in appendix 5.4.

The key findings from this regression analysis are as follows.



### **5.3.6.1 Resident test intensity was positively associated with the number of positive test results in the previous week**

The mean reported test intensities across the evaluation period were approximately 0.26 reported tests per resident for PCR tests and 0.06 per resident for LFD tests (both of these are weekly measures). In both regressions, having a higher average number of positive test results per care home member (i.e., across both residents and staff) in the previous week was associated with large increases in the reported test intensity in the following week. This is likely to demonstrate that rapid or outbreak testing was enacted with greater focus by the care home and the associated health protection team to support containment of the outbreak.

A one-unit change in the average number of positive test results per care home member in the previous week was associated with an increase in PCR test reporting intensity of around 0.30, a value comparable to its underlying mean. Similar increases were estimated for LFDs, with a corresponding increase of 0.14. Both of these results are indicative of the enactment of outbreak testing in care homes.

### **5.3.6.2 Resident test intensity was positively associated with the local prevalence of COVID-19**

PCR test intensities were positively associated with changes in the local level of COVID-19 prevalence (as measured by the estimated prevalence in the lower-tier local authority (LTLA) encompassing the care home), with increases in prevalence associated with (modest) increases in reported test intensity. This was not, however, mirrored in the LFD test results.

### **5.3.6.3 Resident test intensity was positively associated with their care home's CQC rating**

The association between reported test intensity and CQC rating showed that better-rated care homes tended to have higher reported resident test intensities, with similar trends across both PCR and LFD tests. However, the changes in reported test intensity associated with changes in CQC rating were relatively minor. It is important to note that while CQC ratings may be of interest, the overall rating is made across five domains (safe, effective, well-led, responsive and caring) [27], and ratings in some of these domains may not be indicative of how well a care home followed the testing guidance. Additionally, it is important to highlight that the inspection of care homes is not cyclical. A care home's rating will be retained from their last inspection until their next one and, at the onset of the pandemic, inspections of regulated services in adult social care were suspended [28], therefore ratings may not have been accurate reflections of care homes' practices during the pandemic.

The implications of CQC ratings were discussed with stakeholders from care home providers and other care home organisations. These are detailed in appendix 5.3.

## **5.3.7 To further understand how testing was conducted in care homes, we also explored the factors that were associated with staff testing intensity. Staff testing intensity was positively associated with increases in policy testing rates and CQC ratings and negatively associated with the number of positive results in the previous week**

To examine factors associated with staff testing intensity, we performed a similar series of regression analyses for staff PCR and LFD tests.

Additional information on the analysis approach and supplementary analysis tables can be found in appendix 5.4. The key findings from this regression analysis are as follows.

### **5.3.7.1 Staff test intensity was associated with some key policy changes**

For the staff LFD model, we included four key policy changes (see appendix 5.4 for more information) to the LFD testing guidance and found that of these, the introduction of LFD testing in December 2020 [12] was associated with an average increase in LFD reported test intensity of about 0.1 units; the move to daily (pre-shift) LFD testing in February 2022 [26] was also associated with an increase in LFD testing reporting intensity, by about 0.25 units – a large increase relative to its mean.



### 5.3.7.2 Staff test intensity was positively associated with better CQC rating

As with the resident models, the results from our regression analysis indicate that care homes that had better CQC ratings ('good' or 'outstanding') reported more tests per capita on average when compared with care homes rated 'poor' or 'requires improvement' (see appendix 5.4 for further information). This was most marked for LFD reporting, with care homes rated 'outstanding' having, on average, 0.1 additional tests per capita reported than those rated 'inadequate'. As noted in section 5.3.6.3, the impact of a CQC rating being associated with resident testing intensity, while it may be a finding of interest, should be treated with caution given the multiple factors behind a rating, the length of time since the last inspection etc. Therefore, this finding should be similarly viewed with caution.

Independent care homes also had substantially higher levels of test results registered for staff than other types of care homes, although we suggest caution in interpreting this result as we had very few such care homes in our dataset. As noted by an UKHSA stakeholder, local authority care homes are rare and are atypical in their resident base, as such, these care homes may have residents with different characteristics.

### 5.3.7.3 Staff test intensity was negatively associated with the number of positive test results in the previous week

Counterintuitively, for both regressions, higher average numbers of positive test results per care home member were associated with decreases in reported test intensity in the following week. This may be linked to the individual subsequently not needing to continue PCR testing for 90 days once they were found to be positive.

## 5.4 We explored whether the adult social care testing service supported the hypothesis of the evaluation and whether it achieved the policy's intended objectives and purpose

### Summary of key findings

Did the adult social care testing service fulfil its objectives and purpose across UKHSA, the government's and DHSC respective policies?

- ▶ We looked at the impact of testing on the following:
  - ▶ Testing and transmission in care homes and onward association with mortality.
  - ▶ Type and size of care home impacting transmission and outbreaks.
  - ▶ Impact of local prevalence on care homes' levels of positivity.
  - ▶ Impact of CQC rating on care homes' reporting rates and ability to control outbreaks.
  - ▶ Impact of staffing levels per resident.
- ▶ Testing in care homes was associated with reduced transmission among residents and staff; assuming our associations represented causal effects, we projected that the testing programme reduced COVID-19 deaths.
- ▶ Support of the workforce was perceived to improve over time, predominantly when testing became available, but overall the workforce did not always feel supported.
- ▶ The workforce was under considerable pressure during the pandemic and the experiences of the first wave may have impacted the perception of support.
- ▶ Frequently changing guidance was highlighted as being particularly challenging.
- ▶ Testing helped to protect both staff and residents.
- ▶ The adult social care testing enabled visitors and essential caregivers to visit care homes and provided a major benefit to support residents with care homes opening up to such visits.
  - ▶ The restrictions on care home residents did not support their independence nor did they respond to their individual needs through long periods of the pandemic.

SUMMARY

- ▶ Visiting at the end of life was inconsistently applied by care homes, despite the guidance stating this was allowed.
- ▶ Lockdowns and visiting restrictions had a negative impact on residents' wellbeing, but testing of visitors enabled care homes to open up, which was seen as a major benefit to residents.
- ▶ Funding enabled local authorities and providers to operationalise the testing service, and providers involved in pilot studies of testing felt supported.
  - ▶ Local authorities and providers had considerable funding made available, some of which was to support the operational delivery of the testing service.
  - ▶ Providers involved in testing pilot schemes and policymaking felt supported.

#### Was the care homes testing cost-effective?

- ▶ Overall, the testing in care homes can be considered to have been cost-effective throughout the evaluation period.
  - ▶ Potential savings from reductions in hospitalisations and QALYs saved would have been offset by the costs required to increase the testing regimen.
  - ▶ The testing in care homes was substantially more cost-effective prior to the full vaccination rollout.

What were the behavioural barriers and facilitators to taking a COVID-19 test, reporting a result and acting on the outcome of a result, to help explain why UKHSA's intended aims may or may not have been met?

#### We synthesised from retrospective data that:

- ▶ Factors that impacted testing and reporting behaviours included trust, perceptions of value and the ease of testing and reporting processes.
  - ▶ The switch to home testing was seen as beneficial by care home staff.
  - ▶ Concerns about the accuracy of test results (mainly LFDs), alongside individuals' capacity to not suffer financial losses in the event of needing to self-isolate, may have impacted how some staff reported their results or acted following a positive LFD result.
  - ▶ Self-reporting of LFD results was viewed positively, but the workload associated with conducting a test and registering and reporting results was seen as being time intensive for a group of staff with an already high workload.
  - ▶ Frequent changes in guidance led to variations in the implementation of testing protocols among care homes.

### 5.4.1 Testing in care homes was associated with reduced transmission among residents and staff; assuming our associations represented causal effects, we projected that the testing service reduced COVID-19 deaths

5.4.1.1 To explore the impact of testing on transmission in care homes, we looked at the relationship between testing and outbreaks. Testing was associated with the size of outbreaks when they were discovered and the ability to control outbreaks

In this section, we show that testing was associated with the size of outbreaks when they were discovered and the ability to control outbreaks subsequent to their discovery. We then go further with this analysis to show the different factors that impacted transmission and mortality rates. In the Poisson regression model underlying this analysis, the number of tests conducted by residents (and the prevalence of COVID-19) is used as the offset variable. Thus, the size of the care home will be accounted for via the number of tests conducted. This method would still uncover the factors that are related to increased counts of positive tests in a small care home, relative to the number of tests conducted in that care home. Further details on the statistical methodology and findings from the data can be found in appendix 5.4.

Unfortunately, we were unable to measure the impact of care home transmission on hospitalisations, as hospitalisations data were not available at the care-home level of granularity necessary to undertake appropriate analysis. Further details about data capture are discussed in chapter 6.



### **Testing was associated with outbreak size when discovered**

We conducted a regression analysis to investigate how testing intensity in both residents and staff was associated with the number of positive test results found in the following week for care homes that did not report any positive test results in the week prior. Additional information on the analysis approach and supplementary analysis tables can be found in appendix 5.4. The key findings from this regression analysis are as follows.

#### **Staff testing had a greater association with initial outbreak size than resident testing**

Staff testing in the previous week was associated with smaller outbreaks in both residents and staff when they were initially uncovered, which we interpret as the outbreaks being detected sooner. Testing in residents was not as strongly associated with the average initial outbreak size in residents and for staff had no association with the outbreak size. Testing of staff via LFD was associated with smaller initial outbreak sizes in staff on average than testing via PCR.

We considered the association of CQC rating of care homes with the size of initial outbreaks discovered; the base CQC rating to which all estimates are relative was 'inadequate'. The general trends were that care homes that were better rated tended to discover smaller outbreaks: in 'outstanding' care homes, the initially detected outbreaks in residents were, on average, 22% smaller than in 'inadequate' care homes; the corresponding figure for staff outbreaks was 14%.

#### **Outbreaks were smaller when first discovered in nursing homes and larger in care homes primarily serving those with learning disabilities**

Initial outbreaks found in nursing homes were typically smaller when compared with those in care homes supporting other residential cohorts.

Stakeholders from UKHSA noted that care homes for adults aged less than 65 years are typically small, with shared living and eating spaces; they have characteristics more aligned to those of households and would likely have similar transmission characteristics, of an early, high attack-rate followed by a plateau. This could potentially mean that larger outbreaks were detected because of a faster rate of transmission in such settings. It could also mean that outbreaks were detected later. However, care homes serving those with learning disabilities generally discovered larger outbreaks, in both staff and residents, likely meaning these outbreaks were detected later. During the Omicron phase, outbreaks also tended to be larger when initially discovered.

#### **Initial outbreak sizes were, on average, smaller in larger care homes when discovered**

Care homes that were larger tended to have smaller outbreaks when they were initially discovered (the effect magnitude here is relatively large in size, as it measures the proportional change in outbreak size for a one-person increase in total resident count). It is unclear, however, what mechanism drives this association.

#### **The number of care home workers per resident was positively associated with outbreak size**

Having either a higher number of care home workers per resident or a higher fraction of agency workers was associated with larger initial outbreak sizes, although these effects were relatively modest. (Having more care workers per resident was, however, associated with faster declines in outbreak size once outbreak testing was enacted (see section 5.4.1.2).)

A study in Ireland, conducted between late February 2020 and May 2020, found that 21 of 28 nursing homes surveyed had COVID-19 outbreaks. The study also noted that the greater the staff to resident ratio, the lower the likelihood of confirmed/suspected COVID-19 and the lower the case fatality ratio [29].

### 5.4.1.2 Testing was associated with the ability to control outbreaks

Regressions were conducted to investigate how, subsequent to positive cases being found within a care home, the response was able to identify (and presumably isolate) cases, leading to reductions in the size of the outbreaks in subsequent weeks. To do so, we considered only weeks where the previous week had at least one positive case in either staff or residents. Our regressions are purely correlative and unlikely to be directly causally interpretable, but they are suggestive of the underlying mechanisms. This analysis considers the testing intensity conducted without discriminating between asymptomatic and outbreak testing regimens.

A key assumption in these regressions is that during an outbreak, new cases arise predominantly from previous ones within the care home. While it is possible that, during an outbreak, additional cases could be imported from outside the care home, these introductions are likely to be relatively rare, and we assume that the majority of new cases are due to those occurring in previous weeks.

The full methodology and results of this regression for cases in residents and staff are included in appendix 5.4. The key findings from this regression analysis are as follows.

#### **There was a strong negative association between testing intensity and the size of outbreak in the following week**

We found a strong association between past testing intensity and positive test counts, where higher levels of testing were associated with smaller outbreak sizes in the following week. This effect was particularly strong between the previous week's staff testing on outbreak sizes in staff and on past resident testing on resident outbreak sizes. This supports the hypothesis that these groups tended to associate more with themselves as opposed to intergroup mixing. Analyses using a similar methodology could be applied to other closed settings involving individuals who are at high risk and where controlling outbreaks is critical to determine impact of transmission.

#### **A higher CQC rating was associated with more rapid control of outbreaks**

Care homes with a higher CQC rating experienced, on average, more rapid control of outbreaks: care homes rated 'outstanding' had a 9% weekly reduction in positive tests among residents versus 'inadequate' care homes. The corresponding figure was 11% for positive tests among staff.

A study in Liverpool also noted that care homes with a rating of 'poor' in the responsive domain had more outbreaks [30]. As noted earlier, caution should be taken when considering the CQC rating, as a rating is retained by a care home until their next inspection; this can often be in place for several years and, during the early part of the pandemic, inspections ceased.

Further discussion of CQC ratings and stakeholders' views around providing more support to care homes that are rated 'poor' can be found in appendix 5.3.

#### **Care home type was associated with outbreak control**

Controlling for other factors, outbreaks in nursing homes, on average, declined in size more rapidly than in other types of care homes.

Care homes that served older individuals and homes for patients with dementia experienced slower declines in the size of outbreaks, particularly among residents. Due to the complexity of dementia, it may be that care homes for individuals with dementia encountered further challenges in relation to residents understanding and maintaining social distancing and wearing PPE [31], and difficulty isolating individuals in the case of an outbreak.

Stakeholders from UKHSA noted that care homes for adults aged less than 65 years have, by design, household characteristics; they are typically small with shared living and eating spaces. The resultant transmission of infection is therefore more like that seen in households, with an early, high attack-rate followed by a plateau. This could potentially mean that larger outbreaks were detected because of a faster rate of transmission in such settings. It could also mean that the outbreaks were detected later.





### **Variants of concern were associated with the ability of care homes to control outbreaks**

High local prevalence of the Delta variant was strongly associated with the ability of care homes to control outbreaks. Positive test counts in residents during the main Delta wave were approximately 50% fewer in additional weeks (the figure was similar for staff positive results). The effect associated with the Omicron wave was less marked, and the direction of the effect was inconsistent across residents and staff.

### **Having more care home workers per resident was strongly associated with a care home's ability to control outbreaks**

Having more care workers per resident (after controlling for CQC rating) was associated with large reductions in the size of outbreaks in subsequent weeks. We set up the model with diminishing returns to the effect of increasing care workers. Such models provided a better fit to the data and demonstrated that the incremental effect of an additional unit of care workers per resident was larger when a care home had fewer care workers per resident (i.e., increasing from 0.1 to 0.2 care workers per resident would have a larger magnitude of effect in reducing outbreak size than from 1.1 to 1.2, even though the difference is 0.1 in both cases). A scoping review of 16 studies from 13 countries noted that deaths in nursing homes in Spain were affected by 'inadequate staff-to-resident ratios, insufficient training, and large numbers of staff on sick leave' [32]. A survey in Ireland, covering the period between late February 2020 and late May 2020 (with a deadline for data returns of the end of May 2020), found that 21 of 28 nursing homes surveyed had COVID-19 outbreaks. The study also noted that the greater the staff to resident ratio, the lower the likelihood of confirmed/suspected COVID-19 and the lower the case fatality ratio [29].

### **LTLA-level prevalence was associated with positivity rates**

Increases in the LTLA-level prevalence of COVID-19 were associated with increased numbers of positive test results (despite this, testing still protected staff and residents), presumably through further introductions of cases into care homes from either the most likely route, e.g., staff, visiting professionals and visitors, or potentially through new admissions or residents returning after having spent time outside of the care home for a period. This was also noted in an earlier report about the COVID-19 pandemic: 'outbreaks in care homes were closely correlated with community prevalence throughout the pandemic.' [7]. The effect size in our evaluation was large, but this reflects the scale of prevalence (0-1) and that, typically, the prevalence was low (usually less than 0.01), meaning that the impacts were smaller than the raw effect sizes indicate.

Details of the impact of testing intensity on resident transmission can be found in section 5.3.6. We were unable to undertake similar analyses for staff transmission due to a lack of data for this sub-group.

### **5.4.1.3 To understand the relationship between testing and mortality in care homes, we explored the factors influencing whether positive COVID-19 cases became deaths. The type of care home – specifically whether they served older residents or those with dementia – had the greatest influence on the association between deaths and positive COVID-19 test results. The number of care workers per resident and the level of testing had a negative association with mortality**

We investigated the factors influencing whether positive COVID-19 cases became deaths, by considering four-week blocks for aggregating positive cases and deaths (which were chosen to overlap by two weeks in the middle, with future deaths depending on the previous cases), to account for the delay between a case being detected and death, should it occur. This is illustrated in Figure 5-6.

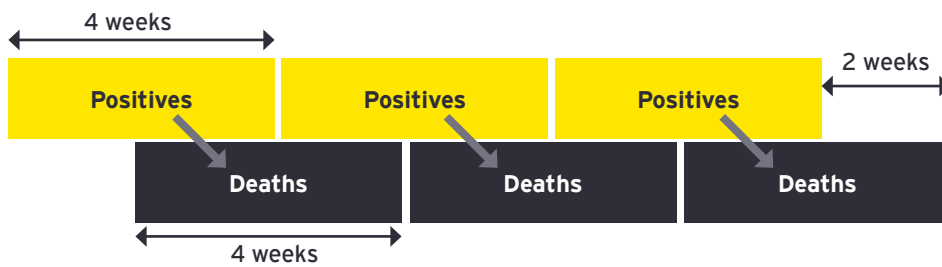


Figure 5-5. Blocked design of the positive COVID-19 test results to COVID-19-related deaths regression model.

By using this design, we could, in principle, miss deaths from positive COVID-19 test results that occurred either more than two weeks before or two weeks after the positive test result was reported (e.g., the dark grey block in Figure 5-5). We could also misattribute deaths to a particular block if the delay from testing positive to death was either short or long. We view this, however, as a largely unavoidable smoothing of the data, which would remain for any other choice of block size. An improved analysis would consider individual-level paired testing and deaths data (to which we did not have access).

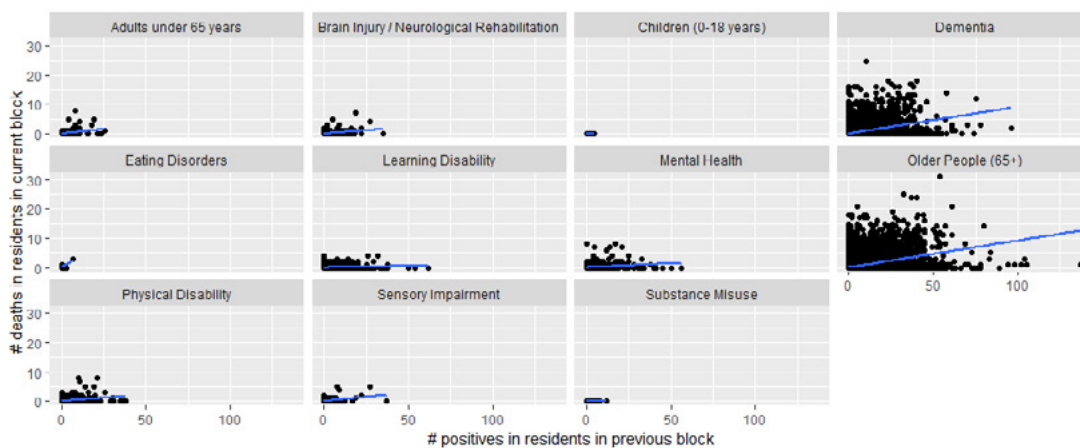


Figure 5-6. Associations between the number of positive COVID-19 tests reported and the number of deaths by primary client type served by care homes. In this plot, the points indicate block-level observations for a particular care home; the blue lines represent linear regression fits assuming a linear relationship between numbers of positive tests reported and numbers of COVID-19-related deaths.

In Figure 5-6, we show the association between the number of reported positive COVID-19 test results and COVID-19-related deaths across care homes serving different types of individuals. This shows that, in those serving older patients or those with dementia, there was a strong positive association between reported positive COVID-19 test results and deaths, likely reflecting the underlying (and well-documented) frailty of these populations to severe COVID-19 outcomes. In other populations, the association was markedly weaker.

We conducted a regression analysis to understand the determinants of resident COVID-19-related deaths. A full description of the methods and analysis can be found in appendix 5.4.

The key findings from this regression analysis are as follows:

**Care homes serving older persons or those with dementia had a higher risk of death from a given positive COVID-19 test**

Care homes that primarily served older persons or those with dementia had a substantially elevated risk of death from a given positive, while those care homes primarily serving individuals with learning disabilities or individuals with mental health issues had lower risks.

In addition, nursing homes had a higher rate of death and, after accounting for block-level variation (one dummy variable for each month block), neither variant type nor vaccination had a strong influence on deaths. However, as noted in appendix 5.4, the measure that we had of vaccination coverage at care home level was imprecise and may have mischaracterised the level of immunity, which may explain why we did not find a strong association between vaccination coverage and death.

Unlike for the previous regressions, CQC rating was not associated with the outcome. As noted previously, we were unable to analyse hospitalisation data, which may have provided additional findings whether CQC ratings were associated with hospitalisations.

### Higher numbers of agency care workers per resident were associated with an increased risk of death in a COVID-19-positive resident

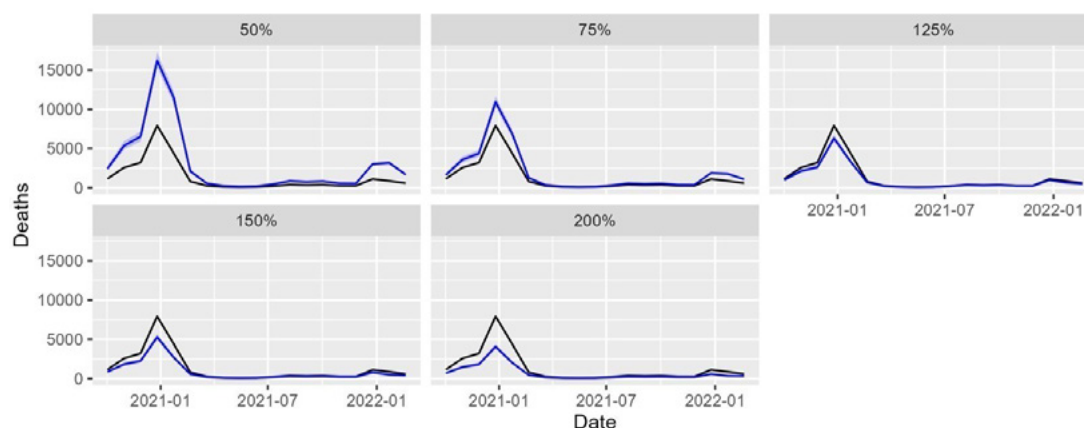
Having a greater fraction of agency workers was associated with worse outcomes. Having more care workers per resident was associated with a reduced risk of death following a positive COVID-19 test being reported. The datasets available for this evaluation did not identify whether the numbers of agency workers were higher or lower than those used by a care home over similar periods.

A study that investigated COVID-19 outbreaks across six care homes in London noted that there were higher rates of infection among staff who worked across different care homes, with the risk increasing with the frequency that an individual worked [33].

### Reductions in testing were associated with increased COVID-19-related deaths

We used fitted regression models describing outbreak discovery and outbreak control, together with the model for COVID-19-related deaths, to estimate the number of deaths that would occur under hypothetical testing and care worker scenarios. Inherently, our approach was statistical as opposed to being mechanism-based and, because of this, a number of additional assumptions were required to produce reasonable projections; we outline these in appendix 5.4. A key assumption of all of our projections is that our regression model estimates represent causal effects, which is unlikely to be true and suggests caution when interpreting our results.

We provide measures of uncertainty in our projections, which are solely based on the uncertainty in the negative binomial regressions that link positive test results with deaths. However, this likely understates the true uncertainty in the projections, as it fails to account for uncertainty in the structure of the models. It also fails to account for the inherent uncertainty in epidemic dynamics, which is particularly acute in care homes, where the relatively small numbers of individuals in each care home mean that the individual epidemics in each care home would unfold in a relatively unpredictable manner.



**Figure 5-7. Projected COVID-19-related total deaths under counterfactual testing scenarios.** Each plot shows the actual deaths (black lines) and the projected deaths (blue lines) with associated uncertainty (see the methods section in appendix 5.4). Each panel corresponds to a different counterfactual testing scenario when the numbers of tests were at the levels shown at the top of each panel relative to the historical levels, e.g., 75% means that testing (in both residents and staff) was at 75% of its factual level.

Our projections are based on statistical models fitted to the testing and deaths data. Each of the scenarios we considered represents reported testing levels relative to the actual scenario (e.g., the 125% scenario represents an increase in reported testing levels by 25%). We did not consider a zero testing scenario, as our models are unlikely to be reliable in this extreme extrapolation. Further details on the statistical and economics analyses for this chapter can be found in appendices 5.4 and 5.5, respectively.

Figure 5-7 shows our model-predicted estimates (blue lines with uncertainty shown as shading) of COVID-19-related deaths in care homes across five scenarios: testing at 50%, 75%, 125%, 150% and 200% of its historical levels. In each of the scenarios considered, we assume that both resident and staff testing is inflated or deflated by the same ratio. The black lines show the reported levels of deaths in all CQC-monitored care homes.

Reductions in testing were associated with increased COVID-19 total deaths: with a testing intensity at 50% of the true levels, we estimate that deaths would increase by 32,160 (uncertainty interval (UI): 27,200-37,740), a 129% increase (UI: 109%-152%) in COVID-19 deaths; with testing at 75%, we estimate an increase of 11,910 (UI: 8500-15,700; corresponding percentage change in deaths: 48% with UI: 34%-63%). An increase in testing levels by 25% would have reduced deaths by 4680 (UI: 2270-6810; 18% (UI: 9%-27%) of overall deaths averted).

At higher levels of testing, our models predict greater, albeit diminishing, deaths averted, but we are cautious in overinterpreting our findings here, as the scenarios considered are far from factual.

Recommendations supporting better preparedness to implement future testing programmes are noted in chapter 6 of this report, while specific considerations and recommendations for the adult social care sector can be found in section 5.6.

**An increase in the number of care workers per resident may have averted deaths in care home residents and may have been cost-effective**

We also considered how increases in the number of actual care workers could have influenced COVID-19-related deaths in care homes within adult social care. Our regression estimates examining the influences of test positivity indicate that having more care workers per resident was associated with slightly larger initial outbreaks being uncovered but faster reductions in outbreak size following their initial discovery. Our regression model, which determines deaths from positive test results in residents, indicates that care homes with higher numbers of care workers per resident had lower rates of deaths.

In Figure 5-8, we show our model-projected estimates of deaths under three counterfactual scenarios, with care workers increased by 25%, 50% and 100%.

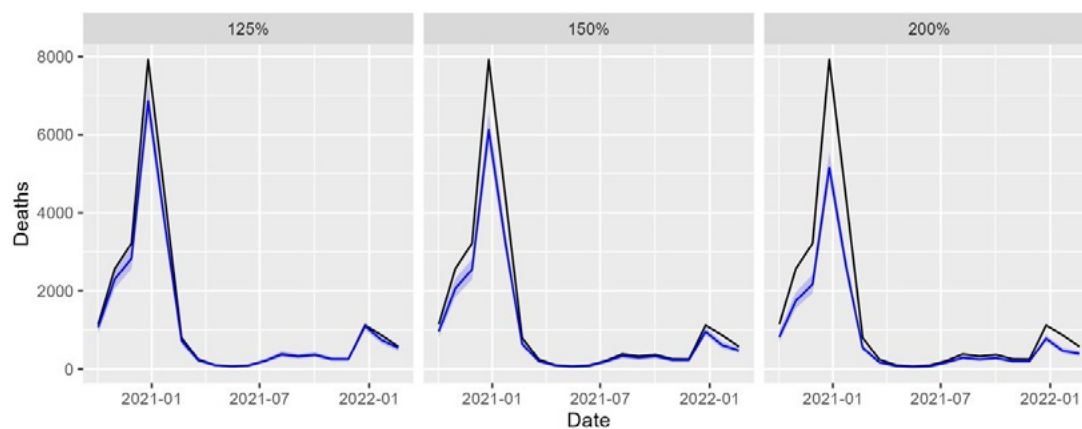


Figure 5-8. Projected COVID-19-related total deaths under counterfactual care worker scenarios.

Each plot shows the actual deaths (black lines) and the projected deaths (blue lines) with associated uncertainty (see the methods section in appendix 5.4). Each panel corresponds to a different counterfactual testing scenario when the numbers of care

workers per resident were at the levels shown at the top of each panel relative to the historical levels, e.g., 125% means that the number of care workers per resident was increased by 25% from its factual level.

We estimate that an increase in care workers per resident by 25% would have averted 2800 deaths (UI: 280-5050), a percentage decrease of 11% (UI: 1%-20%). If care workers per resident were increased by 50%, 5260 deaths (UI: 2880-7360) would have been averted (equating to 21%; UI: 12%-30%). If care workers per resident were doubled, more than 8000 COVID-19 deaths would have been averted.

Please note that the full method and results, with additional sensitivity analyses, are included in appendix 5.4.

A further analysis of the testing data indicated that increasing the number of staff in care homes was positively associated with a reduction in mortality (after accounting for CQC rating). Overall, increasing staff from 125% of actual staffing to 150% would have averted approximately 90% more deaths.

In the year to March 2022, there were 1.79 million posts in adult social care, of which 165,000 were unfilled [34]. The above findings imply that filling all of these vacancies would result in an 8% increase in the workforce.

### **Increasing staffing levels would have also resulted in increased quality-adjusted life-years (QALYs) gained and financial cost savings**

Increasing staff levels during the entire evaluation period to 125%, 150% and 175% of actual staffing levels would have resulted in an additional 19,000, 35,700 and 57,200 QALYs gained, respectively (Table 5-3).

**Table 5-3. Costs of additional deaths averted from increased staff in care homes.**

	<b>Full evaluation period (October 2020-March 2022)</b>			<b>FY21 (October 2020-March 2021)</b>			<b>FY22 (April 2021-March 2022)</b>		
	<b>Baseline compared with an increase in staff to:</b>			<b>Baseline compared with an increase in staff to:</b>			<b>Baseline compared with an increase in staff to:</b>		
Comparator	125%	150%	175%	125%	150%	175%	125%	150%	175%
Deaths averted	2800	5300	8400	2600	4500	7000	250	800	1500
Additional QALYs gained	19,000	35,700	57,200	17,300	22,300	47,200	1700	5300	10,000

FY, financial year; QALY, quality-adjusted life-year

Please note that a fuller description of the key assumptions and limitations of this analysis, together with supplementary analyses, are included in appendix 5.4.

### **5.4.2 Support for the workforce was perceived to improve over time, predominantly when testing became available, but overall the workforce did not always feel supported**

'Supporting the workforce' as an objective was very broad. The policy did outline ways in which the workforce would be supported [1], including headings of 'Ensuring we have the staff we need'; 'Security and Wellbeing'; 'Appreciation' and 'Using technology to support social care and quality of life' [1]. However, with the exception of a target of attracting 20,000 people into the sector over the following 3 months, the remaining support, as noted above, consisted of broad, non-measurable parameters. Based on the evaluation consortium's desktop research and qualitative findings, along with insights from documents received from the secretariat, we determined that the care homes sector understood support for the workforce to largely comprise areas related to guidance, testing availability and the consideration of staff members' mental wellbeing following the first wave of the pandemic. Wherever possible, the evaluation sought to focus on information that covered the time period of the evaluation (October 2020 to March 2022), while recognising that the perception of support among the workforce may have been influenced by their experiences during the first few months of the pandemic. For example, this was noted in relation to the lack of PPE during the first wave and to the initial period when residents were discharged to care homes without COVID-19 testing.



#### **5.4.2.1 The workforce was under considerable pressure during the pandemic and the experiences of the first wave may have impacted the perception of support**

The workforce across the social care sector faced immense pressures and an increased workload during the pandemic [35]. Staff in care homes [30] and those working in residential and domiciliary care settings [36] were under a considerable burden in dealing with COVID-19. Beyond the impact of increasing workloads, and working to keep residents as safe as possible, social care workers themselves were among those at the highest risk of COVID-19 mortality [10], with many also experiencing mental health issues [37].

There are indications that staff shortages resulted in care homes using more agency staff, which was a known route of increasing the risk of infection ingress and transmission in care homes [38].

Some care homes highlighted that future recruitment procedures will involve an assessment of candidates' attitudes towards COVID-19, '... alongside gaining a sense of the candidate's perception about responsibility for care and working as part of a team' [39].

#### **5.4.2.2 Frequently changing guidance was highlighted as being particularly challenging**

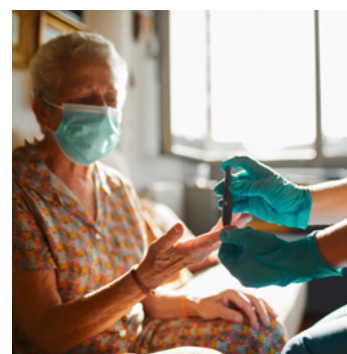
The frequently changing guidance (including testing regimens, isolation and visiting) was consistently highlighted – in the insight documents received from the secretariat, stakeholder discussions and the academic literature – as having caused major challenges for staff, who were then required to implement these changes, often at short notice. Although this chapter focuses on the guidance and policies aimed at adult social care (specifically at care homes), it was noted that the testing regimen for healthcare workers did not change as frequently; furthermore, regular asymptomatic PCR testing was not required for healthcare workers. It has been pointed out, however, that due to the vulnerability of care home residents and their closed environment, the testing strategy was required to be more stringent than that of the healthcare sector [40]. This, alongside vaccines being required as a condition of employment in the social care sector prior to this being the case in the healthcare sector, was highlighted by external stakeholders as demonstrating that the two sectors were not treated equally. Stakeholders from care home organisations further highlighted that the guidance differed across the devolved nations, which they felt was challenging to keep track of. The challenges associated with the testing and reporting of results are explored further in appendix 5.3.

#### **5.4.2.3 Financial support for staff was available**

Despite the considerable funding available via the Infection Control and Testing Fund [41], some stakeholders from care home organisations noted that this was implemented too late and in their opinion was open to interpretation, which may have impacted distribution and uptake. Our evaluation also found that many care home workers feared a loss of income if they were required to self-isolate. Furthermore, the stakeholders noted that funding for staff, either for isolation or recognition of their work, was not the same across the devolved nations, causing them to question the fairness of staff being treated differently for undertaking the same job.

#### **5.4.2.4 Testing helped to protect staff and residents**

As described in section 5.5, testing in care homes was associated with a reduction in transmission, which may have enabled care homes to remain open and helped to protect staff and residents from infection. Furthermore, the use of testing to support visits was perceived by care home staff to help reduce staff members' workload, as during periods when visitors were restricted staff faced additional pressures to meet residents' emotional needs [42]. It also meant that care staff were no longer needed to supervise remote visits.



### **5.4.3 The adult social care testing service enabled visitors and essential caregivers to visit care homes and provided a major benefit to support residents when care homes opened up to such visits**

The objectives of testing in care homes that focused on residents were very broad and therefore challenging to evaluate. For the purposes of this evaluation, we looked for any evidence of how the testing in care homes affected residents' mental, emotional or physical wellbeing and the care that they received either from staff or from visitors. Overall, it was noted that periods of lockdown and visiting restrictions had a negative impact on residents, but as care homes opened up, testing facilitated the sector to allow visitors and supported visiting to be undertaken in a safe manner. This provided reassurance to care homes that the risk of introducing the virus was somewhat controlled.

#### **5.4.3.1 Lockdowns and visiting restrictions had a negative impact on residents' wellbeing, and testing enabled care homes to open up to visitors**

The national lockdowns and resultant long periods of visiting restrictions (with the exceptions of visiting being permitted for named essential caregivers, which was effective from June 2021, or for end-of-life visits) had a profound impact on residents. Those with dementia were particularly impacted, as restrictions such as isolating, mask wearing and social distancing could be confusing for an individual or forgotten by them [43].

The purpose of testing visitors to care homes was to both support residents and reduce the risk of the virus being introduced into a care home [20]. This was in addition to other infection control measures, such as the wearing of PPE and social distancing. The evaluation consortium was not able to evaluate whether the testing of visitors reduced risk with regards to introducing COVID-19 into the closed environments of care homes, due to a lack of appropriate data.

A qualitative review identified that residents' wellbeing, cognitive function, activity levels and levels of depression were all negatively impacted by COVID-19 restrictions, mainly around care home lockdowns and periods of no visits [32]. Some care homes encouraged their residents to become involved in meaningful activities to support the additional tasks that the care home faced or to ease the impact of the lack of visits [37], and staff often supported residents' emotional wellbeing by adopting familial roles [35]. The impact of outbreaks and the design of care homes may have resulted in some care homes remaining closed for longer periods than anticipated [37].

Testing in care homes enabled care homes to feel more comfortable about opening up to visitors [44]. The benefits of visiting identified included the ability to 'restore a sense of normality for residents', for residents and families to re-establish bonds, and to 'reduce the risks of social disconnect from the world outside care homes' [42]. Some of the guidance, particularly around close contact between visitors and residents, was seen by some as confusing and requiring further clarification [45]. There was, however, also the perception that testing with LFDs enabled physical interactions, such as hugging and holding hands, between residents and family [42], which could improve the mental health of both residents and visitors [44].

Despite it being noted that visits outside of a care home setting could be positive for a resident's health and wellbeing [46], there were periods of time (particularly prior to June 2021) during which residents would be required to self-isolate for 14 days upon returning to their care home following a visit outside [47]. Although such restrictions did ease and were welcomed by the care sector, in December 2021, with the emergence of the Omicron variant, residents who were not double-vaccinated were required to self-isolate after an outside visit – even if it was as simple as being socially distanced and sitting on a park bench.

It is unclear how such guidance and restrictions impacted residents, but they could be seen as a disincentive to the resident (e.g., not leaving the care home due to needing to self-isolate on return), as a deprivation of their liberty [46], or as a direct contradiction to supporting their independence and responding to their individual needs, as written in the policy:



Personalised care enables individuals and their carers to keep well and lead fulfilling lives. Social care is also vital for many in allowing individuals and their families to remain in employment and/or volunteering and continue with their essential contribution to our society. For many who use social care services, independence will be defined at a personal level and is at the heart of how social workers and care staff work alongside people to ensure their independence, self-determinations and aspirations can be achieved...[1].

#### **5.4.3.2 Visiting at the end of life was inconsistently applied by care homes despite guidance stating this was allowed**

In terms of supporting people at the end of their lives, even during periods when care homes were closed to visitors, guidance from April 2020 advised that in situations such as the end of life, visits should be supported where possible [46]. Research published in October 2020 highlighted the different approaches that care homes took to facilitate end-of-life visits, but it recognised that some family members themselves were shielding and unable to visit [39].

#### **5.4.4 Funding enabled local authorities and providers to operationalise the testing service, and providers involved in testing pilot studies felt supported**

The aims of the adult social care testing service to support local authorities and care providers were wide ranging and included areas on communications, funding and collaboration across services [1]. In this evaluation, we looked for evidence related to support via funding and policy, as these were critical elements for the testing service to be implemented successfully across the sector.

##### **5.4.4.1 Local authorities and providers had considerable funding made available, some of which was to support the operational delivery of the testing service**

A major proportion of the support for local authorities and providers of care came from the considerable amount of funds made available via the Adult Social Care Infection Control Testing Fund [41]. Some stakeholders from care home organisations noted that, while this funding was welcome, in their opinion it came too late and was open to interpretation and therefore may not have been consistently applied across the sector.

Part of the funding was to support local authorities and the care homes implement the required testing, at scale and at speed. It is critical to note that this was a substantial undertaking and involved the set-up of testing that had previously not existed.

##### **5.4.4.2 Providers involved in pilot schemes and policymaking felt supported**

Although noted often in our evaluation that the guidance for care homes changed frequently, there was no distinction made with regards to a care home's size or setting. It is, however, important to mention that some large care home organisations and associations of smaller and medium providers that we spoke to stated that they were involved in the pilot studies for the testing programme and/or were spoken to for support during the design of policies. These stakeholders reported feeling supported – albeit after a difficult start in which 'we were all on a learning curve'.

Interestingly, some of the insights (through documents supplied by the secretariat) identified frustration from smaller care homes around the apparent lack of understanding of the realities of operating a smaller care home and how the workload around testing was impacting them. This was in addition to smaller care homes noting that representatives from larger care home organisations may not have worked in care homes themselves, meaning they lacked a perspective on the daily working situation within a smaller setting [44]. This suggests that smaller care homes may have felt less supported and highlights the importance of consulting with a cross-section of care homes and providers in any future pandemic.

As highlighted in our evaluation, the policy paper for the COVID-19 action plan in adult social care had four objectives [1], three of which were broad or non-specific.



The objectives also evolved slightly in the publication of the winter plans policy papers for 2020/21 [2] and 2021/22 [3], demonstrating the evolving needs of the sector during the pandemic.

This made the quantitative and qualitative analysis challenging to both ascertain and evaluate whether the objectives as stated were met. The evaluation nevertheless sought to establish key, measurable quantitative indicators and included a search of the broader qualitative research, utilising our Theory of Change. Details of these indicators and outcomes can be found in appendix 5.2.

### 5.4.5 Testing in care homes can be considered cost-effective throughout the evaluation period

Having ascertained that the adult social care testing service partly fulfilled its aims (predominantly related to testing reducing transmission and mortality), we next looked at whether it was cost-effective. To do this, we looked at mortality averted, QALYs gained and associated costs; we then combined these with the projected impact of different testing rates.

#### Overall, the testing in care homes can be considered cost-effective

The economic evaluation of the impact of testing of residents and staff in care homes on mortality in residents used our statistical findings (Figure 5-7). The effectiveness of the actual testing (baseline) was compared with the effectiveness of testing at 50%, 75%, 125%, 150% and 200% of the actual testing volume. The costs of these reduced and increased testing volumes were adjusted accordingly. We assumed that overhead and indirect costs remained the same regardless of testing volume. Only the direct costs and direct overhead costs were proportionally adjusted.

The actual UKHSA testing rates (baseline) averted 32,200 and 12,000 more deaths than if testing had been performed at 50% and 75%, respectively, of the actual testing volume. If testing had been increased to 125%, 150% or 200% of the actual level, 4700, 8000 or 11,700 more deaths could have been averted, respectively, during the entire evaluation period (October 2020 to March 2022).

**Table 5-4. Summary of the costs and cost-effectiveness of the testing programme in care homes compared with hypothetical changes in the testing volume for FY21 and FY22.**

	Full evaluation period (October 2020-March 2022)			FY21 (October 2020-March 2021)			FY22 (April 2021-March 2022)		
	Baseline compared with percentage testing volume			Baseline compared with percentage testing volume			Baseline compared with percentage testing volume		
Comparator	50%	150%	200%	50%	150%	200%	50%	150%	200%
Cost (GBP billions) <sup>1</sup>	2.56	5.03	6.26	1.40	2.76	3.45	1.16	2.05	2.74
Cost per death averted, in residents only, due to testing (GBP)	38,300	154,100	210,200	28,300	103,000	142,500	68,000	396,600	507,200
Cost per QALY gained from deaths averted in residents due to testing <sup>2</sup>	5700	22,700	31,000	4200	15,200	21,000	10,000	58,500	74,800

<sup>1</sup>Baseline (actual) costs: FY21 = GBP 2.09 billion; FY22 = GBP 1.71 billion; full evaluation period = GBP 3.80 billion.

<sup>2</sup>A QALY of 6.78 per death was used.

FY, financial year; QALY, quality-adjusted life-year.

Table 5-4 illustrates the cost-effectiveness of the actual testing using various comparators (see appendix 5.5 for the complete set of effectiveness results).

This translates to a cost of GBP 38,300 per death averted compared with a lower testing rate of 50% of the actual rates. If testing had been conducted at increased levels of 150% and 200% of actual levels, it would have cost GBP 154,100 and GBP

210,000, respectively, per additional death that could have been averted. In terms of QALYs, the actual testing had a cost of GBP 5700 per QALY gained compared with a testing rate of 50% (of the actual rate), making it a highly cost-effective strategy at both the Green Book willingness to pay threshold of GBP 70,000 per QALY gained [48] and the NICE threshold of GBP 30,000 [49]. If testing had been increased to 150% and 200% of actual levels, it would have cost GBP 22,700 and GBP 31,000, respectively, for each additional QALY that could have been gained. This suggests that increasing testing of residents and staff to up to double the actual volume may also have been a cost-effective intervention, although the degree of cost-effectiveness diminishes. Given the data limitations, this analysis did not include potential cost savings from averted hospitalisations. If these were taken into account, the testing in care homes would have been even more cost-effective.

**While cost-effective throughout, the testing in care homes was substantially more cost-effective prior to the full vaccination rollout**

Figure 5-9 illustrates the costs per QALY gained at various testing rates in care homes by financial year. The whiskers represent the cost-effectiveness ranges using a minimum QALY of 4.98 per death averted and a maximum of 8.8 per death averted [50]. Testing in care homes was cost-effective compared with lower levels of testing at 50% and 75% of the actual volume for both FY21 and FY22. If testing had been increased to levels of 125%, 150% or 200% of the actual testing, the additional QALYs that could have been gained would also have been cost-effective for FY21 and may have been cost-effective for FY22 at 125% or 150%. The incremental cost per QALY gained for FY21 was substantially lower than for FY22, indicating that testing in care homes was more cost-effective prior to vaccination rollout. FY22 aligned with the rollout of vaccination; by April 2022, the start of FY22, 85% of those aged more than 65 years had received their first dose of the vaccine [51]. Given the effectiveness of the vaccine in reducing hospitalisations and deaths due to COVID-19, testing in care homes had a smaller relative impact and, while still cost-effective overall, became less so. On average, testing in care homes was 3.5-times more cost-effective prior to vaccination rollout for the scenarios considered. Although the rollout of vaccination made ongoing testing less cost-effective, given uncertainties around the long-term effectiveness of vaccines and the potential for future variants of concern, continued testing could be considered a reasonable and overall cost-effective insurance strategy. This is particularly important for individuals deemed to be at high risk, as disease severity could change or the intervention may stop working due to the emergence of new variants of concern. Even if a major change such as vaccine rollout changes the cost-effectiveness of testing, this does not mean testing should stop but rather that the strategy should be reviewed in the light of such major changes.

It must be noted that while we have attempted to quantify the deaths averted by testing in care homes and the corresponding economic benefits thereof, we believe these to be an underestimate of the benefits, as many wider social benefits have not been included because they are challenging to quantify. These include issues such as the benefits of end-of-life quality and the disbenefits of isolation, and the resulting mental distress experienced by patients in care homes due to reduced visitations. In addition, averting hospitalisations would have freed up hospital and staff capacity, enabling better care for emergencies and other diseases.





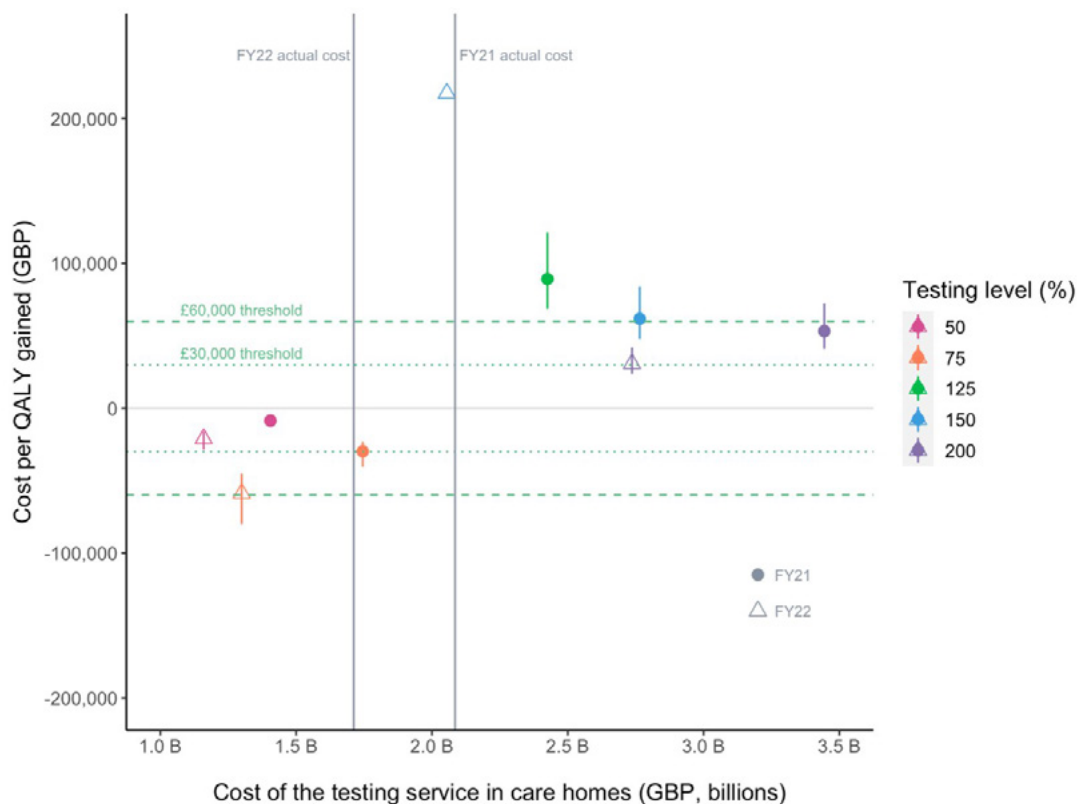


Figure 5-9. Cost-effectiveness of actual testing levels in care homes in England compared with various hypothetical levels of testing. The whiskers represent the cost effectiveness ranges using a minimum QALY of 4.98 per death averted and a maximum of 8.8 per death averted. The points falling below the GBP 70,000 willingness to pay threshold are considered to be cost-effective. The points to the right of the vertical lines indicate testing volumes that would be more expensive than the actual strategy was (125, 150 and 200% of the actual testing volume).

Table 5-5. Economic analysis of costs per death averted for various testing rates and time periods.

	Full evaluation period (October 2020-March 2022)	FY21 (October 2020-March 2021), pre-vaccination	FY22 (April 2021-March 2022), post-vaccination
Cost per death averted in residents only, compared with testing at 50% (GBP)	38,300	28,300	68,000
Cost per QALY gained in deaths averted in residents, compared with testing at 50% (GBP)	5700	4200	10,000
Deaths averted with 25% more staff	2800	2550	250
Additional QALYs gained from 25% more staff	19,000	17,300	1700

FY, financial year; QALY, quality-adjusted life-year

## **5.4.6 It is highly likely that a testing strategy will be needed in care homes for any future pandemic involving a respiratory infection; should testing in care homes be rolled out again there are key behavioural and operational considerations that could be applied in the future**

As noted in our research questions, an intended purpose of testing in care homes was to reduce transmission among staff and residents and consequently reduce hospitalisation and mortality rates. It is highly likely that care home residents (and service users of the other sectors within adult social care) would be classified within the high-risk group in any future pandemic involving a respiratory virus, therefore it is essential to ensure the response for this cohort is correct. It is important to recognise that testing in any future pandemics (including testing of adult social care service users and staff) will be dependent on various factors relating to the specific virus involved, including transmission properties (both symptomatic and asymptomatic) and vaccine effectiveness. While the testing rate for COVID-19 in care homes was shown to be at an appropriate level, in that it reduced transmission among staff and residents, was associated with the ability to control outbreaks and can be considered to have been cost-effective, there are key learnings from this pandemic around how to improve engagement with and the uptake and the efficiency of testing.

Below, we highlight some of the facilitators and barriers associated with testing, reporting and acting on a positive result, with a focus on care homes. Further details can be found in appendix 5.3.

### **5.4.6.1 Facilitators to taking a test**

#### **Trust in PCR tests facilitated testing**

In February 2021, most care homes (85% of approximately 1500 care home respondents) reported satisfaction with the PCR testing experience [44]. PCR testing was also generally considered the 'gold standard' [52] and thought to be effective at detecting COVID-19 [53], which may have encouraged participation in testing.

#### **Trust in government improved over time**

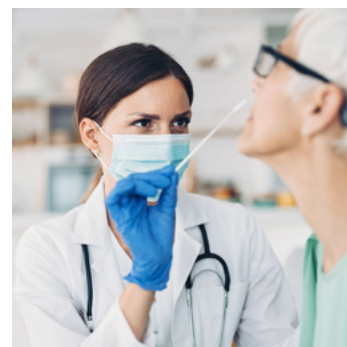
Actions taken by governmental organisations at the start of the pandemic, with 'an absence of testing, followed by a lack of clarity on testing processes and constantly changing guidelines which led to confusion', led to care homes feeling 'left out' [44] by the government. A survey of 1500 care home staff in February 2021 found that 'there remain feelings of being "let down"', with some care home staff (25%) being unsure whether they could trust DHSC in relation to care home testing [44]. It is notable that when asked the following: 'To what extent do you agree with the following statement: I trust the DHSC to do the right thing for care homes', 75% either agreed or strongly agreed. This implies that trust in DHSC, as part of central government, by those working in care homes, changed over time, with levels of trust improving from the start of the pandemic to early 2021 [44], which may have positively impacted testing participation. From our review of the existing research, the impact of trust in the government on testing uptake and adherence is unclear; however, this should be explored for any future pandemic.

#### **A key perceived value of testing was widely reported to be that it enabled visits**

As noted earlier in this chapter, the benefits of visiting residents were numerous.

Care home staff felt that the time taken to administer testing was often underestimated and not planned for [42]. Care home managers felt that staff and visitors experienced confusion due to the frequent changes to visiting policy, leading to 'frequent calls and requests from visitors around changing guidance' [44]. Managers also felt that frequent changes in guidance did not allow homes sufficient time to prepare and obtain the correct equipment to support visits [44].

Stakeholders noted that the registration of LFD tests for visitors against a care home's UON was to identify these tests accordingly, but that the system was originally set up for staff testing. As such, care homes were more likely to ask for verification of a test result verbally and not necessarily review the electronic results.



The use of testing to support visits was also perceived by care home staff to help reduce staff members' workload, as during periods when visitors were restricted staff faced additional pressures to meet residents' emotional needs [42]. It also meant that care staff were no longer needed to supervise remote visits; furthermore, the use of LFDs enabled care homes to feel more comfortable about opening up to visitors [44].

#### **The move to home testing acted as an enabler to LFD testing**

The move to home LFD testing in February 2021 was reported to enable care home staff to adhere more closely to the testing requirements. Stakeholders from UKHSA noted that this was also broadly reflected internally and as such was acted upon rapidly (including a requirement to procure and distribute tests) following regulatory approval of self-testing. Prior to the availability of self-testing at home, care home staff reportedly had to attend care homes for testing on their days off or stay at work outside of their shift times without additional pay [42, 54]. Some care home staff were reported to find this (on-site testing) 'impractical and inequitable' and that being 'tested multiple times a week was not compatible with the contextual realities of the working schedule of care home employees' [42]. Care home managers reported that the move to enable staff to self-test at home was beneficial both for care homes [13] and for staff [55], although some care homes continued with onsite testing due to concerns that staff would not conduct testing appropriately [31]. Facilitating workers to test outside of their workplace (such as care homes) is key to enabling them to adhere to testing protocols.

Although the findings described above refer to at-home LFD testing, stakeholders from UKHSA and DHSC noted that PCR home testing was available but added between 24 and 48 hours to the turnaround time for results. The evaluation consortium did not find any specific qualitative information relating to home PCR testing for care workers.

#### **5.4.6.2 Barriers to taking a test**

##### **The experience of taking a test was a barrier to testing for some residents and staff**

Early in the pandemic, care home staff reported difficulty in swabbing residents due to residents' physical discomfort [56]. Stakeholders from UKHSA and DHSC noted that, in general, the workforce in care homes was not trained to take swabs, and this initially presented a considerable challenge. Furthermore, residents were reported to find the testing daunting [56, 57], with particular difficulties faced by those with dementia and those who lacked the capacity to understand the reasons for testing [57, 58]. A minority (15%) of adult social care workers surveyed in 2022 also reported that they did not like the experience of taking a COVID-19 test, with this sentiment particularly high among younger staff [53]. It took time to convince residents and staff to accept testing [58]. More time and flexibility were also required from staff to identify an appropriate time to test residents [57]. This additional workload (particularly at the start of any testing intervention, which requires a new skill to be learned) should be considered in the development of any future testing protocols and weighed against the critical public health benefits that such testing (and associated workload) would provide.

##### **Frequent changes in guidance impacted the ability of care home staff to participate in testing, which led to variations in the implementation of testing protocols among care homes**

Care home staff reported challenges in relation to the guidance on testing requirements and protocols, in particular with keeping up with the frequency of updates to testing protocols [44], which changed approximately 19 times throughout the evaluation period. Care homes requested that communications should make it clearer what has changed when updates are sent through, with greater notice of upcoming changes, and for communications to be sent earlier in the day to support staff to be able to action them within working hours [44].

Conversations with stakeholders from care home organisations highlighted the very short notice that was received of the move to twice-weekly LFD testing, in December 2020, as being particularly challenging to implement in a short space of time, during what was also the Christmas period. It should be noted, however, that this specific change was in response to the emergence of new variants that had been shown to be

more transmissible than the existing variants [12]. Similarly, the change in December 2021, to staff testing with LFDs three times a week, was due to the emergence of the Omicron variant [14].

While many of the DHSC communications were reported as being clear and effective at highlighting key information [44], other issues identified included unclear testing guidance [58], incomplete guidance [59], or training materials and guidance not applicable to atypical care home settings [13]. There were also evident issues with the communication of changes throughout care homes, with much lower reported knowledge of testing guidance among frontline workers than managers [53]. This may be linked to reports in early 2021 from care home staff that there was a lack of information they could share with their teams [58]. Stakeholders from UKHSA and DHSC noted that a considerable amount of engagement was undertaken with this sector, including weekly WebEx meetings; however, as noted in these insights, challenges remained despite the efforts to engage. There was also reported to be limited engagement with testing communications among some care home managers and staff, which may have led to gaps in compliance knowledge [59]. This highlights the importance of clear, effective and engaging communications that support the transmission of information throughout a care home. Of equal importance is the need to ascertain and be proactive in checking whether care home providers and care home managers understand the testing requirements, particularly when key changes are announced.

In some circumstances, there appears to have been conflicting information in the guidance given to care homes by providers. In February 2021, a care home reported that their head office requested they move to twice-weekly PCR tests, with LFDs only used before shifts for unvaccinated staff members [44], at a time when the guidance was for weekly PCR tests and twice-weekly LFD tests.

#### **There were challenges experienced with the provision and courier collection of tests**

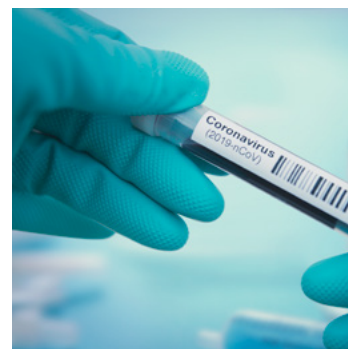
Care homes reported some challenges with ordering and receiving test kits, such as confusion around which type of test kits were being delivered, making it difficult to plan inventory [13]. There were also reported delivery delays and extended waiting times for PCR results between September and November 2020, although the majority of results were returned within stated government target times [20].

Courier collection of PCR tests was available when sending more than eight tests to a laboratory [15]; eight or fewer PCR tests had to be dispatched via the nearest Royal Mail priority post-box. The process of arranging a courier was a challenge highlighted by several care homes [59], with not being able to track couriers or test kits reported to create anxiety for some managers [58]. Stakeholders from care home organisations noted that couriers would go to a site using postcodes obtained from the CQC database, and these were not always correct, which initially caused some operational issues. The evaluation does however recognise that such an operational set up from scratch was a considerable undertaking, with large numbers of courier journeys required for the delivery and collection of testing kits. UKHSA stakeholders advised that these issues were addressed over time and resulted in fewer complaints or issues being raised over this.

#### **There were staff concerns over the accuracy of LFD tests**

Care home staff members reported viewing regular LFD testing as a useful safety measure [13]. However, questions were raised by some staff members over the accuracy of LFD results, with care home staff citing concerns over the reliability and accuracy of tests [44] and the effectiveness of LFDs for detecting COVID-19 [53]. One stakeholder noted '... there wasn't any consistency sometimes where somebody would do a test twice...and they'd come out positive on the second test, but they were actually negative on the first test ...'.

UKHSA stakeholders noted that interpreting diagnostic tests, particularly when individuals were conducting their test but not following the correct testing methodology as per the guidance (e.g., swabbing technique, volume of buffer solution used or length of time required to wait before analysing the result), proved challenging; they also recognised that there are numerous reasons – all in themselves



valid – as to why tests may return different results. UKHSA stakeholders further noted that the dual testing regime (asymptomatic staff testing and outbreak testing for staff and residents) was in place for most of the pandemic, partly because LFD tests are less sensitive than PCR tests.

Providers did come to recognise that the speed at which they could obtain LFD results aided them in acting quickly to contain infections and reduce the risk of COVID-19 entering a care home in the first place [60]. Concerns around the accuracy and reliability of LFDs were reported to have been influenced by news and media stories [13, 44] and anecdotal evidence received through peer networks [59]. In some instances, mistrust of LFD results was compounded by differences observed between LFD and PCR test results, when both types of test were used concurrently in asymptomatic testing protocols [44]. In early 2021, when the guidance was for care home staff to test themselves twice-weekly with LFDs, concerns about their lack of sensitivity led some providers to consider the use of LFDs unsafe, with a minority requesting care homes not to use them [13].

It is possible that attitudes to the utility of LFDs changed over time, as summarised by one stakeholder: ‘the confidence in the lateral flow test was fairly low to begin with. I think people now rely on the lateral flow test.’

### **Concerns about the consequences of a positive test may have impacted staff willingness to participate in testing**

While many care home staff expressed concern about testing positive due to the financial consequences of having to isolate, this was highlighted as being a potential challenge for care assistants in particular, as they may be more financially vulnerable [42]. Of adult social care workers surveyed in April and May 2022, 8% (of 651) reported that they ‘could not test positive’ as they could not afford to self-isolate/not work [53]. Financial support provided by local authorities could potentially support workers if they were required to self-isolate, however allocation differed across local authorities [52]. In our conversations with stakeholders representing care home providers, they highlighted that they continued to pay staff for COVID-19-related absences up until the funding ended. It is imperative that funding is made available to support adherence to testing and isolating.

### **Care homes experienced space constraints that hindered their enactment of testing policies**

Variations in the application of testing protocols among care homes were influenced by the diverse range of facilities and rooms available for testing and isolation among homes [54]. Some care homes reported having multiple rooms with outside access; others reported ‘a single entrance and limited free space’, which limited the ability to socially distance visitors prior to their being tested [44] or meant that there was no space to conduct visitor testing onsite [59]. This highlights the importance of exploring how to support and enable testing and infection control within a diversity of settings, including older buildings [42].

#### **5.4.6.3 Facilitators to reporting tests**

##### **The introduction of the COVID-19 digital reader facilitated reporting**

The COVID-19 LFD digital reader was introduced in June 2021, to increase the accuracy of interpreting LFD results and improve the reporting process [61]. In a pilot study of the digital reader, carried out between June and December 2021 and that included adult social care residential homes, the digital reader was considered easy to use, with high rates of successful and repeated use [61]. Further research found that adult social care workers with experience of using the digital reader reported a positive experience, with nearly half reporting that it made them more likely to report their LFD results [53]. However, in the same survey, nearly half of adult social care workers (47%) were not aware of the digital reader, but 65% thought that it sounded appealing and 45% said it would make them more likely to report their LFD result [53]. This implies that improving awareness of the digital reader and highlighting its speed and effectiveness may have positively impacted LFD reporting rates.

Although outside of the evaluation period, insights from adult social care workers who were using the LFD digital reader, in June and July 2022, suggested that some users felt it supported ‘quicker, easier, reducing human error and the incidence of



misreporting'; however, a high proportion (one third of 693 respondents) considered that the digital reader had no benefits and that it made some users feel patronised and not trusted to enter their results correctly [62].

The above findings highlight that, although that there were some benefits to the digital journey enabled via the use of the LFD reader, including saving time and, more importantly, increasing the accuracy of reading and reporting results, communicating these benefits alone has not always worked, and individuals who used the digital reader may have been unclear about its overall intended purpose.

#### **Larger care home organisations developed mechanisms to ensure reporting compliance**

As noted in section 5.5, care homes that were larger tended to have smaller outbreaks when they were initially discovered. Also as noted previously, smaller care homes tend to cater for adults aged less than 65 years and the setting is more similar to a typical household - with transmission expected to occur in a similar manner as it does in a household. In interviews with stakeholders from larger care home organisations, they noted that they set up internal checks to ensure that staff reporting was aligned to requirements. Stakeholders from larger care home organisations advised that they received reports from DHSC that allowed them to analyse their actual reported numbers of tests versus expected numbers of reported tests. Care homes identified as not reporting were offered support by their respective organisation. We were unable to establish whether individual care homes had similar access to such reports.

#### **5.4.6.4 Barriers to reporting tests**

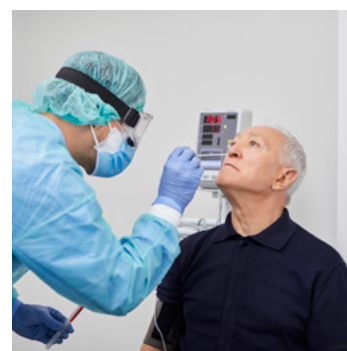
##### **LFD registration was perceived to place a high burden on staff**

A key theme that has emerged throughout the evaluation is the impact of testing (conducting tests, registering tests and recording the results) on care home staff, particularly at times of high testing volumes (and prior to staff being able to test at home with LFDs) when there were concurrent, regular PCR and LFD tests and onsite visitor testing [54]. Care home staff reported mental fatigue and exhaustion more generally [42], with a majority of care home nurses and managers meeting criteria for clinically significant levels of distress [63]. The additional testing requirements were perceived to place a further high burden on staff [44] at a time of disruption to working practices and a generally increased workload [42].

##### **The registration process for care homes was time-consuming and challenging**

As each individual test and its result had to be registered for auditing purposes [54], the registration of tests had a considerable impact on the workload of care home staff, with some stakeholders representing care home organisations noting that they had administrators who worked on this task only. While the registration process for PCR tests was seen as more complex and time-consuming due to the greater information requirements [31], the registration process for LFD tests was much more frequently reported to be an issue. It is important to highlight that the registration of PCR tests was required for the correct processing of results by the testing laboratory, which would link the result to the individual user (staff or resident) and their respective UON. The recording of LFD results was more reliant on an individual staff member either advising their care home of their result (which could subsequently be recorded on their behalf) or correctly recording the result themselves.

The 'bulk upload' process enabling care homes to register multiple LFDs at once was reported to be particularly problematic [44]. Prior to the self-reporting portal being made available for LFD results, for care homes this largely meant completing a spreadsheet [64]. This allowed multiple individuals' PCR and LFD results to be entered, with separate spreadsheets for staff and residents. The rationale was that this would be quicker than individual registration for each result, particularly the entry of personal details, which could be reused in future uploads of the spreadsheet. The spreadsheet could be uploaded to the government portal, with further instructions to cross-check that the data matched the information entered in the spreadsheet [65].



Internal UKHSA findings suggested that lower IT literacy levels among care home staff may have presented a challenge for staff to use the spreadsheets for the bulk upload of results from care homes [58]. Research conducted in February/March 2021 with care homes that had not reported any results showed that nearly a third of them did not know how to register results [44]. The second most frequently cited reason was difficulties with the registration process [44]. A further burden identified by care home managers was the need to keep an additional local record of LFD results for local reporting and for reporting to their head office, CQC or for local authority inspections [13]. The evaluation did not determine whether the importance of this additional record keeping was seen, but it was noted by stakeholders of some care home organisations that they used such information to identify and support care homes for whom the reporting rates (mainly LFDs) were below expected levels.

It was also noted that smaller care homes may have faced greater struggles with reporting LFD results in large volumes compared with larger care homes [13]. To support registration by care homes, the processes and systems used need to be simple and quick to navigate, particularly where staff are time-poor.

**Despite self-reporting being considered easier, it was still considered time-consuming and there remained confusion around the reasons to report tests**

Self-reported adherence to reporting requirements indicated that the majority of care home staff reported all tests [44]. The ability to self-report via the government portal was introduced in the spring of 2021, enabling staff members to report their own LFD results, thereby reducing the workload for care home teams. Care homes reported no issues with their staff's ability to self-report LFD results, although some staff members did require individual training to understand the reporting process [13].

Non-compliance with reporting appears to have been influenced by a lack of awareness of the need to report all LFD results, a lack of understanding of the rationale for why reporting is required [44], and feeling as though there were too many tests being taken to report them all [53]. The online portal for uploading results was perceived to be cumbersome and time-consuming [57], causing some staff to choose either not to test or not to register their results [59]. In discussions with UKHSA stakeholders, it was suggested that entering results via the portal remained complex, requiring the navigation of multiple screens to enter a result. Self-reporting must be made as simple as possible to ensure compliance.

It took time to convince residents and staff to accept testing [58]. More time and flexibility were also required from staff to identify an appropriate time to test residents [57], with care home staff citing concerns over the reliability and accuracy of tests [44] and the effectiveness of LFDs for detecting COVID-19 [53]. However, providers did come to recognise that the speed in obtaining LFD results aided them in acting quickly to contain infections and reduce the risk of the infection entering the care home in the first instance [60].

**5.4.6.5 Barriers and facilitators to acting on a positive result**

The main action following a positive LFD result (beyond further testing through rapid or outbreak testing), or for a period of time if identified as being a close contact (and not wearing PPE or maintaining social distancing) of someone who had tested positive, was to isolate and obtain a confirmatory PCR result (see appendix 5.1 for further details on confirmatory testing). The length of time required to isolate was dependent on the policy in place during that period.

A positive PCR result required the individual to commence self-isolation immediately and follow the time period for isolation as instructed by the guidance at that time.

Our research uncovered a number of potential barriers to isolation, which we have discussed below in relation to staff and resident isolation.

**Staff self-isolation was dependent on an individual's capacity to not suffer financial losses while away from work**

During the early stages of the pandemic, it was identified that staff were concerned that a positive test would result in them receiving reduced pay, in the form of Statutory Sick Pay (SSP), thereby disincentivising staff to either have a test or report a result [66]. The same report noted that 'analysis of the Income Replacement Ratio for workers only entitled to Statutory Sick Pay suggests that for some workers their

weekly income could be reduced by up to two-thirds if they had to self-isolate', with greater reductions if individuals were on higher rates of pay [66]. The same theme emerged in the early part of the Vivaldi study, a large-scale survey of COVID-19 infections in care homes, which also noted that where staff did receive sick pay, there were lower levels of infections in residents [67].

A customer insights report from UKHSA noted that 8% (of 651) of adult social care workers said that they 'could not' test positive, as they could not afford to self-isolate [53]. This was more apparent among younger adult social care workers, of whom 22% stated this as being a barrier to acting on a positive result. When this issue was raised with stakeholders of care home organisations, particularly when trying to understand the discrepancy between the numbers of LFD results reported and the expected numbers, they noted that funding for sick pay was available (via the Adult Social Care Infection Control Fund [68]) and that this was provided to the workforce.

### **Concerns around the accuracy of LFD tests impacted how staff/care homes may have behaved following a positive result**

Where there was mistrust among care home staff about the accuracy of LFD tests, particularly with respect to false-positive results, there were concerns about requiring staff to isolate and the subsequent pressure on an already depleted workforce [42].

### **The care home environment posed challenges when seeking to isolate residents**

It was noted that during the early part of the pandemic there were structural challenges in some care homes when it came to creating separate units or space that allowed residents to isolate if they were suspected to have COVID-19 [69]. Some care homes were able to create areas in which positive or suspected COVID-19 residents were kept separate or away from non-positive or symptomatic residents [70].

### **Isolating residents with varying cognitive capacities was challenging**

The isolation of residents who had varying cognitive capacities or other impairments was identified as a challenge, such as residents with differing degrees of dementia [40] or mobility [71]; it was also highlighted that some residents often wished to isolate with their door open but other residents would sometimes wander into their rooms [69]. This was similarly noted in a systematic review of COVID-19 management in social care, which also pointed out that isolation can be distressing and have a negative impact on residents' health and wellbeing [36]. One review noted that a care home moved residents who had tested positive to a lounge area that had been set up as a communal ward – the benefit being that the residents were not isolated in their rooms [39].

The above findings highlight the challenges of isolating residents and the subsequent impact on their wellbeing. Prior to COVID-19, no similar strategies of isolating residents were noted to have been implemented. Therefore, the lessons learnt from this strategy should be considered for other infectious diseases in the future.

## **5.5 Conclusion**

Using testing to protect high-risk groups has been demonstrated to be an effective strategy, as was the case in protecting care home residents. Testing was associated with reduced transmission among staff and residents; assuming our associations represented causal effects, we projected that testing reduced COVID-19 deaths in care home residents. In addition, testing supported care homes to open to visitors and allowed visits to be undertaken safely with reduced risk of infection being introduced to care homes; this was critical in having a positive onward impact on residents' wellbeing.

Testing in care homes was 3.5-times more cost-effective prior to the vaccination rollout; furthermore, the testing intensity was appropriate for residents and staff. However, an increase in the proportion of care home staff (absolute numbers) would have been a cost-effective way to prevent more deaths among residents. The Adult Social Care Plan stated that 20,000 people had been encouraged to enter the sector for work [1], but the costs of such an objective and whether the 20,000 target was met are unclear. The movement of staff among care homes was recognised to be a factor in the ingress of COVID-19 into care homes; relevant advice to reduce this movement as much as possible was provided in the 2020/21 Adult Social Care Winter Plan [2], with updates provided following the rollout of the vaccine programme [72].

Beyond the critical objective that testing should reduce hospitalisations and mortality among care home residents, the remaining objectives outlined in the adult social care policy paper [1] included supporting the workforce; supporting individuals' independence, supporting people at the end of their lives and responding to individuals' needs; and supporting local authorities and care providers [1]. Given the broad nature of these objectives and limited data (both quantitative and qualitative) relating to each of them, it was difficult to fully evaluate and draw conclusions as to whether these objectives were met. However, we recognise that:

- ▶ Testing helped to protect staff and residents and was associated with reduced transmission among residents and staff
- ▶ Testing in care homes provided a major benefit to support residents through enabling safe visits
- ▶ Local authorities and care providers had considerable funding made available to them, which aided the operational delivery of testing
- ▶ Providers involved in pilot studies of testing and in policymaking felt supported

Given the likelihood of care home residents being a high-risk group in any future pandemic involving a respiratory infection, there are considerations and recommendations about how to improve uptake and reporting of testing in a complicated sector that is responsible for looking after some of the most vulnerable members of our society. Implementing these recommendations could lead to further improvements in the efficiency of testing in care homes, which could result in it being delivered for a lower cost.

## 5.6 Key considerations and service-level recommendations for future testing strategies

### Summary of key considerations and recommendations

We present the overall testing programme recommendations in chapter 6 of this report, with recommendations referring to testing services for high-risk groups and their contacts being particularly relevant to adult social care. Additional considerations and recommendations specific to the adult social care testing service are as follows:

#### Considerations:

- ▶ Different policies across adult social care and healthcare led to challenges in care homes when healthcare workers did not abide by their regulations; different policies among devolved administrations also led to operational challenges.
- ▶ Changing policies for cohorts outside of care homes caused frustration among the workforce (for example, ending of visitor testing when staff testing was still required).
- ▶ Adult social care services that were not part of the initial testing rollout felt forgotten and left out; clear communication and justification of the timings could improve understanding and acceptance by the different sections of the sector.
- ▶ Inaccurate information led to operational and logistical challenges.
- ▶ Registering and reporting tests (even when using an LFD reader) was highly time consuming, but a more streamlined, automated approach could help, given the volume of results that had to be reported.

#### Recommendations:

- ▶ Ensure the communications around guidance are clear and concise to support effective implementation.
- ▶ Identify and enable targeted support; this could be determined by, for example, CQC rating or type of care home.
- ▶ Employ responsive testing strategies following the rollout of any major new interventions, such as vaccination, that impact the target group; these strategies should be informed by data and evaluated.

SUMMARY

## 5.6.1 Considerations

### 5.6.1.1 Different policies across adult social care and healthcare led to challenges in care homes when healthcare workers did not abide by their regulations; different policies among devolved administrations also led to operational challenges and confusion

Our evaluation noted repeated variations in policies between those issued to care home staff and those issued to healthcare workers. These differences in the guidelines related to, for example, online training, regular PCR testing, pausing of testing for 90 days and mandated vaccinations. As communicated by UKHSA stakeholders, there are likely to be valid reasons why, on occasions, guidance may differ between these sectors.

This non-alignment and the implementation of guidelines at different times had an impact on care homes. Stakeholders of care home organisations noted that there were incidents in which healthcare professionals refused to show proof of a negative test or undertake an LFD test when requested to do so, as this was not required within the health sector – despite healthcare personnel being required to follow care home guidance when entering their premises. Care home organisations and national care associations have reported that this contributed to the perception of care homes being treated differently or of being forgotten; this was also noted in DHSC insights from February 2021 [13].

Important consideration should be given, therefore, to ensuring that were such policies to remain differentiated in the future across the health and care sectors (including testing policy, vaccination policy etc.), particularly in relation to staff who may look at the advice and guidance provided to the NHS and compare it to their own, that good communication and a clear rationale must be provided outlining why the risks associated with the different sectors are mitigated by differing policies. The comparison of guidance should be taken into account when planning guidance for either cohort.

By the very nature of their role, healthcare workers will always be at the epicentre of any future pandemics, so similar good communication and information about different testing policies (such as those in the adult social care setting) would be prudent to highlight, particularly for settings where individuals are at high-risk of morbidity and mortality.

If alignment of guidelines is not feasible, individuals working across services must follow the guidance for the setting they are attending (e.g., taking an LFD test if requested or if unable to produce a previous negative result). As noted by one stakeholder from a care home organisation, '... it is how you implement that guidance and how you give clarity to healthcare professionals that they're going into a different environment, a different regulatory environment and they need to comply with the rules and regulations associated with that environment.' Were such policies to remain differentiated in future pandemics, consideration should be given to how care homes or other settings in adult social care are enabled to escalate instances where individuals from the healthcare sector do not comply with the guidance that is being requested of them. This should not be viewed as punitive action against fellow professionals, but merely as supporting the adult social care sector to reduce the risk of infection ingress and, as far as possible, to keep staff and residents safe.





As highlighted in this chapter, older residents of care homes and those suffering with dementia were at higher risk of morbidity and mortality following a positive COVID-19 test. The policies relating to testing and self-isolation did not differ according to the type of residents that a care home served – as noted by UKHSA stakeholders, guidance (such as for testing and isolation) should be based on ‘...an understanding of the setting’s characteristics (e.g., density of care contacts, size) and vulnerability to residents to pathogens.’

Larger care home organisations noted that guidance relating to testing, isolation, support/incentive payments and mask wearing differed across the devolved administrations. Stakeholders of these organisations raised the challenges that this caused, both from an operational and a communications perspective, when trying to ensure that the correct information was disseminated to care homes in different parts of the UK. Additionally, they noted that the differences in support or incentive payments led to feelings of unfairness among staff.

Such differences in the guidance (particularly the guidance related to testing and isolating) are likely to be more acutely felt by staff working in one devolved nation but living across the border in another. This evaluation did not establish how many workers this applied to.

The evaluation recognises that health policies are matters for each devolved administration; therefore, a recommendation to align policies across the UK nations is both complicated and a politically sensitive matter. Nevertheless, and in the interest of public health, it might be beneficial if a commonality in policies could be found. Were this not to be feasible, it might affect those organisations and/or staff directly affected by this issue.

#### **5.6.1.2 Changing policies for cohorts outside of care homes caused frustration among the workforce (e.g., the ending of visitor testing when staff testing was still required)**

As with testing for healthcare workers, the evaluation did note that testing guidance for visitor and visiting professionals differed to that for adult social care. Conversations with stakeholders from care home organisations revealed that frustrations among the care home workforce were noted when step-down approaches were taken. Examples provided included visitors no longer needing to take an LFD test, but staff continuing to have to do so, despite both groups being in the community; or CQC inspectors, by law, being allowed entry to a care home but not mandated to show a negative result. The external stakeholders we spoke to highlighted that such differences made the sector feel ‘targeted’.

The evaluation recognises that there were challenges associated with any changes to testing guidance. As noted with the issues around differentiated policies, where a risk-based approach remains (particularly if there are no other infection control provisions such as PPE or social distancing), consideration should be given to ensuring that testing for visitors or other individuals coming into a care home also remains. This will support and provide assurance to care homes that the risk of infection ingress by all those who enter the premises is minimised.

We encourage UKHSA, in collaboration with DHSC, to seek the input of the care home sector when any changes to the guidance are proposed, thereby enabling the sector to feel listened to and supported with respect to such changes.

#### **5.6.1.3 Adult social care services that were not part of the initial testing rollout felt forgotten and left out; clear communication and justification of the timings could improve understanding and acceptance by the various sections of the sector**

Although the evaluation focused on testing in care homes, other services within adult social care also participated in testing, but this was rolled out to the extra-care, supported living and domiciliary care sectors approximately 6 months or more following the initial rollout of PCR testing in care homes serving residents over the age of 65 years or those with dementia. In conversations with stakeholders from care organisations, it was noted that such a delay in testing led to some sections of the sector, such as extra-care supported living, feeling forgotten and coming second to care homes.

It is recognised that initial testing capacity was limited and therefore UKHSA had to prioritise testing requirements based on differing risk profiles assessed across the sector. It is possible that testing availability would be similarly restricted at the onset of any future pandemic, and therefore not available to the entire adult social care sector simultaneously. In such a scenario, the identification of individuals at highest-risk of mortality following a positive test result (which in our evaluation was noted to be older residents or those with dementia and was the care home population cohort who were first to receive regular asymptomatic PCR testing), should be communicated across the sector, detailing in as far as possible the rationale of a stepped rollout and why some services in the sector may be in receipt of tests prior to other service users or staff and carers.

It is important to engage with, and have clear communication and messaging to, all these groups about the reasons why testing may not be implemented in their respective settings, but is made available to other settings within adult social care. The services for which testing is not being concurrently implemented may need to be provided with additional assurances, alongside indicative timelines of when testing may be implemented in their respective services, thereby reducing the likelihood of parts of the sector feeling forgotten with respect to the provision of testing.

#### **5.6.1.4 Inaccurate information led to operational and logistical challenges**

As noted in this chapter, care home organisations reported that initial issues with couriers arose from them sometimes going to locations based on incorrect information provided by CQC. Providers and registered managers are responsible for ensuring that CQC holds the correct details for their care homes, but it is unclear how rapidly any changes to these details are updated in the CQC central database.

There are further issues for services not registered by CQC and how their details are held/updated, particularly in cases where individuals are recognised to be receiving care and would be just as vulnerable as those in care home settings.

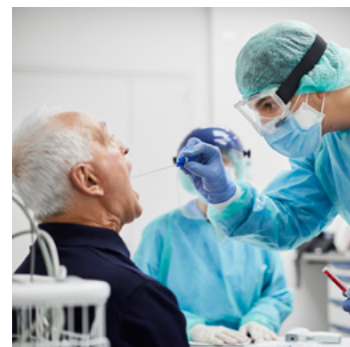
Consideration should therefore be given to ensure that current processes are reviewed and improved for pandemic preparedness, potentially incorporating synergies into existing care home infrastructure, so outbreaks and isolating individuals can be monitored in real-time for public health purposes. Furthermore, such systems could ensure that all bodies involved in supply chains and logistics have up to date information for relevant locations, including their address (plus postcode), contact name, contact number and email. This would reduce the risk of challenges associated with a similar rapid scaling up of a mass testing programme or other key public health and health protection activities.

#### **5.6.1.5 Registering and reporting tests (even when using an LFD reader) was highly time-consuming, but a more streamlined, automated approach could improve the speed at which high volumes of results are reported**

Challenges with the process and time needed to register tests were widely reported for both LFD and PCR tests. This was a particular issue for care home staff, due to the pressures they faced working with a high-risk cohort, the disruption to their working practices and the increases in their workload due to the pandemic. Providing a simplified and wherever possible automated approach to registration (such as the LFD digital reader reporting tool, which was noted to be effective by those who used it) would support staff in their ability to comply with testing and reporting protocols. This tool, now that it is available, should be promoted by UKHSA at the earliest opportunity, among care home staff and others, as being a tool that simplifies the reporting process.

It is recognised and was noted by UKHSA stakeholders that there are challenges and security implications related to logging on to and recording information on gov.uk applications. However, to support a true reflection and understanding of a testing service, it would be prudent to design a simpler reporting mechanism.

As noted earlier in this chapter, insights from staff who used an LFD reader to report their results revealed that some still felt that the use of a digital reader had no benefits [62].



These findings indicate, that, wherever possible (and with appreciation of the challenges faced in the requirements to rapidly develop a user-friendly digital tool during a pandemic), the reporting requirements and associated technology should enable and facilitate reporting as much as possible; this view was shared by stakeholders from care home organisations.

UKHSA may also wish to further explore a system of incentives to encourage compliance with reporting. This approach would only be feasible where UKHSA has access to sufficiently detailed datasets that allow them to understand which care homes (or other settings) are under-reporting. As noted in conversations with stakeholders from care homes, some were able to analyse these data internally and offer support where necessary, while others had reports from DHSC available to them. However, there should be recognition and consideration of the increased workload and other pressures that the care home workforce may face during a pandemic, so any incentivisation should be aligned with the recognition and behavioural understanding as to why testing is being undertaken and reported. Such incentivisation or other mechanisms to support reporting compliance may warrant a review of any legalities surrounding such schemes; therefore, as part of future preparedness, UKHSA could consider undertaking some work in this area to gain further understanding both of what is acceptable and legal in this space.

A tool that allows a comparison of reporting among care homes could also act as a tool to connect care homes that are experiencing challenges with well-performing care homes and their infection control teams, to enable learning from best practices. This should be undertaken as a support mechanism and not one that is driven by competition among providers in the market.

#### **Case study: Aligning policies for the care sector with those of the healthcare sector during a pandemic – an example from Germany**

A range of strategies and policies were implemented across the globe to deal with the pandemic, and one approach may not obtain similar success across nations. It is also challenging to determine the impact or success of these interventions with regards to their desired public health outcomes without a proper evaluation. However, it is possible to identify some trends, similarities and differences to the strategies implemented in England as well as recognising shared barriers and facilitators of policymaking related to COVID-19 testing.

This case study discusses the example of Germany scaling up testing and providing the care sector with the same support as the healthcare sector at the onset of the pandemic. The 16 states in Germany have slightly different regulations with respect to the adult social care sector, as well as additional regulatory bodies [73]. However, in the case of Germany (and where it differed from England), from the early days of the pandemic, care homes were prioritised (alongside hospitals) for testing during the first epidemic wave [74]. Germany was able to rapidly scale up testing for a variety of reasons; specifically, scientists at the Charité hospital in Berlin developed one of the first PCR tests for COVID-19 [75], the laboratories across the network were largely already accredited and equipped to carry out PCR assays [75], and armed forces personnel and volunteers were supplied and financed by the federal governments to support testing in long-term care facilities [76]. Although not specific to testing, Germany also viewed care homes and hospitals through the same lens when it came to the supply of PPE [74].

#### **Considerations for testing in care homes:**

Testing of care home residents in England (either at a care home or prior to hospital discharge) was not implemented in the early stages of the pandemic. This, alongside the challenges around obtaining PPE, made some in the sector feel left out. Future pandemics involving a respiratory infection may similarly impact this sector, in which the service users tend to be older and more vulnerable. The healthcare sector would be similarly impacted, by the very nature of healthcare workers' role of working in the health system. As discussed in the recommendations, future policies should consider that guidance, testing and other provisions be made available to both hospitals and care homes. The example from Germany demonstrates that both sectors were supported simultaneously, which may have led to a lower mortality rate among care home residents there when compared with the UK during the first epidemic wave [74].

## CASE STUDY

## 5.6.2 Recommendations

### 5.6.2.1 Ensure the communications around guidance are clear and concise, to support effective implementation

We recognise that the testing strategy for COVID-19 required multiple updates to the testing service guidance due to the increasing knowledge base, epidemiological developments, and changes in human behaviour. Additionally, policy changes were not only related to testing but also to many other interventions implemented at the same time. As noted in conversations with external stakeholders, those who were involved in the testing pilot studies or in policymaking felt more prepared for potential upcoming changes, thereby highlighting that it would be helpful to have advance notice of any revisions to guidance, to manage expectations.

Care home staff reported challenges and confusion around keeping up with the frequency of updates to testing guidance [44], which changed approximately 19 times (excluding those for the general population) throughout the evaluation period, particularly understanding the changes, with notable challenges also highlighted around changes to policies announced or issued late in the evening or on weekends, with little time given to implement the required changes. A streamlined approach to communicating updates to the guidance, including executive summaries and easier to digest information, alongside a clear and evidence-based rationale of any changes would enable care homes to implement the guidance more effectively.

Additional consideration should be given to the timing of guidance releases, with timely notification of changes to allow time for the policy to be implemented. Where appropriate, a consistent messaging approach should be utilised, for example, what are we doing, why are we doing this, what has changed and what will happen if we do not do this?

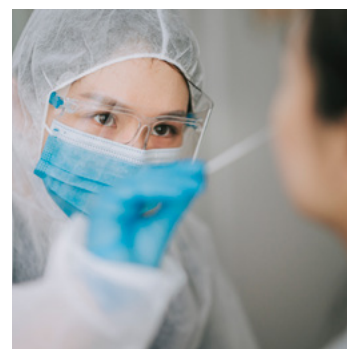
It is incumbent on all parties within the adult social care sector (including those from organisations and national associations) to share their views, requirements, capabilities and capacities. Facilitating continuous feedback on the experiences that the sector faces can enable real-time modifications of a testing service, were that be required. Such involvement could take the form of advisory meetings, workshops, focus groups or interviews and is key to obtaining continuous, ongoing engagement with the testing service.

It is recognised that a central and key aspect of the approach to the pandemic was to use existing social and organisational structures at local levels to manage the rollout of testing, with the approach managed at local level. Future pandemics are likely to rely on a similar strategy, with technology and data supporting the performance management. Such elements may involve data sharing across different organisations and would therefore require forward planning to work through the legal model, information governance and social structures. The preparedness for this, specifically around governance and the use of social institutions, would be a useful element to work on now, to support rapid implementation in any future pandemics.

### 5.6.2.2 Identify and enable targeted support – this could be determined by CQC rating or type of care home, for example

The evaluation consortium has observed that certain types of care homes had larger outbreaks when first discovered. These were learning disability care homes, smaller care homes and those with a higher number of residents per carer. Other care homes, such as those predominantly caring for residents with dementia, took longer to get an outbreak under control.

Our evaluation also found that care homes with fewer reported tests tended to discover outbreaks of a larger size, suggesting they were found later. Therefore, data-driven decisions should be made throughout any pandemic, to target support at care homes with low rates of test reporting. Larger care home organisations noted that they set up their own data-reporting dashboards and required care homes to report the number of test results (this matches information gleaned from DHSC insights in February 2021) [13], allowing them to rapidly identify those care homes whose reporting appeared to be lower than the guidance levels. However, associations representing smaller providers acknowledged that in some instances there was a lack of knowledge with respect to IT and technology infrastructure to be able to



report all the results as required. Consideration must be given to how to provide positive, targeted support to providers who appear not to be reporting the number of results expected.

### **5.6.2.3 Employ responsive testing strategies following the rollout of any major new interventions, such as vaccination, that impact the target group; these strategies should be informed by data and evaluated**

Our evaluation showed that testing in care homes was substantially more cost-effective prior to the vaccine rollout. Given the effectiveness of the vaccine in reducing hospitalisations and deaths from COVID-19, the testing regimen in care homes subsequently had a lower impact and became approximately 3.5-times less cost-effective, suggesting that this strategy may have benefited from a review once vaccination had been rolled out to this group.

In discussions with stakeholders, it was noted that the Scientific Advisory Group for Emergencies (SAGE) reviewed the role of testing post-vaccination, which informed the government's 'Living with COVID-19 strategy' [77]. Such reviews and their impact should be raised with policymakers, to support any changes to testing strategies, with a recognition that confidence in the effectiveness of such interventions would need to be established in the first instance, prior to any testing regimen changes.

Following the rollout of any new intervention that is anticipated to substantially impact high-risk groups, the intervention's impact on the effectiveness and cost-effectiveness of the testing programme should be evaluated. It is recognised that such evaluation will be dependent on relevant data (with a time-lag factored in) and modelling being available to support such changes for groups that remain at high risk. This decision-making is also highly dependent on the support of strong modelling and analytics capabilities. There are inherent risks associated with policymaking for high-risk groups – within this cohort in particular the challenge regarding how acceptable it would be to make the wrong decision will ultimately be the key question for policymakers.

Further information on recommendations for testing strategies can be found in chapter 6.







# Recommendations

# Recommendations

This chapter concludes the evaluation, putting forward key recommendations for the future and covers:

# Recommendations

## 6.1 Introduction

In response to the COVID-19 pandemic, the government committed to testing, initially commencing in March 2020 [1]. In May 2020, NHS Test and Trace (NHSTT) was formally established, at pace and during a time of unprecedented urgency, as an Executive Agency of the Department of Health and Social Care (DHSC) [2]. The UK Health Security Agency (UKHSA) was then established, also as an Executive Agency of DHSC, on 1 April 2021 and was operational on 1 October 2021 [3]. UKHSA combines the health protection, clinical and scientific functions of Public Health England (PHE) with NHSTT and the Joint Biosecurity Centre (JBC) [3].

NHSTT was tasked with enabling mass-scale testing to rapidly identify individuals with COVID-19 and their close contacts, thereby minimising the spread of the disease [4]. The testing programme was initiated and rolled out at a time of great turmoil and uncertainty. However, it played an integral role in the management of the pandemic, through its various testing services.

The overall success and effectiveness of any national pandemic testing programme is dependent on multiple contextual factors, shaped by the particular features of the pandemic, such as the stock of tests, the efficacy of these tests, people's actions in response to their test results, the evolving epidemiological context etc. A national testing programme will comprise a variety of testing service settings, such as schools, healthcare and adult social care. The combined impacts of the various testing service settings include the public health impact, their cost-effectiveness and the population's behavioural responses. These contextual factors, as well as the political backdrop at the time, were all considered as part of this retrospective evaluation.

With any retrospective evaluation, we look back to look forwards. While perhaps an obvious point, this was one of the key premises of the evaluation, as it enabled learnings to be made based on the experiences of the past, which could then be applied to current or future ways of working, in a way that is empathetic to the challenges faced. In this case, the retrospective evaluation helped to define what was intended by implementing the national testing programme, to evaluate the outcome and develop recommendations for the future, based on feasibility and impact. The evaluation consortium also attempted to understand how the findings of the evaluation have been shaped by the particular conditions of this pandemic, which has enabled us to suggest how the testing approach could be adapted if these conditions were to differ in any future pandemic. While this retrospective evaluation focused on the national response to COVID-19 in terms of testing, the learnings can be applied to support wider pandemic preparedness and public health policy. In this chapter, we provide a series of programme-level conclusions and recommendations for how testing could be best applied in the future, building on the learnings from the evaluation of the national COVID-19 testing programme in England, in particular the period between October 2020 and March 2022.

## 6.2 Conclusions in relation to the original hypotheses and research questions, as well as conclusions from operational insights gleaned and implications for the future

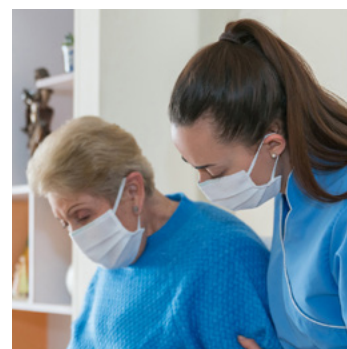
Overall, we can conclude that:

- ▶ The national COVID-19 testing programme in England increased case identification throughout the evaluation period and at its peak identified an estimated 40% to 50% of all possible cases (symptomatic and asymptomatic).
- ▶ Testing appears to be an effective public health intervention for high-risk groups in the adult social care and healthcare settings; without the testing programme there would have been higher rates of full-time equivalent (FTE) absenteeism, outbreaks, nosocomial infections and deaths in these groups.
- ▶ There were insufficient real-time data to be able to draw data-led conclusions about whether testing resulted in a wider reduction in community transmission, hospitalisations and deaths; however, we explored the potential gains in costs and QALYs (quality-adjusted life-years) gained if this assumption were true.
- ▶ Testing in low-risk groups instilled confidence and trust to resume day to day activities, an impact that could be achieved through a less intensive and disruptive testing strategy; this should be explored in more detail.
- ▶ We were unable to measure the indirect effects of testing in low-risk groups with regards to hospitalisations and deaths in the community due to limitations, in the way the data were collected at the time.
- ▶ We were also unable to measure the direct effects of testing in low-risk groups, for example reductions in COVID-19-related absenteeism, as we were unable to obtain the necessary data within the time constraints of this evaluation.
- ▶ Testing uptake increased across all groups upon rollout of the universal testing service; however, it is worth noting that this uptake in testing also coincided with increased prevalence at the time. In addition, following the rollout of the universal testing service, asymptomatic testing uptake increased among low-income groups but increased even more among higher-income groups. Therefore, in absolute terms, it achieved more testing in deprived populations but actually widened the relative inequity of testing. However, despite this widening inequity, it is worth considering the benefit of limiting overall community transmission by the increased uptake of testing among the wider population.

From our operational insights, we can conclude that the national testing programme was successful in:

- ▶ Establishing a coordinated rollout strategy at pace when previous infrastructure or supply routes did not exist and at a time when much was still being learned about the disease itself as well as there being frequent changes in policy.
- ▶ Providing equality of access, as testing during the evaluation period remained free for everyone at the point of access.
- ▶ Putting thought and effort into making user journeys and citizens' experience as streamlined as possible at every stage of interaction, including requesting a test, taking a test, uploading the results and the self-isolation protocols, despite the ever-changing policy landscape.
- ▶ Acknowledging the need to focus on evaluation, observed through insertions of intent in the testing standard operating procedures (SOPs) and the creation of a Testing Initiatives Evaluation Board (TIEB) to advise and quality assure those evaluation initiatives that were taking place. For example, the evaluation of LFD testing to gain regulatory approval for self-testing, the evaluation of rapid COVID-19 testing in schools [5], the development of the Canna model [6] and the Liverpool community testing pilot [7].

In addition to what went well, there are a number of operational insights gleaned that can support improvements for the future, in terms of testing aims, uptake and reporting, recognising that these may have been logistically challenging to implement during the COVID-19 pandemic. The implications of these findings include:





- ▶ While there was logic and intent behind the testing strategies, it should be noted that no Theory of Change (ToC) or similar methodology or criteria for planning, participation, and therefore, adaptive management, was in place prior to the pandemic. Nor was one developed at pace during testing rollout that was used to articulate why a testing service was set up, its aims and objectives, and what assumptions were made, with the purpose of using it to measure outcome and impact. There is value in the advance construction of a variety of ToCs, or similar, based on the likely different conditions/characteristics of possible future pandemics. Using the learnings from the rollout of a mass testing programme of such scale to inform development of ToCs, or similar, would obviate some of the need to work reactively, which was not always possible during the pandemic situation. This could be supported by preparing (and collating existing) outline SOPs for a range of future pandemic scenarios that consider learnings from this pandemic.
- ▶ A ToC (or similar) approach would also ensure that aims and objectives are not in direct conflict with one another. For example, the universal testing service had the aims of increasing equity while also increasing access for all; however, in the absence of a deliberate focus on health equity during the strategy development process, our analysis showed that such strategies for asymptomatic LFD testing unintentionally widened health inequities. Well-designed strategies in the future should include supportive actions to intentionally address the barriers or unintended consequences that underserved populations may face during the implementation of testing in a pandemic. Such efforts could help ensure maximum effects across communities that may be experiencing health inequities. Similarly, the schools testing service had an aim of increasing confidence to send pupils back to school, i.e., to minimise disruption, while also finding more positive cases via a testing regimen that was perceived to be disruptive, with a lack of evidence regarding whether this ultimately had the intended impact on community hospitalisations and deaths.
- ▶ While some of the aims and objectives observed had measurable aspects, there were some that would have required further data or trials to be measurable. In the future, testing services would benefit from having clearer, measurable aims and objectives that are underpinned by a measurable framework of the type mentioned above.
- ▶ It was not possible to analyse certain indirect effects, such as the impact of schools testing on wider community hospitalisations and deaths, due to the way the services were rolled out at the time and therefore the way the data was collected.
- ▶ Insights from our qualitative findings and stakeholder interviews suggested that much of the analytics capability during the COVID-19 pandemic was focused on other NPIs, with limited analysis undertaken of the public health impact of testing on disease transmission and outcomes.

### 6.3 We have two key recommendations for UKHSA to consider as part of future pandemic preparedness planning:

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**Recommendation 1:** Testing, and in particular asymptomatic testing, in any future pandemic scenario should be simplified from the start, utilising a Theory of Change approach, or equivalent, with clear and measurable aims from the outset that are easy to communicate to the public.

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To optimise the use of resources and to reduce confusion by allowing the streamlining of guidance, different strategies should be considered for high-risk populations versus high-contact populations, with the assumption that all groups then self-isolate and contact-trace following a positive result. It should be noted that high-risk status will be different for different diseases and could change dynamically throughout a pandemic due, for example, to vaccine-induced and/or natural immunity or the emergence of new variants with higher or lower pathogenicity.

The aims of any future testing programme should also be considered at the start, to clearly identify what the testing programme is seeking to achieve. For example, there are several potential uses for testing programmes, such as 'test to treat', 'test to protect', 'test to release' etc. Once this is established, any future testing programme should consider having three main components: a high-intensity regimen

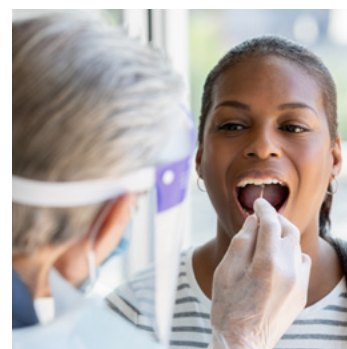


for protecting high-risk groups, a low-disruption regimen for high-contact-low-risk groups, and a high-access service, similar to the universal testing service, with enhanced targeting to allow user-defined regimens while increasing equity (Table 6-1). This should be underpinned by a dynamic and clear communication strategy to mitigate the risk of confusion.

**Table 6-1. The three components needed for any future testing programme: a high-intensity strategy, a high-efficiency strategy and an open-access strategy.**

High-intensity strategy	High-efficiency strategy	High-access strategy
<p>A high-intensity regimen involves testing high-risk groups and their contacts at a high frequency, both in and out of isolation.</p> <p>Such a regimen prioritises reducing contact of high-risk individuals with infected individuals while balancing against reducing the average period of isolation.</p> <p>An example of a high-intensity regimen for a similar pandemic setting is to test with a given frequency, isolate following a positive result and continue testing at the same frequency until the first negative test result. The frequency of testing and the population for high-intensity testing can be adapted to suit the tests available. For example, early in the pandemic, weekly PCR tests would be appropriate, whereas later, when rapid tests are available at scale, daily rapid testing would be possible. As in each of these phases the approach is simple and intuitive (i.e., proceed as normal with a negative result and isolate with a positive result), with only the frequency or the choice of diagnostic changing; guidance could be streamlined and updates easily communicated. These and other simplified strategies can be explored in detail using mathematical modelling.</p> <p>A high-intensity strategy is aimed at having a direct impact. With this type of strategy, success or impact can be evaluated through measures such as quality-adjusted life-years (QALYs). This is a high-cost and high-effect strategy, and it identifies positive cases and outbreaks, particularly within vulnerable populations, in an impactful way, while minimising the unnecessary isolation of essential workers.</p>	<p>A low-disruption regimen involves testing high-contact-low-risk groups at mid- to low-frequency, with simple isolation guidance.</p> <p>Such a regimen minimises disruption and cost as a priority while balancing against the possibility of reducing community transmission.</p> <p>An example of a low-disruption regimen, aimed at individuals in a high-contact population, would be to test with a given frequency (lower than that for the high efficiency regimen) and then to isolate for a period that aligns with the duration of the infection. Isolation would end after this fixed period with no need to test to release, and, following the isolation period, the testing regimen would be as before. Efficiency could be defined based on model simulations that maximise the reduction in transmission while minimising the time spent isolating. The frequency of testing could be adjusted to suit the availability of tests and/or the epidemiological conditions at various phases of the pandemic. A scheduled test to release option could be added to the isolation period to allow early release, which would reduce disruption at the expense of simplicity of the regimen.</p> <p>Indirect effects may be possible if very high effect sizes can propagate through the transmission pathway, but this cannot be relied upon unless trials of such interventions are designed and sufficiently powered to estimate the indirect effect size. If there is no strong evidence for indirect effects, a low-disruption strategy should focus less on contact tracing, especially in low-risk groups.</p>	<p>A high-access service is similar to the universal testing service, with access to testing for reasons defined by the users, to be rolled out when self-testing at scale is feasible.</p> <p>Such a service aligns with the partnership between public and programme by enabling users to define and implement testing practices to suit their requirements.</p> <p>Examples are, by definition, difficult to provide as the service ensures that unanticipated use cases can be included in the programme. This type of regimen would benefit from understanding the user base and should be combined with increased behavioural research into under-represented groups and the exploration and development of targeted guidance and communications based on the behavioural research evidence to enhance access.</p>

While it is recognised that decisions were made based on information available at the time, the nation's experience with COVID-19 has taught us that the emergence of new variants, with different characteristics, alongside constantly changing interventions (for example the vaccine rollout programme), requires a change in testing strategy to achieve the maximum impact and cost-effectiveness. From this evaluation, we can conclude that while some of the testing strategies were cost-effective at the outset, once the vaccine had been introduced their impact and value-for-money rapidly deteriorated. While policy and guidance changed frequently, the fundamental testing strategy did not change. Although the impact of the evolving variants was considered at the time, knowing what we know now, how the evolution of new variants could impact a testing strategy should be considered more purposefully in the future. Any change in regimen should be underpinned by a clear and robust communication to avoid confusion across sectors, as identified in previous chapters.



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**Recommendation 2:** To enhance the efficiency of testing, three enabling functions must be prioritised immediately as part of pandemic preparedness strategies. In doing so, UKHSA has the opportunity to build on past experiences and be more prepared ahead of any future pandemics.

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### 1. Data

- ▶ The evaluation consortium experienced a number of challenges in accessing data throughout the evaluation timeframe, as outlined in previous chapters. This highlights the need to develop an understanding of the critical public health data to be collected and measured, with a plan in place to capture this information in the future.
- ▶ This should be underpinned by strong analytics and modelling capabilities, particularly building capability to model testing interventions. Currently, however, the government is rationalising public health capability in this area. Modelling capabilities should be considered as a key tool to unlock effective public health intervention both as 'business as usual' and as part of pandemic preparedness.
- ▶ While progress was made to establish a technology-enabled, dashboard-led approach, learnings should be considered and built on to ensure a more cost-effective mechanism for data collection is established; these approaches would also support public health surveillance more generally if delivered in a joined-up way within UKHSA as part of its business as usual.
- ▶ Data from partner departments, such as the Department for Education, should be accessed and reviewed early on, to ensure that these data fulfil the requirements for the measurement of indicators, with data-sharing agreements set up in advance.
- ▶ Valuable datasets from the academic community were available throughout the COVID-19 pandemic, e.g., REACT prevalence data and the nowcasting of incidence data by the Medical Research Council (MRC) biostatistics unit, and could have been incorporated in a real-time evaluation. Key performance indicators, such as the percentage of all cases that UKHSA identified, could have been made more readily accessible to decision makers and operational leads to support appropriate action.

### 2. Live impact and outcome evaluation

- ▶ Data, modelling and analysis are only useful if processes and capabilities are in place to act on the results, supported by an 'evaluation-first' mindset and culture. There should be an evaluation framework, similar to the one developed by the Public Health Clinical Oversight (PHCO) function for COVID-19. This evaluation framework should balance operational requirements and speed with the quality of evaluation and there should be greater accountability for enforcing its use (e.g., the Senior Responsible Officer (SRO) of a testing service has named accountability to deliver an evaluation, with an agreed budget to cover the costs of the evaluation).
- ▶ The framework should make clear the need for measurable aims and objectives, via a ToC or similar approach, and have a requirement for measurable indicators underpinned by the supporting data infrastructure described above. These indicators can be prepared in advance for a variety of pandemic scenarios; mathematical modelling could be employed to facilitate the identification and impact of these indicators.
- ▶ The framework should also recognise the need for cluster randomised controlled trials (RCTs) as part of a testing service rollout, with a clear rationale for this that is communicated to the public, balancing the ethics of evaluation requirements with equity of access. These processes and methodologies can be built into business as usual now as part of existing health protection functions, to be used to support general public health, build capability and support pandemic preparedness.
- ▶ Real-world evidence gathering via RCTs, designed around minimal operational disruption, would support the assessment of whether intended aims are achieved. This is an innovative concept with few examples world-wide. However, learnings can be gleaned from the RCTs designed to analyse the uptake and impact of vaccinating primary school-aged children against influenza [8, 9]. In addition, it should be noted that real-world evidence approaches are developing following the pandemic [10]. Research should be carried out in preparation, and in collaboration with implementers (to ensure feasibility), so that rapidly modifiable, rollout-by-trial

designs are available in advance. Incorporation of national case and prevalence data in real-time and fully integrated at an LTLA level as part of public health surveillance, using novel debiasing approaches, could allow for robust disease surveillance and assessment of programme performance in real time, which was explored in more detail in chapter 2. It should be noted, however, that this will always involve a trade-off. For example, a phased deployment allowing for real-time evaluation of impact may come at the expense of equity, e.g., all of the testing services implemented during the COVID-19 pandemic were rolled out at the same time for everyone; however, we believe this is a trade-off worth having as it will best facilitate a) accountability and measurement of impact and b) a more agile testing approach that can be optimised for efficiency for the high-risk and high-contact groups as well as over different phases of the pandemic.

- ▶ Real-time evaluation will require immediate access to hospitalisation data, so data access agreements should be set up in advance, streamlined and maintained for UKHSA and UKHSA partner analysts.
- ▶ In addition, a model (or models) should be developed now to support future pandemic preparedness and could be used more widely to support standard health protection responses in the future, by modelling various interventions and to inform decision-making. Using this model, sensitivity analyses and comparisons of different testing channels and services could be explored. For example, if the availability of a specific type of testing is a constraint, modelling could be used to create a competitive analysis of each testing option to support prioritisation. Such a model could also help drive the monitoring of assumptions on which the intervention was based, to measure impact and evaluate the intended outcome.

### 3. UKHSA's operating model

- ▶ There is a need for closer internal working among the groups within UKHSA, their commercial functions and their external partnerships (e.g., with DHSC) in delivering the above with regards to pandemic preparedness as a part of business as usual.
- ▶ Regarding UKHSA's internal operating model, large investments are currently being made in improving UKHSA's cloud-storage capabilities, application programming interface (API), and its analytics and knowledge management capabilities via programmes being driven by the Technology and Data analytics and surveillance functions, e.g., the Big Rocks programme and the National Bio surveillance Network programme. The Testing Operations function may wish to align a testing programme's needs with these large-scale technology-enabled initiatives that are being funded.
- ▶ Calculations should be made to determine the most cost-effective way of setting up this data and analytics infrastructure, e.g., should this capability or capacity be invested in permanently via the initiatives described above, or would cost-effective partnerships with external suppliers support a scalable solution that can be switched on or off?
- ▶ If the latter is explored, contractual rigour is essential - despite writing an evaluation requirement into clinical SOPs that were subsequently delivered by partnerships during the COVID-19 pandemic, these outcome- and impact-focused evaluations on testing were not observed.



**Case study: Learning from previous experience and using a data-centric approach helped curtail the spread of COVID-19 in South Korea**

While recognising the vast cultural differences between England and South Korea, including differences in trust in data protection, it is still worth considering how South Korea managed the COVID-19 pandemic using data and where challenges arose.

South Korea was one of the best-performing countries in managing the COVID-19 pandemic, by building on its previous experience in handling Middle East Respiratory Syndrome (MERS) and using a data-centric approach to curtail the spread of SARS-CoV-2 [11].

South Korea deployed extensive digital surveillance technology, which allowed the country to contact-trace thousands of potential cases to test and isolate them before they unknowingly infected others [12]. South Korea's tracking strategy relied heavily on its digital infrastructure, using a wide range of data sources – location history, immigration records, CCTV footage and credit card transactions – to keep track of confirmed cases and their contacts [12].

It was also one of the first countries to launch a centralised data sharing platform that helped reduce tracking to just under 10 minutes per patient [13]. Once data had been collected, they were used by health authorities in their contact-tracing efforts and also released to the public to help minimise virus hotspot activity.

However, the richness of the data collected did raise some privacy concerns. While data were anonymised, in some cases it was possible to determine a patient's identity through the detailed movement histories collected [12]. Despite these concerns, a survey found that 89.1% of the public supported the government's surveillance practices [14].

In the aftermath of the MERS outbreak, the South Korean government recognised the importance of a swift response and amended its Infectious Disease Control and Prevention Act (IDCPA) to allow health authorities to collect data on confirmed and potential cases during infectious disease outbreaks.

The public was provided with a 'right to know', with the health ministry required to disclose the information it collected. This helped legitimise the government's surveillance strategy and at the same time encouraged public cooperation. In addition, South Korea regularly updated its guidelines for pandemic surveillance and testing, while consulting relevant agencies and the public. Having a more transparent approach helped win the confidence of the public, with the Korea Disease Control and Prevention Agency demonstrating its flexibility and awareness to address privacy concerns [12]. It even opened up channels for patients to review their logs, allowing for corrections on a case-by-case basis [12].

This provides an example of how technology can be used for an effective pandemic response. The manner in which the technology was deployed was key, as having a two-way communication process with the general public helped create the correct balance between public safety and individual privacy.

Ultimately, our evaluation found that England's national COVID-19 testing programme achieved many of its aims and was most likely cost-effective. While this level of testing has not been available before in England, this pandemic has allowed us to understand how best to use testing effectively. As part of this learning, any future testing programmes could be optimised by streamlining testing, while adapting the testing strategy for different needs during different stages of a pandemic. To be adaptive, appropriate data would need to be accessed, collected and analysed in real time and used to assess the testing programme and its constituent elements against indicators derived from a Theory of Change developed at the outset.

A conscious effort should begin now to establish the foundations necessary to initiate and implement a national testing programme, rapidly and at scale, in the face of any future pandemics that threaten the health of the population.





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# Appendices contents





# Appendix 1: Introduction



# Introduction

# 1.1 Introduction to the appendices

This appendix has the following structure:

**Appendix 1.1** provides details of the timeline of key events and interventions for the general population during the pandemic.

**Appendix 1.2** outlines the prioritisation matrix used to ascertain the priority services which the evaluation consortium analysed.

**Appendix 1.3** details the data availability, those requested and those which were used and analysed by the evaluation consortium.

**Appendix 1.4** is the Ethics Approval obtained by the evaluation consortium from UKHSA to conduct a multistage mixed-methods evaluation of the UKHSA testing response during the COVID-19 pandemic in England.

## 1.1.1 Policy timeline

Government testing policies in England evolved throughout the course of the pandemic, in response to increased prevalence of COVID-19, the availability of new diagnostic devices (LFDs, LAMP tests), the emergence of variants of concern and changing interventions (e.g., vaccine rollout).

Please see the service-specific appendices, as outlined below, for the service-specific policy timeline reflecting the COVID-19 testing landscape relevant to that service setting.

- ▶ Appendix 3 – Schools
- ▶ Appendix 4 – Healthcare
- ▶ Appendix 5 – Adult social care

## 1.2 Prioritisation matrix

There were 9 testing services in total that the evaluation consortium was asked to review. Due to data and time constraints and advice from the Scientific Advisory Group a decision was made to undertake a deeper dive into a smaller volume of services rather than a broad evaluation across all. As a result, a prioritisation matrix was developed to aid in deciding which testing services to prioritise, based on the following parameters: (1) availability and completeness of previous evaluations, (2) availability of sufficient data for the evaluation consortium team to evaluate, (3) testing volume of the service by person hours, (4) proximity of the service to risk groups, and (5) spend on testing.

**Table 1: Prioritisation matrix**

Priority category	Targeted community testing	Universities	Private sector	Public sector	Events	Elective care	Schools	Adult social care	Healthcare
Previous evaluation	Partial	Partial	Partial	None	None	None	Partial	Partial	Partial
Sufficient qualitative data available	Medium	Medium	Low/medium	Low/medium	Low/medium	Low/medium	Medium	Medium	Low
Sufficient statistical data available	Low	Low	Low	Low/medium	Low	Medium	Medium	Medium	Medium/High
Sufficient economics data available	Medium	Medium	Medium	Medium	Low	Low	Medium	Medium	Medium
Testing volume	Medium	Low	Low	Medium	Low	Low	High	High	Medium
Proximity to risk group	Medium	Low	Low	Medium	Low	High	Low	High	High
Testing spend	Medium	Low	Low	Low	Low	Low	High	High	High

**Table 2: Definition of rating across each category**

Priority category	Definition of rating		
	Low/none	Medium/partial	High/complete
Previous evaluation	No prior evaluations apparent or accessible	Evaluations accessible for limited time periods or contexts	Evaluations accessible for complete time period and contexts
Sufficient qualitative data available	Very limited/no information accessible on user experience, implementation of service and/or affecting factors	Some/limited research accessible on user experience, implementation of service and/or affecting factors	Comprehensive information accessible on user experience, implementation of service and affecting factors
Sufficient statistical data available	Data are absent, difficult to access or unreliable	Data are available for some priority evaluation measures	Data are available for most or all priority evaluation measures
Sufficient economics data available	Little or no data available, difficult or not possible to cost	Sufficient economics data available, but would require additional work to obtain all assumptions data needed	Most or all economics and assumption data available
Testing volume reported	Less than 5% of overall tests reported	Between 5% and 20% of overall tests reported	More than 20% of overall tests reported
Proximity to risk group	Those testing are less likely to be from or to come into contact with high-risk groups than in the general population	Those testing are as likely to be from or to come into contact with high-risk groups as the general population,	Those testing are more likely to be from or to come into contact with high-risk groups than in the general population
Testing spend	Less than 5% of overall testing spend	Between 5% and 12% of overall testing spend	More than 13% of overall testing spend

## 1.3 Data availability

### 1.3.1 Overview

As part of the evaluation, the evaluation consortium analysed several public, UKHSA, and third-party datasets to conduct various statistical and economic analyses.

While some datasets were readily accessible as they were within the public domain or owned by UKHSA, others had to be accessed via third-party relationships that UKHSA had with external organisations or sourced by the evaluation consortium through its own connections.

Some datasets that were publicly available lacked the required level of granularity to be usable in the analysis. This meant that the required datasets often had to be acquired directly from third parties, which led to several delays as it was time consuming to go through the relevant organisations' documentation and approval processes. These delays meant that it took the evaluation consortium longer to perform the analyses than anticipated and some evaluation indicators had to be descope to meet the agreed upon deadlines as a result.

### 1.3.2 Overview of processes undertaken to obtain data

Several processes were put in place to ensure the evaluation consortium could access the required datasets in a timely manner, including:

- ▶ Within three weeks of commencing the evaluation, the evaluation consortium provided the secretariat with a comprehensive list of the datasets required to analyse the evaluation indicators identified. Once the secretariat had provided the evaluation consortium with datasets it had immediate access to, appropriate internal stakeholders and third parties were approached to gain access to the remaining datasets.
- ▶ Daily meetings were organised with the evaluation consortium and the secretariat to review progress against outstanding data requests and escalate where necessary.
- ▶ Updates were presented at the monthly Liaison Board meetings, with regards to the status of all data requests. Any outstanding challenges with regards to access and the associated risks to the evaluation consortium's ability to measure impact were flagged. This helped give senior UKHSA stakeholders visibility on the data concerns, allowing them to work together with the evaluation consortium to expedite these requests wherever possible.
- ▶ Data sourced by the secretariat were indexed and saved on the UKHSA SharePoint, which was made available to the evaluation consortium.
- ▶ For externally sourced data, the evaluation consortium worked alongside UKHSA and the source organisation to expedite the data requests where possible, articulating the need and proposed use of the dataset within the evaluation.

### 1.3.3 Key datasets accessed and those not made available in the timeframe of the evaluation

The following two tables set out the key datasets analysed as part of the evaluation as well as those requested but not accessed.

**Table 1-1.** Overarching datasets (not including publicly available datasets) accessed and used by the evaluation consortium.

Dataset accessed	Source	High-level overview of use within the evaluation	Date requested/date received
CQC - COVID-19-related deaths in residents and staff	Applied for access, access granted for resident data only (CQC did not hold staff mortality data)	Critical data for assessing the impact of testing within care homes	Requested: 12/09/22; Received: 04/11/2022
REACT-1 dataset	Applied for access; access not possible through UKHSA; we reached out to the REACT team directly who granted us access (after us putting in a request which went to their steering committee)	REACT-1 necessary for analyses across all services to estimate local COVID-19 prevalence to control for local transmission; it was also used to estimate true infection burden	Requested: 12/09/22; Received: 07/11/2022
ISARIC dataset	Applied for access to ISARIC consortium, access granted	Data on nosocomial COVID-19 cases in a sample of England hospitals required for healthcare-specific analyses	Requested: 12/09/22; Received: early December 2022
Pillar 1 & 2 testing datasets	Applied for access, access granted	Testing data were central for all our analyses	Initial request: 12/09/22; Received: roughly 20/10/2022. There were a range of further requests of different cuts / granularities of the data with these being delivered throughout the evaluation period
Office for National Statistics (ONS) – Schools vaccination	Applied for access at school's level. However, data could only be obtained for vaccination at LSOA level by age	Required for modelling the schools testing service	Requested: 12/09/22; Received: 02/11/2022
Vaccinations in care homes/domiciliary care/community care	Applied for access, access granted	Required in ASC analyses to control for level of immunity of care home residents	Requested: 12/09/22; Received: 04/11/2022
Care home characteristics	Applied for access, access granted at care home level. The data were difficult to merge with the testing and COVID-19deaths data and this matching process was time-consuming and imperfect	Required in ASC analyses to determine testing coverages, vaccination coverages, primary client of care homes, visitor policies, CQC rating, number of staff members (employed and absent) and other care-home specific time-invariant and time-varying	Requested: 12/09/22; a range of different datasets were received that were necessary to match up care homes across the various datasets. The last of these was received on 02/11/2022
Schools' vaccinations data	Applied for access, access granted	Required to control for level of immunity in regressions assessing determinants of #s of positive cases due to LFDtesting	Requested: 12/09/22; Received: 07/12/2022
UKHSA financial accounts and cost data	Applied for access, access granted	Required to calculate total programme cost, cost of each of the three priority services, and unit costs for LFD and PCR tests. These costs were analysed by financial year and test type. This informed the economic evaluations	Data was requested and reviewed iteratively from the start of the project until 14/12/2022, with follow up data requests, analyses and discussions occurring throughout this period
UKHSA LFD and PCR test purchase and distribution volumes	Applied for access, access granted	Required to allocate costs by service (ASC, HCW, Schools), calculate unit costs and assess reporting rates	Data was requested and reviewed iteratively from the start of the project until 14/12/2022, with follow up data requests, analyses and discussions occurring throughout this period



**Table 1-2.** Overarching datasets requested but not accessed

Dataset requested	Reason for exclusion from evaluation	High level overview of use within the evaluation	Date requested/request closed
Hospital Episode Statistics (HES)	Data was received late and required a lot of pre-processing to be in a useable format	ISARIC contains patient-level COVID infection and deaths data but does not contain information on other patient comorbidities / characteristics necessary to control for the other causes of patient outcomes – these data are contained in HES	Initial request: 12/09/22 (we requested individual patient level data not HES explicitly); Received: 21/12/2022
DfE – Absences data	Could not obtain this at school level in the timeframe of the evaluation	Data essential for determining the association between testing and absences in schools	Initial request: 12/09/22; Not received
COVID-19 Hospitalisation in England Surveillance System (CHES)	Not received as focus shifted towards obtaining HES data	Data useful in addition to HES to analyse nosocomial infection determinants	Initial request: 12/09/22 (we requested individual patient level data not HES explicitly); Not received
Office for National Statistics (ONS) - Coronavirus Infection Survey (CIS)	We were initially told that access would be possible through UKHSA's agreements with ONS, but this was not the case. We then applied for access to full datasets which required researchers to take ONS certifications (only one such test being available per week) meaning these data were received late and with access to one researcher only within their safe rooms. Therefore, could not be incorporated into analyses	Since there are relatively few random samples conducted at fine granularity (e.g., by LTLA by week or by age group and LTLA by week), we planned to use CIS data in concert with REACT data to determine fine-level COVID prevalence	Initial request: 12/09/22; Received access in mid-December
DfE – School workforce census	Could not obtain in granularity required within timeframe of the evaluation	Necessary for assessing impact of testing on staff	Initial request: 12/09/22
DfE – Schools census data (pupils)	Access to most recently published schools census data in March 2023 - too late for evaluation	Necessary for determining the denominator for our testing coverage-based analyses	Initial request: 12/09/22
ONS – Schools infection survey (SIS) 1 & 2	Not received	Critical data for assessing the impact of testing on transmission levels in schools	Initial request: 12/09/22; Not received
CQC – Hospitalisation	Applied for access, however request was closed after learning that CQC do not hold such data	Necessary for more comprehensively assessing the impact of resident / staff testing on mortality in care homes	Initial request: 12/09/22

# 1.4 Introduction – Ethics REGG approval NR0347



UK Health  
Security  
Agency

26<sup>th</sup> October 2022

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Dear Reshania

**Re:** A multistage mixed-methods evaluation of the UKHSA testing response during the COVID-19 pandemic in England

**R&D Ref:** NR0347

Thank you for submitting your study to the Research Support and Governance Office (RSGO) for review by the UKHSA Research Ethics and Governance Group (REGG).

UKHSA REGG approval for your study has been granted. This approval is granted based on the information provided in the REGG application form and accompanying study documentation, and on the understanding that the study is conducted in accordance with the conditions stated in the applicable UKHSA policies and procedures.

Approval is only granted for activities for which a favourable opinion has been given by the UKHSA REGG. All amendments must be submitted to the RSGO. Any change to the status of the project (including changes to the research team) and any change to the project closure date must also be notified to the RSGO.

The UKHSA is currently undertaking the implementation of a research management system and institutional repository. Aligned to this, from 1 September 2020 the UKHSA Open Access policy requires peer-reviewed research outputs to be made available open access. For further information contact [Paul Rudd](#).

If you need any further support or information, please do not hesitate to contact the [UKHSA RSGO](#) quoting the reference number for your study.

Wishing you every success with your study

Yours sincerely,

Dr Elizabeth Coates  
Head of Research Governance  
Research Support and Governance Office



## Appendix 2: Overarching

# Overarching

## 2.1 Introduction to the appendix

This appendix has the following structure:

Appendix 2.1 draws on the results of qualitative research and covers operational findings that emerged from the review of data vaults shared by UKHSA Secretariat and publicly available information; it also includes a rapid review of the behavioural literature, which relied on documents received from UKHSA Secretariat and those found as part of a rapid literature review.

Following an overview of the studies included in the review of the behavioural literature, appendix 2.1 is divided into four sections:

- ▶ Conducting and reporting a test
- ▶ Isolation after a positive test result
- ▶ Programme-specific findings

Appendix 2.2 describes methods and findings of the statistical workstream that are not otherwise detailed in chapter 2.

Appendix 2.3 describes methods and findings of the economics workstream that are not otherwise detailed in chapter 2.

### 2.1.1 Overview of the included studies

In total, 112 identified sources were included in this analysis (Table 1). The literature database search yielded 30 publications, and 82 sources were identified through stakeholders (UKHSA). The sources covered data collection from April 2020 until July 2022. Of the 112 included, 61 used interviews, 22 used focus group discussions, 59 used surveys and 19 used other methods.

The focus of the sources was mainly on testing (69/112) and isolation (64/112), with 3 covering reporting and 2 labelled as 'other'.



**Table 1:** Overview of evidence included in the analysis of healthcare worker testing, reporting and isolation behaviours.

Publication	Methodology			Setting		Context
	Reference	Methods	Description of the sample	Data collection period	Country	
<b>Literature search</b>						
Al-Oraibi, A., Fothergill, L., Yildirim, M., Knight, H., Carlisle, S., O'connor, M., Briggs, L., Morling, J. R., Corner, J., Ball, J. K., Denning, C., Vedhara, K. & Blake, H. 2022. Exploring The Psychological Impacts Of Covid-19 Social Restrictions On International University Students: A Qualitative Study. <i>Int J Environ Res Public Health</i> , 19.	IDI+FGD	A total of eight online focus groups were conducted, comprising 29 international students, with group sizes varying between three to five students. Seventeen one-to-one interviews were held with university staff members. International students – focus groups University staff – interviews	Between January and February 2021	International	Isolation	Testing in universities – Focus groups held with international university students, and interviews held with university staff
Blake, H., Carlisle, S., Fothergill, L., Hassard, J., Favier, A., Corner, J., Ball, J. K. & Denning, C. 2022a. Mixed-Methods Process Evaluation Of A Residence-Based Sars-Cov-2 Testing Participation Pilot On A Uk University Campus During The Covid-19 Pandemic. <i>Bmc Public Health</i> , 22, 1470.	Survey+ IDI/FGD	University students living onsite Student survey – 152 Staff interviews – 13 Student focus groups – 30	April – June 2021	England	Testing and isolation	Convergent parallel mixed methods evaluating intervention fidelity and barriers/enablers to implementation of an asymptomatic testing programme in university
Blake, H., Corner, J., Cirelli, C., Hassard, J., Briggs, L., Daly, J. M., Bennett, M., Chappell, J. G., Fairclough, L., McClure, C. P., Tarr, A., Tighe, P., Favier, A., Irving, W. & Ball, J. 2020. Perceptions And Experiences Of The University Of Nottingham Pilot Sars-Cov-2 Asymptomatic Testing Service: A Mixed-Methods Study. <i>Int J Environ Res Public Health</i> , 18.	Survey, interviews and focus groups	99 surveys and 41 interview or focus group participants with university students	July – October 2020	England	Testing	Student perceptions and experiences of a university testing programme – thematic analysis conducted of views gathered from survey, interview and focus group data.
Blake, H., Knight, H., Jia, R., Corner, J., Morling, J. R., Denning, C., Ball, J. K., Bolton, K., Figueredo, G., Morris, D. E., Tighe, P., Villalon, A. M., Ayling, K. & Vedhara, K. 2021. Students' Views Towards Sars-Cov-2 Mass Asymptomatic Testing, Social Distancing And Self-Isolation In A University Setting During The Covid-19 Pandemic: A Qualitative Study. <i>Int J Environ Res Public Health</i> , 18.	Focus groups	25 university students from 1 institution	October 2020	England	Testing and isolation	Focus group discussion with university students on testing and isolation during the pandemic. Thematic analysis conducted on output of focus groups.
Blake, H., Somerset, S., Mahmood, I., Mahmood, N., Corner, J., Ball, J. K. & Denning, C. 2022b. A Qualitative Evaluation Of The Barriers And Enablers For Implementation Of An Asymptomatic Sars-Cov-2 Testing Service At The University Of Nottingham: A Multi-Site Higher Education Setting In England. <i>Int J Environ Res Public Health</i> , 19.	Interviews	25 service staff who worked on the asymptomatic testing at the University of Nottingham	May – July 2022	England	Testing	Interviews with workers who set up and managed asymptomatic testing site at a university

Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
Burns, J., Mc Goldrick, N., Sigerson, D., Edwards, M., Culshaw, S., Clark, C., Watling, C., Braid, R., O'keefe, E., Gorman, M. & Conway, D. I. 2022a. A Health Inequalities Impact Assessment Of The Surveillance Of Covid-19 In Asymptomatic Patients Attending Dental Settings In Scotland. <i>Community Dent Health</i> , 39, 254-259.	Survey and online scoping workshop that fed into a Health Inequalities Impact Assessment	35 members of dental teams across Scotland	October 2020	Scotland	Testing and reporting	Before asymptomatic testing was in policy Focused on dental sector Patient participation in testing programme
Denford, S., Martin, A. F., Love, N., Ready, D., Oliver, I., Amlot, R., Yardley, L. & Rubin, G. J. 2021. Engagement With Daily Testing Instead Of Self-Isolating In Contacts Of Confirmed Cases Of Sars-Cov-2: A Qualitative Analysis. <i>Front Public Health</i> , 9, 714041.	Interviews	52 participants, with 35 who had taken part in a feasibility study to evaluate daily contact testing, and 17 who had declined the offer and opted to self-isolate	11-23 December 2020 and 4-12 January 2021	UK overall	Testing and isolation	Daily contact testing rather than asymptomatic testing – focus on attitudes towards contact testing as an alternative to contacts of positive cases having to isolate Before Universal Testing
Denford, S., Martin, A. F., Towler, L., Mowbray, F., Essery, R., Bloomer, R., Ready, D., Love, N., Amlot, R., Oliver, I., Rubin, G. J. & Yardley, L. 2022. A Qualitative Process Analysis Of Daily Contact Testing As An Alternative To Self-Isolation Following Close Contact With A Confirmed Carrier Of Sars-Cov-2. <i>Bmc Public Health</i> , 22, 1373.	Interviews	60 – People who had been in close contact with a confirmed SARS-CoV-2 carrier and had consented to take part in the trial	24 June – 8 July 2021	England	Testing and isolation	Daily contact testing rather than asymptomatic testing – focus on attitudes towards contact testing as an alternative to contacts of positive cases having to isolate Study covers before and after introduction of Universal Testing
Dennis, A., Robin, C. & Carter, H. 2022. The Social Media Response To Twice-Weekly Mass Asymptomatic Testing In England. <i>Bmc Public Health</i> , 22, 182.	Other – review of social media	5783 comments – members of public	5th April – 28th May 2021	England	Testing	Analysis of social media comments from members of the public in England about twice-weekly asymptomatic testing Study is from period when Universal Testing was first introduced
Eraso, Y. & Hills, S. 2021. Self-Isolation And Quarantine During The Uk's First Wave Of Covid-19. A Mixed-Methods Study Of Non-Adherence. <i>Int J Environ Res Public Health</i> , 18.	Survey+ IDI/FGD	residents in six North London boroughs 681 – Survey 16 – interviews	1-31 May 2020	England	Isolation	Early in the pandemic Before universal, asymptomatic testing was available
Green, K., Micocci, M., Hicks, T., Winter, A., Martin, J. E., Shinkins, B., Shaw, L., Price, C., Davies, K. & Allen, J. A. 2022. Perceived Feasibility, Facilitators And Barriers To Incorporating Point-Of-Care Testing For Sars-Cov-2 Into Emergency Medical Services By Ambulance Service Staff: A Survey-Based Approach. <i>Bmj Open</i> , 12, E064038.	Survey	226 surveys (179 complete) with 26 follow up surveys from emergency and non-emergency ambulance service staff in the UK, including paramedics, technicians, assistants and other staff	Initial survey: 3 December 2020 to 11 January 2021 Follow up survey: 8-22 February 2021	UK overall	Testing	Patient participation in testing programme Exploring point of care testing in ambulances Before Universal Testing was established

Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
Hanley, S., Raybould, G., Baxter, E., Gray, J., Sharkey, D. & Walker, K. F. 2022. Maternity Services' Responses To The Covid-19 Pandemic: How Public Health England Guidance Was Implemented In Practice. Journal Of Hospital Infection, 129, 214-218.	Survey	44 maternity healthcare workers from 33 NHS hospitals in England, including 14 midwives, 3 senior midwives, 2 senior trainee obstetricians, 21 consultants obstetricians, 1 clinical fellow, 1 service director, 1 labour ward coordinator and 1 clinical midwifery manager	November 2020 to July 2021	England	Testing and isolation	Patient participation in testing programme
Hirst, J. A., Logan, M., Fanshawe, T. R., Mwandigha, L., Wanat, M., Vicary, C., Perera, R., Tonkin-Crine, S., Lee, J. J., Tracey, I., Duff, G., Tufano, P., Besharov, M., Tarassenko, L., Nicholson, B. D. & Hobbs, F. D. R. 2021. Feasibility And Acceptability Of Community Coronavirus Disease 2019 Testing Strategies (Facts) In A University Setting. Open Forum Infect Dis, 8, Ofab495.	Survey and interviews	214 survey participants and 18 interviews with university staff and students at the University of Oxford	October 2020 to January 2021	England	Testing	University testing Before Universal Testing
Isherwood, K. R., Kyle, R. G., Gray, B. J. & Davies, A. R. 2022. Challenges To Self-Isolation Among Contacts Of Cases Of Covid-19: A National Telephone Survey In Wales. J Public Health (Oxf).	Surveys	2027 – Individuals were eligible for inclusion if they: (i) had been successfully contacted by TTP after forward contact tracing (ii) were a close contact of a confirmed case of COVID-19; (iii) were aged 18 years or over; (iv) resident in Wales; and (v) had completed their self-isolation period at the time of telephone survey. Contacts were excluded from the study if they were: (i) under the age of 18; (ii) currently selfisolating; (iii) not a resident in Wales	11 November and 1 December 2020	Wales	Isolation	Daily contact testing rather than asymptomatic testing – focus on attitudes towards contact testing as an alternative to contacts of positive cases having to isolate Before Universal Testing
Jayes, L., Bogdanovica, I., Johnston, E., Chattopadhyay, K., Morling, J. R., Devine, S., Richmond, N. & Langley, T. 2022. Perspectives Of Attenders And Non-Attenders To Sars-Cov-2 Asymptomatic Community Testing In England: A Qualitative Interview Study. Bmj Open, 12, E064542.	Interviews	With 18 members of the public who attended a community testing centre and 15 who had not	February – May 2021	England	Testing	Community asymptomatic testing Study period covers before and after the start of introduction of Universal Testing
Knight, H., Carlisle, S., O'connor, M., Briggs, L., Fothergill, L., Al-Oraibi, A., Yildirim, M., Morling, J. R., Corner, J., Ball, J., Denning, C., Vedhara, K. & Blake, H. 2021. Impacts Of The Covid-19 Pandemic And Self-Isolation On Students And Staff In Higher Education: A Qualitative Study. Int J Environ Res Public Health, 18.	Interviews and focus groups	26 university staff interviews and 11 university students participating in focus groups	January – March 2021	England	Testing and isolation	University testing programme Before the introduction of Universal Testing
Mahmood, F., Acharya, D., Kumar, K. & Paudyal, V. 2021. Impact Of Covid-19 Pandemic On Ethnic Minority Communities: A Qualitative Study On The Perspectives Of Ethnic Minority Community Leaders. Bmj Open, 11, E050584.	Interviews	19 – Community leaders recruited through organisations representing ethnic minority communities and religious places of worship	October – November 2020	England	Testing, reporting and isolation	Community testing Focus on ethnic minority communities Before Universal Testing

Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
Martin, A. F., Denford, S., Love, N., Ready, D., Oliver, I., Amlot, R., Rubin, G. J. & Yardley, L. 2021. Engagement With Daily Testing Instead Of Self-Isolating In Contacts Of Confirmed Cases Of Sars-Cov-2. <i>Bmc Public Health</i> , 21, 1067.	Surveys	319 people who had agreed to daily testing 205 who were not offered daily testing - adult contacts of confirmed COVID-19 cases who consented to daily testing, and a comparison group of contacts who were not offered testing and instead self-isolated	11 and 23 December 2020 and 4 to 12 January 2021	England	Testing	Daily contact testing rather than asymptomatic testing – focus on attitudes towards contact testing as an alternative to contacts of positive cases having to isolate Before Universal Testing
Mathers, J., Poyner, C., Thompson, D., Rudge, G. & Pritchett, R. V. 2022. Exploration Of The Uptake Of Asymptomatic Covid-19 Lateral Flow Testing In Birmingham, Uk: Survey And Qualitative Research. <i>Bmj Open</i> , 12, E056606.	Survey, interviews and focus groups	220 survey participants and 21 follow-up interviews with adult residents of Birmingham	April 2021	England	Testing	Universal asymptomatic testing
Mowbray, F., Woodland, L., Smith, L. E., Amlot, R. & Rubin, G. J. 2021. Is My Cough A Cold Or Covid? A Qualitative Study Of Covid-19 Symptom Recognition And Attitudes Toward Testing In The Uk. <i>Front Public Health</i> , 9, 716421.	Interviews	40 people (21 members of the general population, 19 students)	30 November and 11 December 2020	England	Testing	Focus on symptom recognition Mixture of general public and university students Before Universal Testing
Robin, C., Symons, C. & Carter, H. 2022. Local Community Response To Mass Asymptomatic Covid-19 Testing In Liverpool, England: Social Media Analysis. <i>Jmir Form Res</i> , 6, E34422.	Other – review of media and social media comments	Overall, 1096 comments were sampled: 219 newspaper comments, 472 Facebook comments, and 405 tweets Members of Liverpool local community	2-8 November 2020	England	Testing	Social media analysis Community asymptomatic testing Before Universal Testing
Smith, L. E., Amlot, R., Lambert, H., Oliver, I., Robin, C., Yardley, L. & Rubin, G. J. 2020. Factors Associated With Adherence To Self-Isolation And Lockdown Measures In The Uk: A Cross-Sectional Survey. <i>Public Health</i> , 187, 41-52.	Surveys	Adults in the UK recruited online - 217 with experience of isolation of 2240 total respondents	6-7 May 2020	UK overall	Isolation	Focus on adherence to isolation rather than on testing Relatively early in the pandemic – first lockdown Before universal testing
Smith, L. E., Potts, H. W. W., Amlot, R., Fear, N. T., Michie, S. & Rubin, G. J. 2021. Do Members Of The Public Think They Should Use Lateral Flow Tests (Lft) Or Polymerase Chain Reaction (Pcr) Tests When They Have Covid-19-Like Symptoms? The Covid-19 Rapid Survey Of Adherence To Interventions And Responses Study. <i>Public Health</i> , 198, 260-262.	Surveys	3665 – adults in England or Scotland	1-2 and 14-15 June 2021	UK (England and Scotland)	Testing	Focus on whether people choose PCR or LFT and why/in which circumstances After Universal Testing was introduced
Smith, L. E., Potts, H. W. W., Amlot, R., Fear, N. T., Michie, S. & Rubin, G. J. 2022. Intention To Adhere To Test, Trace, And Isolate During The Covid-19 Pandemic (The Covid-19 Rapid Survey Of Adherence To Interventions And Responses Study). <i>Br J Health Psychol</i> , 27, 1100-1118.	Surveys	12,976 – Selected only participants who lived in England due to differing restrictions across the four UK nations. and were eligible for the study if they were aged 16 years or over and lived in the United Kingdom. Quotas were applied based on age and gender (combined), and reflected targets based on data from the Office for National Statistics	27 April 2020 to 27 January 2021	UK Overall	Testing and isolation	Before Universal Testing

Publication	Methodology			Setting		Context
	Reference	Methods	Description of the sample	Data collection period	Country	
<b>Literature search</b>						
Street, A., Lee, S. J. & Bevan, I. 2022. The Hidden Burden Of Medical Testing: Public Views And Experiences Of Covid-19 Testing As A Social And Ethical Process. <i>Bmc Public Health</i> , 22, 1837.	Interviews	70 – members of the general public (aged 19-85) living in the Lothian region of Scotland	7 July to 24 September 2020	Scotland	Testing	Before Universal Testing
Van Der Scheer, J. W., Ansari, A., Mclaughlin, M., Cox, C., Liddell, K., Burt, J., George, J., Kenny, R., Cousens, R., Leach, B., Mcgowan, J., Morley, K., Willars, J. & Dixon-Woods, M. 2022. Guiding Organisational Decision-Making About Covid-19 Asymptomatic Testing In Workplaces: Mixed-Method Study To Inform An Ethical Framework. <i>Bmc Public Health</i> , 22, 1747.	Survey and interviews	50 survey participants and 11 interviews with staff members from workplaces used as case studies	November – December 2020	England	Testing and isolation	Workplace testing Exploring how workers feel about workplace testing and the implications of testing and isolation on their work Before Universal Testing
Vandrevala, T., Montague, A., Terry, P. & Fielder, M. D. 2022. Willingness Of The Uk Public To Volunteer For Testing In Relation To The Covid-19 Pandemic. <i>Bmc Public Health</i> , 22, 565.	Surveys	778 - UK residents (181 males and 589 females, 8 other/prefer not to say); their ages ranged from 18 to 80yrs. old, with the average age being 47yrs. Te sample was predominantly white (86%), with remaining participants identifying as 'Black', 'Asian', 'Mixed' and 'other' ethnic groups (14%).	April – May 2020	UK overall	Testing	Early in the pandemic Before Universal Testing
Wemyss, C., Hobson, S., Sweeney, J., Chua, P. R., Binti Mohd Khairi, S. A., Edwards, M., Burns, J., Mcgoldrick, N., Braid, R., Gorman, M., Redmond, S., Clark, C., Brown, C., Watling, C., Conway, D. I. & Culshaw, S. 2022. Improving Participation And Engagement With A Covid-19 Surveillance Programme In An Outpatient Setting. <i>Bmj Open Qual</i> , 11.	Survey	338 healthcare workers including dental core trainees, consultant and senior dentists and dental nurses.	August – October 2020	Scotland	Testing	Preprint Patient participation in asymptomatic testing programme in a dental hospital in Glasgow



Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
<b>Evidence overlapping between service settings</b>						
Kierkegaard, P., Hicks, T., Allen, A. J., Yang, Y., Hayward, G., Glogowska, M., Nicholson, B. D., Buckle, P. & Committee, C. S. 2021. Strategies To Implement Sars-Cov-2 Point-Of-Care Testing Into Primary Care Settings: A Qualitative Secondary Analysis Guided By The Behaviour Change Wheel. Implement Sci Commun, 2, 139.	Interviews	22 primary care physicians from 21 primary care practices across three regions (London, Thames Valley and South Midlands, North East and North Cumbria)	September – November 2020	England	Testing	Overlapped with asymptomatic healthcare testing analysis Patient participation in testing programme Focus on primary care GPs, early in the pandemic before asymptomatic testing of HCW was in place. Focus on LFDs (POC) and antigen testing ?? before LFD available in PHC - perceptions vs pilot Testing HCWs and patients Patients, HCWs and ASC prioritised for PCRs when symptomatic PCR testing first scaled up in 2020 ~9April2020, May became available for symptomatic testing for everyone in UK.
Watson, D., Baralle, N. L., Alagil, J., Anil, K., Ciccognani, S., Dewar-Haggart, R., Fearn, S., Groot, J., Knowles, K., Meagher, C., Mcgrath, C., Muir, S., Musgrove, J., Glyn-Owen, K., Woods-Townsend, K., Mortimore, A., Roderick, P., Baird, J., Inskip, H., Godfrey, K. & Barker, M. 2022. How Do We Engage People In Testing For Covid-19? A Rapid Qualitative Evaluation Of A Testing Programme In Schools, Gp Surgeries And A University. BMC Public Health, 22, 305.	Interviews and focus groups	210 participants from 4 schools, 1 university and 2 general practices in the South East of England, participating in the Southampton COVID-19 Testing Pilot Programme: 8 general practice staff, 30 pupils, 21 school staff, 12 pupil/parent pairs, 13 parents, 12 senior school representatives, 81 university students, 28 university staff and 5 senior university representatives  In total: 77 interviews and 20 focus groups	4 June 2020 to 7 November 2020	England	Testing and isolation	Spoke to i) individuals who had been approached about taking part in the pilot Saliva Testing Programme including some who tested positive; ii) those who were approached but declined to take part; and iii) senior university, primary care and school representatives responsible for delivering the Saliva Testing Programme in their organisations.
<b>Stakeholder identified sources (UKHSA Secretariat)</b>						
Alcinda lee – serial testing of contacts in the context of institutions	Interviews	9 – Full-time, part-time, contractors, freelancers, zero-hour contract who cannot work from home or a mix of working from home and outside.  Mixed experience with Covid-19 test, trace and self-isolation.	3-4 December 2020	England	Testing and isolation	Other

Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
Analyst: Harpreet Singh Chawla QA: Liza Benny Review and sign off: Dr Matt Barnard – Effect of test and trace support payments scheme on ease of self-isolation and isolation compliance – Analysis of ONS Isolation Compliance Survey Data	Surveys	12,486 respondents – The analysis uses data from surveys of confirmed positive cases and contacts conducted by ONS and is broken down by characteristics including age, gender, ethnicity and receipt of any benefits.	March – July 2021	England	Isolation after positive result	Other
Anna Fok – Test and Trace Contacts Insights Study: Wave 2	Surveys	1122 – adults aged 18 or more who has tested positive for Covid-19 and were at the end of their 10-day self-isolation period.	8-13 March 2022	England	Isolation after positive result	Universal testing
Anna Fok – COVID Test and Trace Cases Insights Study: Wave 3	Surveys	1168 – adults aged 18 or more who has tested positive for Covid-19 and were at the end of their 10-day self-isolation period.	12-16 April 2021	England	Isolation after positive result	Universal testing
Anna Fok – COVID Test and Trace Cases Insights Study: Wave 4	Surveys	1044 – adults aged 18 or more who has tested positive for Covid-19 and were at the end of their 10-day self-isolation period.	10-15 May 2021	England	Isolation after positive result	Universal testing
Anna Fok – Indicators of Clinically Extremely Vulnerable Individuals' Responses to COVID-19 Outbreak	Surveys	2979 – Clinically extreme vulnerable (CEV) individuals	18-30 January 2021	England	Isolation (both positive and negative)	Universal testing
Anna Fok & Tim Gibbs – COVID Test and Trace Cases Insights Study: Wave 1 (Pilot)	Surveys	2552 – adults aged 18 or more who has tested positive for Covid-19 and were at the end of their 10-day self-isolation period.	1-13 February 2022	England	Isolation after positive result	Universal testing
Anna Fok et al. – COVID Test and Trace Cases Insights Study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 February 2021	England	Testing and isolation	Universal testing
Anna Fok et al. – COVID Test and Trace Cases Insights Study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 June 2021	England	Testing and isolation	Universal testing
Anna Fol et al. – COVID Test and Trace Cases Insights Study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 July 2021	England	Testing and isolation	Universal testing
ATE Ad hoc research – Self test reporting: Insights	n/a	n/a - n/a	n/a	UK in general	Reporting results	Universal testing
Cameron Smith, Joanna Milward, Alexandra Duncan, Mehr Panjwani, Rachel Badman, Matthew Barnard  Social Research and Evaluation Unit, All Hazards Intelligence  – Understanding experiences of the Test and Trace Support Payment: A Qualitative Follow-up Study	Interviews	31 participants – ONS Cases and Contacts Insight Survey participants and were not asked to take part in further research as a result;	1 May 2021	England	Isolation after positive result	Universal testing

Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
Clare Delargy, Dr. Giulia Tagliaferri, Ollie Sugg, Dr. Yihan Xu, Martina Maglicic, Hannah Burd - Calls (not texts) work best to encourage self-isolation - results from a field experiment in the Test & Trace programme	Other	6,812 trial participants (2652 control, 1219 texts only, 1503 calls only, 1438 texts + calls) – close contacts of confirmed case	17 August to 10 September 2020	England	Isolation after positive result	Universal testing
Contact persons: Dr Leah Jones et al. - Test seeking behaviours; attitudes, barriers and facilitators	Other	<N/a: This is a literature review> – <N/a: This is a literature review>	<N/a: This is a literature review>	UK in general	Testing	Universal testing
Danielle Cornish et al. – Covid Test and Trace self isolation insights study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	October – November 2021	England	Testing and isolation	Universal testing
Danielle Cornish et al. – Covid Test and Trace Contacts Behavioural Insights Study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 October 2021	England	Testing and isolation	Universal testing
Danielle Cornish et al. – Covid Test and Trace Contacts Behavioural Insights Study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 February 2022	England	Testing and isolation	Universal testing
Danielle Cornish et al. – Covid Test and Trace Contacts Behavioural Insights Study. Contacts not required to self isolate	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 November 2021	England	Testing and isolation	Universal testing
Danielle Cornish et al. – Covid Test and Trace Contacts Behavioural Insights Study. Contacts not required to self isolate	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 January 2022	England	Testing and isolation	Universal testing
Danielle Cornish et al. – COVID Test and Trace Self-Isolation Insights Study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 December 2021	England	Testing and isolation	Universal testing
Eleonore Batteux, Stefanie Bonfield, Leah Jones, Holly Carter, Natalie Gold, Richard Amlôt, Theresa M Marteau, Dale Weston - The effects of negative asymptomatic test result messages on understanding of residual risk and behavioural intentions	Other	1200 – representatives of the UK population (not specified)	n/a	UK in general	Other	Universal testing
Eleonore Batteux, Stefanie Bonfield, Leah Jones, Holly Carter, Natalie Gold, Richard Amlôt, Theresa Marteau & Dale Weston – The effects of negative asymptomatic test result messages on understanding of residual risk and behavioural intentions	Surveys	1200 – Online experiment (12-15th March 2021) with a representative sample of the UK population where participants imagined they had taken an LFT as part of an asymptomatic testing programme	12-15th March 2021	England	Other	Universal testing
Ellie Sheppard, Abbey Lawrence, Andrew Senior, Alasdair Fellows – COVID-19 Self-Test (Innova SARS-CoV-2 Antigen Test – Anterior Nares) Service Evaluation: Assisted Testing	Surveys	1226 – (across all ages, vaccination statuses and symptom statuses) from the pool of individuals who had attended an NHS Test and Trace Regional or Local Testing Site seeking a PCR test.	30 November 2021 and 24 December 2021	England	Testing	Universal testing

Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
Emily Weigold – Asymptomatic Testing Expansion: Behavioural Evaluation Evidence Response	Other	n/a – n/a	n/a	England	Testing	Universal testing
Evaluation and Social Research Unit – Supporting COVID-19 testing and vaccination in a deprived local authority: A case study of Blackpool	Interviews	8 – Four members of Blackpool public health team, the programme director of a large VCFS organisation and 3 Community Champions	May and June 2021	England	Testing	Universal testing
Evaluation and Social Research Unit – Supporting COVID-19 testing in a deprived local authority: A case study of London Borough of Hackney	Interviews	Four – Four key members of Hackney public health team	March and April 2021	England	Testing	Universal testing
From: Matthew Barnard/ Rachel Badman, Clearance: Martin Neighbours (Deputy Director Data and Analytics, Test and Trace Programme) – Compliance with self-isolation: publishing findings of ONS commissioned surveys	Other	n/a – n/a	n/a	England	Isolation after positive result	Other
Georgiana Brown – Customer Insight, UKHSA – Asymptomatic Testing: Who is Testing and Why? (Wave 2 Report – Debrief)	Interviews	2359 – adults aged 16-75 with targeted boost samples among groups of interest (ethnic minority groups and those in areas of higher deprivation)	9 August – 13 September 2021	England	Testing and reporting	Universal testing
Georgiana Brown – Customer Insight, UKHSA – DTCC (Daily Testing of Covid Contacts) – Voice of the Customer Insight update	Surveys	9838 – <customers at the main stages of the test, trace and isolate journey>	17 December 2021 – 19 January 2022	England	Testing and isolation	Universal testing

Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
ICF Consulting Services Limited – Evaluation of the Enduring Transmission Pilot in Peterborough, Fenland and South Holland	Interviews	<p>Untreated – 764,686</p> <p>Treated – 228</p> <p>Total – 764,914 – A total of 717 treated people were included in the pilot's MI (individuals supported by Rosmini from June to December 2021). Of these, 504 individuals could be linked to CTAS data based on their postcode, gender, ethnicity and age (measured at assessment date). Among these 504 treated people, 276 could not be used for analysis for various reasons. Removing these 276 individuals from the sample of 504 treated people linked to the CTAS database resulted in a final sample of 228 treated people.</p> <p>The sample of 764,686 untreated people was obtained by considering all individuals aged 18-67 who resided in LADs other than Fenland, Peterborough and South Holland (after excluding all LADs where other Test &amp; Trace pilots were rolled out), and with non-missing value on all the variables of interest (demographics and outcome).</p>	23 June – 22 November 2021	England	Isolation after positive result	Other
Isable Beynon and Jane Evans – COVID Test and Trace Cases Insights Study: Wave 8	Surveys	976 – adults aged 18 or more who has tested positive for Covid-19 and were at the end of their 10-day self-isolation period.	1-6 November 2021	England	Isolation after positive result	Universal testing
Jane Evans et al. – COVID Test and Trace Cases Insights Study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	September – October 2021	England	Testing and isolation	Universal testing
Joe hillier; sarah tunkel – weekly tieb updates . Serial contact testing pilots Evaluation summary	Survey+ IDI/FGD	n/a – employees	January – March 2021	England	Testing and isolation	Public/Private sector
Jonathan Coles – Public Sector Self-Collect Evaluation – (Draft) Final Report	Survey+ IDI/FGD	not clear – Public sector employees	1 March – 30 June 2021	UK in general	Testing and reporting	Public/Private sector
Josh Turner-Norgate (Implementation and Process Evaluation team, Evaluation and Social Research Unit, All Hazards Intelligence , UK Health Service Agency) – Evaluation of Covid-19 guidance and support for the migrant worker community delivered by voluntary and community sector organisations (VCSOs)	Interviews	23 service users and 8 stakeholders – Service users (migrant workers) and stakeholders (staff from voluntary and community sector organisations)	29 March – 7 April 2022	England	Testing and isolation	Universal testing



Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
Joshua Turner-Norgate – Understanding the impact of a COVID-19 outreach programme delivered by voluntary and community sector organisations (VCSOs) for migrant worker communities and the role of VCSOs in communicating public health messaging	Interviews	23 service users and 8 staff members from 4 VCSOs – Voluntary and community sector organisation (VCSO) service users and stakeholders.	17 January – 31 March 2022	England	Testing and isolation	Universal testing
Linsey Brown et al. – COVID Test and Trace Contacts Insights Study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 June 2021	England	Testing and isolation	Universal testing
Linsey Brown et al. – COVID Test and Trace Contacts Insights Study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 August 2021	England	Testing and isolation	Universal testing
Linsey Brown et al. – COVID Test and Trace Contacts	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	1 May 2021	England	Testing and isolation	Universal testing
Linsey Brown et al. – COVID Test and Trace Contacts Insights Study	Interviews	n/a – Respondents were sampled through the Contact Tracing and Advice (CTAS) database, held by NHS TT.	June to July 2021	England	Testing and isolation	Universal testing
Liza Benny & Harpreet Singh Chawla – Summary Evaluation Findings: Venue Alerts	Quant data analysis+qual	n/a – Recipients of venue alerts in England	24 September 2020 – 19 July 2021	England	Isolation (both positive and negative)	Public/Private sector
Louise Vinter, Georgiana Brown – Brand perceptions tracker – wave 1 report plus wave 2-3 KPIs	Surveys	2,029 adult – Adults aged 18+ in England	9-17 December 2020	England	Testing and isolation	Universal testing
Lynsey Brown & Tim Gibbs – Test and Trace Contacts Insights Study: Wave 3	Surveys	1100 – adults aged 18 or more who has tested positive for Covid-19 and were at the end of their 10-day self-isolation period.	1-10 April 2021	England	Isolation after positive result	Universal testing
Lynsey Brown & Tim Gibbs – Test and Trace Contacts Insights Study: Wave 4	Surveys	1194 – adults aged 18 or more who has tested positive for Covid-19 and were at the end of their 10-day self-isolation period.	19-24 April 2021	England	Isolation after positive result	Universal testing
Matt Barnard et al. – Lambeth Self-isolation Pilot: Impact Evaluation	Other	not clear – Residents of Lambeth earning up to £30,000 per year were eligible to apply for financial support during self-isolation	not clear	England	Testing and isolation	Universal testing
Matt Barnard, Ellen Clowser, Alexandra Duncan, Meaghan Kall, Marc Montgomery, Rachel Badman – Understanding Compliance with Self-isolation: Summary of survey findings	Surveys	42,892 contacts were invited and 6,813 responded. – Over 18 years contacts who were reached and advice by NHS Test and Trace to isolate.	25 August – 14 September 2020	UK in general	Isolation after positive result	Universal testing

Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
Matt Barnard, Liza Benny, Cameron Smith – Kirklees Self-isolation Pilot: Evaluation Report	Quant data analysis+qual	not clear – Inclusion criteria for the pilot were that individuals: 1) Were required to self-isolate following a positive COVID-19 result; or as a close contact of a confirmed COVID-19 case 2) Adequately demonstrated a loss in income due to self-isolation 3) Earned £26,000 or less per annum 4) Were unable to work from home	COVID-19 Self-Test (Innova SARS-CoV-2 Antigen Test – Anterior Nares) Service Evaluation: Assisted Testing	England	Testing and isolation	Other
Matthew Barnard & Liza Benny – Compliance with self-isolation for those within NHS Test and Trace: Summary of the Evidence	Other	n/a – n/a	n/a	England	Isolation (both positive and negative)	Universal testing
Matthew Barnard, Meaghan Kall, Stephen Finer, Joe Hillier et al – Does mass testing reduce compliance with self-isolation of confirmed positive cases of SARS-CoV-2? Evidence from the Liverpool mass testing pilot	Surveys	In total 247 participants with a Liverpool address had participated in the mass testing pilot and 277 tested positive through normal, symptomatic channels. In addition, the study included 3 participants who had participated in the mass testing pilot but did not have a Liverpool address and 678 participants who did not have a Liverpool address and tested positive through normal, symptomatic channels. – All participants had tested positive for SARS-CoV-2, had their details passed to NHS Test and Trace and had supplied a telephone contact number.	Not clear	England	Isolation after positive result	Other
n/a – ATE evaluation retrospective	Surveys	n/a – Not clear	Retrospective for week commencing 19th April 2021	England	Testing	Not clear

Publication	Methodology			Setting	Context	
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
n/a – Compliance with self-isolation for those within NHS Test and Trace: Summary of the Evidence	Surveys	Exact number hasn't been stated - Surveys were conducted internally and externally as well as analysis of data collected through NHS Test and Trace. Data collection was done from the following sources: 1. Internal surveys 2. Test and trace data on contacts 3. ONS compliance with self-isolation surveys 4. Test and Trace compliance check-in calls data 5. Test and Trace compliance check-in calls - landline data	1. Internal Survey a) Aug/Sep 2020 b) Nov 2020/Mar 2021 2. ONS compliance surveys – Feb-Mar 2021	England	Isolation after positive result	Other
n/a – Kingston Hospital Tracing Pilot- Interim Findings	Other	Baseline period (March 22-June 17 2021): 759 Pilot period (from June 18-4 November) : 2364 – Hospital patients	Baseline period (March 22 – June 17 2021) Pilot period (from June 18 – 4 November)	England	Testing and reporting	Healthcare
n/a – London Borough of Havering Isolation Outreach Pilot Evaluation	Quant data analysis+qual	not clear – The pilot only visited index cases in the community and didn't visit close contact, those in hospital, social care provision or deceased.	7 June – 18 July 2021	England	Isolation after positive result	Universal testing
n/a – Migrant community research	Survey+ IDI/FGD	n/a – semi-structured interviews with both testing participants and the project team	n/a	England	Testing	Universal testing
n/a – Newham Council Welfare Check-in Call Pilot	Interviews	41 – The research participants were adult males and females, aged 20 to 75+, from Black, Asian and ethnic minority groups and White British, from across the Borough, and UK nationals and non-nationals. Of the 1,282 who were consented to take part in the study by the Council, 571 were eligible for screening calls. The 41 interviewed participants were clustered around seven postcode areas within the Borough, and represented the general demographic characteristics and proportions of Newham. All the research participants who took part in the study had tested positive for COVID-19.	Between November and December 2021	England	Isolation after positive result	Other
n/a – Self-test evaluation	Survey+ IDI/FGD	156 responses from 5 companies (for survey) and 24 employees (for In-depth interviews) – Employees	16 March – 25 April	UK in general	Testing	Public/Private sector

Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
n/a – Under represented groups evaluations.. Evaluation Summary of Under-Represented Groups Testing Pilots	Other	n/a – under-represented groups (Roma, refugee, homeless, unemployed, Jewish, Sikh communities)	not clear	England	Testing	Universal testing
n/a – Under represented groups. Redcar Pilot Testing Programme Evidence Summary	Other	400 – under-represented groups (homeless, unemployed)	1 December 2020	England	Testing	Universal testing
n/a – Understanding experiences of the Test and Trace Support Payment: A Qualitative Follow-up Study	Interviews	Not provided – Purposive sampling strategy: sampled from both confirmed cases and contacts of COVID-19. Semi-structured 1:1 telephone interviews (fieldwork May 2021)	May 2021	England	Isolation after positive result	Other
n/a – Weekly TIEB updates. 12 March 2021	Survey+ IDI/FGD	n/a – Private, Public sectors employees, NHS employees	week of March 12 2021	England	Testing and isolation	Healthcare
National Resilience Communications, Covid-19 Communications Hub, Insight, Evaluation and Behavioural Science - Coronavirus Health Behaviours: Quick Read Report	Surveys	n/a – general population	4-6 January 2022	England	Testing	Universal testing
NHS Test and Trace – Asymptomatic Testing: Who is Testing and Why? (Wave 2 Report)	Interviews	2359 – adults aged 16-75 with targeted boost samples among groups of interest (ethnic minority groups and those in areas of higher deprivation)	9 August – 13 September 2021	England	Testing and reporting	Universal testing
NHS Test and Trace – Improving testing and self-isolation adherence in low-income groups: preliminary evaluation of the impact of the Test and Trace Support Payment (TTSP) scheme.	Other	n/a – n/a	1 July – 30 September 2021	England	Testing	Universal testing
Rebecca Jones et al. – International Arrivals Insights Study	Interviews	n/a – The sample included adults who arrived in the UK on 8 and 11 October (Wave 4) and 5 and 8 (Wave 5).	October – November 2021	England	Testing and isolation	International arrivals
Rebecca S Jones – COVID Test and Trace Cases Insights Study: Wave 11	Surveys	1006 – adults aged 18 or more who has tested positive for Covid-19 and were at the end of their 10-day self-isolation period.	7-12 February 2022	England	Isolation after positive result	Universal testing
Rebecca S Jones & Isabel Beynon – Test and Trace Contacts Insights Study: Wave 9	Surveys	895 – adults aged 18 or more who has tested positive for Covid-19 and were at the end of their 10-day self-isolation period.	29 November – 4 December 2021	England	Isolation after positive result	Universal testing
S. McDonald et al. – Blind and Partially Sighted Customer Experience Research Trial 2	Survey+ IDI/FGD	In-depth interviews: 38; Survey responses: 69 – Blind and partially sighted persons	14 December 2020 – 14 January 2021	UK in general	Testing	Other

Publication	Methodology			Setting		Context
Reference	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Literature search</b>						
Sergio Salis, Laura Malley, Diana Mori, Colin Howat and Fiona Sinclair – Impact evaluation of a temporary raise in the wage eligibility threshold for the Test & Trace Support Payment in Bradford	Other	individuals who started a self-isolation period and for whom a compliance outcome is observed (postintervention)= approx.. 15,000; individuals who started a self-isolation period = (postintervention) approx.. 83,000; individuals who were reached by Test & Trace (postintervention) = approx.. 22,000. – Residents of Bradford/other LADs (cases or contacts) who started self-isolating in the pre- or post-intervention period; or those who were reached by Test & Trace via phone in the pre- or post-intervention period; or shared the names of one/more contacts in the pre- or post-intervention period. Note: Only individuals aged between 18 and 67 (working-age population) and who reside in Bradford or one among the other 303 English LADs are included in the analysis	The impact of the Bradford intervention is estimated by comparing the outcome of interest for a cohort of individuals who become at risk of experiencing that outcome between the 10th of April and the 19th of May 2021 (the 40-day period over which the intervention is in place in Bradford) with the outcome observed for a cohort of individuals who become at risk of experiencing the same outcome between the 1st of March and the 9th of April 2021 (the 40 days preceding the pilot). These two cohorts are referred to as the post- and pre-intervention cohorts, respectively.	England	Testing, reporting and isolation	Universal testing
Stefanie Bonfield et al. – Intentions to undertake a PCR or LFT in a range of Covid-19 scenarios: an online experiment	Surveys	752 participants – participants representative of the UK	16-18 July 2021	UK in general	Testing	Universal testing
Team Lead: Matt Barnard Investigators: Liza Benny, Cameron Smith – Kirklees Self-isolation Pilot: Evaluation Report	Interviews	Not clear. No indication of how many interviews were conducted – The main objectives of the qualitative components were to describe the councils understanding of the programme, mapping the range of ways in which they engaged with the 'What Works' framework, including the commissioning, setup and delivery of the pilot. The purpose of this component was to explain how the intervention generated the outcomes or effects observed in the impact analysis, and to illuminate the mechanisms through which the intervention produced its change.  Qualitative depth interviews were used to explore councils' staff and key strategic partners perceptions of the intervention and how this aligned with the programmes intended aims.	The pilot began on 27 May 2021, running for four weeks till 22 June 2021.	England	Isolation after positive result	Other



Publication	Methodology			Setting		Context
	Reference	Methods	Description of the sample	Data collection period	Country	
<b>Literature search</b>						
Test and Trace Evaluation Team – Exploring Compliance with Self-Isolation among Deprived Communities: A Qualitative Research Protocol	Interviews	1104 – Deprived communities (postcodes in bottom three deciles Index of Multiple Deprivation)	15-19 March 2021	England	Isolation after positive result	Universal testing
The Insight Department – Public perceptions overview: Data from Public Perceptions Tracker	Surveys	around 1,000 each week – nationally representative sample of adults aged 18 or more	November 2021 report	England	Testing and reporting	Universal testing
The Insight Department, NHS Test and Trace – Public Perceptions Tracker: Master chart deck	Surveys	n/a – n/a	n/a	England	Testing and reporting	Universal testing
Tim Gibbs et al. – Indicators of Clinically Extremely Vulnerable Individuals' Responses to COVID-19 Outbreak	Interviews	n/a – Clinically extremely vulnerable populations	1 October 2021	England	Testing and isolation	Healthcare
UK Health Security Agency – Public Perceptions Tracker: LFTs Operations and Forecasting	Surveys	1000 per wave (total 5 waves) – adults	17 December 2021 – 31 January 2022	England	Testing	Universal testing
Unclear – Daily Testing for Contacts of COVID-19 Cases (DTCC) – Evaluation	Surveys	c.9,838 respondents – Customers'	17 December 2021 and 19 January 2022	England	Testing, reporting and isolation	Universal testing
Unclear – Behavioural report into perception/trust of NHS App and Covid tests	Surveys	1500 – adults aged 18+	December 2020 – March 2021	England	Testing	UT + HC
Unclear – DTCC – Research Findings January 2022	Interviews	Unclear – Online focus groups and 18-24 y/o, none following COVID regulations or only following very sporadically	10 January and w/c 17 January 2022	England	Testing, reporting and isolation	Universal testing
Unclear – Evaluation of the short-term policy of daily testing of contacts of COVID-19 (DTCC)	Surveys	n/a – n/a	n/a	England	Testing	Universal testing
Unclear – Research exploring the barriers and drivers to following guidance	Focus Groups	6 focus groups, 6 interviews with 18-24 year olds – X 2 groups of people most engaged with and following guidance X 2 groups of people following guidance in a more Ad-hoc manner, picking and choosing X2 groups of people least engaged with guidance and least likely to follow it X6, 60 minute depth interviews with 18-24 y/Os	10 January and w/c 17 January 2022	England	Testing and reporting	Universal testing
Unclear – Responses to Negative test result: LFD Product team survey (March-May 2021)	Surveys	2587 – 90% workplace, 10% org based	March – May 2021	UK in general	Testing	Universal testing
YouGov – NHS Test and Trace W50 and W51	Surveys	2222 adults – England adults (aged 18+)	6-19 December 2021	England	Testing, reporting and isolation	Universal testing

## Section 2 Conducting and reporting a test

### 2.1.2 Individual capability to test and report

#### 2.1.2.1 Understanding testing guidance

##### 2.1.2.1.1 Understanding when and where to test

Most people were aware of the testing services and had heard about local testing sites through work, friends or family, Facebook posts, local news (television or radio), regional newsletters (subscription only) or by searching online for community testing or lateral flow testing [1].

However, some reported frustration at a lack of knowledge regarding where and when to test [2]. A lack of awareness of community testing sites, confusion about eligibility to attend, lack of clarity about where to collect LFD kits, misunderstandings of the process involved and confusion about which guidance was applicable in different circumstances was described [1-4]. This lack of understanding and awareness of where and when to test was described as a barrier to engagement with testing services [1, 3, 4], but confusion and misperceptions were reported to improve over the course of the pandemic [5, 6]. A lack of knowledge was also reported as a reason for not reporting test results [7], and not understanding that reporting was necessary was one of the most common reasons for not reporting a test result [6, 7].

In particular, there was a lack of understanding of when to use LFDs and PCR tests, with many people using LFDs when they were symptomatic rather than following the guidance to conduct a PCR test [8, 9], or misunderstanding the testing requirements once vaccinated [6, 9]. There was also confusion about the need to take a confirmatory PCR test [3, 10, 11]. This was reported as indicating that the public's intended and actual testing behaviours were out of step with government recommendations [8].

A lack of awareness of NHS Test and Trace being involved in mass and community testing was reported, with more than twice the number of people associating it with contact tracing than testing and people associating it with the UK government more than the NHS, Public Health England (PHE) or Serco. Some people also had misperceptions that NHS Test and Trace was responsible for decisions about lockdown enforcement, vaccine rollout and setting care home policies. However, this was late in 2020 before mass testing was widespread [12].

##### 2.1.2.1.2 Understanding how to test

Most people reported being confident in their ability to perform tests correctly [13]. However, a lack of knowledge of how to test was reported as a key barrier to asymptomatic mass testing [3]. Some people reported feeling unsure of whether they were swabbing correctly [14-16] and were unable to correctly self-administer the tests [3]. While saliva sampling was described as easier to perform, a small minority (particularly parents of younger children) reported issues producing enough saliva for the test [17].

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... it's difficult to do it on your own because you're always going to be hesitant to go deep enough. I think it's probably best to get it done by people because there's going to be a lot of inconclusive results and maybe it comes back as a false negative. I just feel like doing it on your own, there's a lot of things that can go wrong. Participant 101, general population [16].

Additionally, the administrative tasks around testing appeared confusing [17].

“

With the labelling I did just double check it as I wasn't sure whether to stick the label over the existing label on the pot, or write it on in pen. ID44 University student, focus group [17].

##### 2.1.2.1.3 Understanding why to test and report

The majority of respondents in one survey (2222 adults through YouGov) reported that testing was important to reduce COVID-19 transmission, with 62% agreeing with regular asymptomatic testing [18]. There were perceptions that these programmes would only work if 'everyone follows the rules' [12], making participation necessary to gain the benefits described in the theme on value below.

At the same time, interviews revealed a lack of clarity about the purpose of testing [4]. Confusion was reported about the impact that mass and community asymptomatic testing (through NHS Test and Trace) had on the COVID-19 pandemic, with many individuals having low perceptions of effectiveness resulting in low trust of the testing programme [12]. People were specifically confused about the role of asymptomatic testing within the broader range of testing services and did not understand the difference in the role played by PCR testing and LFD testing [5]. Misconceptions about COVID-19 and its transmission were also described as barriers to testing for COVID-19 [3].

#### 2.1.2.1.4 Understanding reporting guidance

A common reason for not registering test results was reported to be that people did not think it was important or necessary to report negative results [6, 19]. A persistent lack of understanding of COVID-19 transmission and the benefits of testing has been described as one of the difficulties in promoting testing [20]. Studies also reported that people faced challenges understanding how to report results. Of 786 adults in England who had not reported a test result, 12% said this was because they did not know how to report it. Combined with the lack of understanding of where, when and why to report a result, 50% of respondents cited lack of knowledge as a reason for not reporting their test results [7].

### 2.1.3 Logistics of testing and reporting

#### 2.1.3.1 Physical experience of the test

Sample collection through nasopharyngeal swabbing was broadly considered to be uncomfortable, with some sources reporting that it 'made people gag' [1] and many reporting that they were concerned that it would be painful [2, 21-23]. Nasal swabbing was reported by university staff to be more comfortable than throat swabbing and less likely to induce nausea or vomiting [24].

The fear of the swab being painful was a reason not to test for some (26% of 338 patients who refused asymptomatic COVID-19 testing in one study; the most common reason given) [21]. However, for others, the perceived discomfort did not appear to be a barrier to testing [25] and was either not raised as a barrier [26], was considered 'fine' or 'not too bad' [1], or was considered worth the discomfort for the associated perceived benefits [14].

While several found testing uncomfortable or even "extremely unpleasant," this did not seem to impact on continued self-testing as participants focused on perceived benefits. [14].

Provision of saliva samples for laboratory-based LAMP (loop-mediated isothermal amplification) testing was perceived to be easier to conduct than nasopharyngeal swabbing [17] and was reported as more comfortable to perform [24]. This perceived ease and lower discomfort was considered to be an enabler of testing for COVID-19 [24].

“

The saliva test was really, it's really easy to do and it's not like uncomfortable like the swab tests so, yeah, I much prefer doing them. FG2, S4 [27].

#### 2.1.3.2 Accessibility

Tests were considered to be widely available, particularly when the universal testing programme was in operation [28]. Accessibility to free tests and the availability of tests for family members of those eligible for testing services were reported as key facilitators of testing uptake [24].

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... they are easily available. (Facebook) [28].

However, some reported frustration at challenges in accessing testing [2]. Concerns about the location of test sites and an inability to access them were reported as some of the key barriers to asymptomatic mass testing [3]. While the requirement to travel to test sites was inconvenient for some [17], a lack of transport and the cost of transport were reported as barriers to accessing testing for others [2, 3]. The perception that tests were in short supply and that tests may not be available in the future meant that people tested less so that they could save tests to use in case of future need [29].

#### 2.1.3.3 Convenience, feasibility, and time demands of testing and reporting

Efficient, quick, and easy testing with rapid turnaround times were described as key facilitators of testing [3, 30]. Practicalities and accessibility were cited as factors that influenced engagement with testing services [17], with structural barriers described as a considerable and persistent challenge over time [5].

Well-organised services appeared to facilitate testing. People felt that it was important that testing services were responsive to the rapidly changing context of COVID-19 prevalence and changing guidelines and were appreciative of expansions in the testing services to reflect this [24]. The use of champions to feedback information to tailor the services was suggested as a possible way to ensure that the organisers could adapt to the needs of the service users [27].

“

Well, I think the testing team are brilliant. So, I think anything relating to the process of the testing was always done brilliantly and they would adapt to whatever. I, S12 [27].

Testing location was important and the preference for location depended on personal circumstances; key workers and people working in offices or factory settings were more likely to prefer testing at work, whereas home tests were more popular in London and among lower-income groups [3], as well as other sectors of the workforce who could not work from home [31]. Ordering online and collection from pharmacies for use at home were the most popular channels for accessing tests by the second-half of 2021 [7]. However, the majority of people (2359 adults in England surveyed during the second epidemic wave between August and September 2021) were willing to use any channel of testing, including ordering online, collecting tests from pharmacies or test sites, attending test sites to conduct the test themselves or be helped by volunteers, or receiving tests from volunteers handing them out door-to-door or on the high street [7]. Having multiple options for accessing tests was suggested as a way to increase willingness to test across different groups [7].

#### **2.1.3.3.1 Experience of testing sites**

Most people were satisfied with the convenience of testing and felt that it was 'straightforward regardless of sample collection method' [26]. The perceived convenience of testing was described as a facilitator of testing [32], with nearly 95% of those surveyed after testing at an English university in late 2020 saying they were likely or very likely to test again [3].

Most participants found the programme procedures easy and convenient; registration processes were simple, drop off points were accessible, and testing instructions were clear. It was perceived to be easier to carry out than nasopharyngeal PCR swab tests and test results were received quickly. They felt that making participation as convenient and easy as possible was key to increasing uptake. Parents reported that the test was simple enough for children to take responsibility for carrying out tests independently. [17].

The majority of students in one study were happy with the test pickup and drop-off processes provided by university testing services [27], and university testing services were described as 'organised very well' and 'carried out super efficiently' [33]. The experience of attending community testing sites was described as 'overwhelmingly positive' [1].

However, when inconvenience was described with attending testing sites, it was described as a 'key practical barrier' [32]. The use of testing centres was not always convenient, as some people reported needing to take public transport to get there [10, 17]; the drop-off timings were described as inappropriate, which created dissatisfaction [27]; booking a test could be difficult [3]; and poor organisation and long queues resulted in long waiting times regardless of the use of a booking system [32]. Those who experienced long queues reported being less likely to try again [32].

“

3 1/2 hour wait at [location] even though I booked! Didn't bother waiting, won't bother again! [angry face emoji]. [Facebook, November 6, 2020] [32].

Non-compliance with testing was explicitly linked in university testing services to 'students being away, or missing drop-off times due to academic commitments' [27]. Practical improvements were recommended to increase engagement with testing services [17].

Some (13% of 338 decliners) patients declined routine asymptomatic testing, giving the reason 'I don't have enough time for the test to be done' [21], and in another study, some pregnant women declined pre-labour testing as they viewed the additional visit as 'unnecessary' [34].

“

I think making it easy for them reduces the barriers and makes it more likely that they'll get involved with us. I, S4 [27].

These findings could be interpreted to mean that making LFD testing available at home could overcome some of the barriers to testing for COVID-19 that testing centres represented.

#### **2.1.3.3.2 Experience of testing at home**

LFDs conducted at home were considered particularly convenient and 'well easy' to perform [28, 35], as they could be 'fit into [people's] daily routines' [31]. In one study, 85% of respondents (2106 people in March to June 2021) preferred to test at home over testing at a testing site [31]. This was because testing at home saved time travelling to a testing site (80%) and gave people more flexibility (80%) [31]. In fact, one of the top criteria for the decision about which testing option to pursue was being able to have a test near home [31].

“

Do 2x simple tests and we can all move on. Zero harm, 5mins of your time...simple. (Facebook) [28].

Home LFDs were viewed as easier and more convenient than PCR testing [36]. LFD testing was also appreciated for its shorter turnaround time than laboratory-based testing [27, 35].

Participants largely found the testing process easy and quick since the roll out of home testing kits, and one participant contrasted this with their previous experience of travelling to a central location in Birmingham to get tested [35].

### **2.1.3.3 Experience of reporting**

People reported practicality issues with reporting results, saying that the time and effort was a challenge [6, 19], as well as technology and cache issues [19]. Some people reported being too busy to report their test results, while others described started to register online or on the phone, but the process taking too long and so they abandoned the attempt to report the result [7].

There was variation in people's preference for which platform to report results on. People were more likely to register a result via gov.uk (31% of 2359 adults in England surveyed during the second epidemic wave between August and September 2021) than register a result on the NHS Test and Trace app (19%) or over the phone with NHS Test and Trace (9%) [7]. Nearly one third of individuals informed people they lived with and one fifth informed their employer or people they were planning to meet after the test [7]. A small proportion (17%) informed people they had met with before the test was taken, or did not report the test result to anyone at all (16%) [7].

### **2.1.3.4 Financial resources required for testing**

Most people said they would be willing to pay to test [37], particularly those testing regularly [7]. However, people also indicated that they would continue to do activities without testing if the tests were not free [7]. Rumours of LFD test kits no longer being made available free of charge also caused concern. This in turn caused people to use any test kits they had with more caution, thus reducing people's likelihood of testing [38]. It may therefore be inferred that free tests facilitated more frequent testing.

## **2.1.4 Consequences of testing and reporting**

### **2.1.4.1 Consequences of testing and reporting regardless of result**

#### **2.1.4.1.1 Risk of transmission**

People expressed concern that the testing centres themselves were sites of potential infection that put 'themselves and others at risk' [17, 30, 39]. Conducting tests at testing centres frequently involved waiting in long queues, often with a lack of social distancing in the queues and proximity of symptomatic and asymptomatic individuals [32]. People also reported poor infection control practices at testing centres [17]. This contributed to concerns that the testing process itself could lead to transmission of COVID-19 [1, 32] and led to people citing home testing as being safer in terms of transmission as a reason for preferring home testing [31].

“

I just wouldn't do that wait in a queue like that it's pathetic and more to the point riskier. [Facebook, November 6, 2020] [32].

#### **2.1.4.1.2 Environmental consequences of testing services**

People were concerned about the environmental impact of the waste resulting from testing, particularly the 'of hundreds of pieces of plastic' from the test kits, which were perceived as non-recyclable and compounded by millions of people testing [17, 28].

Some were concerned about the amount of plastic in testing kits and the environmental impact of an expansion of the testing programme. [17].

This acted as a barrier to testing, especially during the universal testing service period, and 'led to some individuals not wanting to get tested due to the amount of waste the tests will produce' [28]

“

We only have a few years in which to prevent complete climate breakdown and we're doing the opposite of what we should be doing. I've declined another box of tests. (Facebook) [28].



### 2.1.4.1.3 Anxiety around testing

Anxiety around testing was commonly described [17, 21, 26], and healthcare workers were concerned that asymptomatic testing would create additional anxiety for patients undergoing procedures [21].

People described weighing up the public good with their individual interests to make decisions on testing under circumstances, e.g., weighing the physical discomfort (particularly for children) against competing priorities and obligations that they did not want to renege on (particularly caring responsibilities) and the logistical challenges of accessing treatment. These dilemmas caused considerable distress for individuals and created anxiety around testing [2]. People reported not testing to avoid having to make decisions in the event of receiving a positive result [38].

“

I don't test because I don't want to know. [38].

This anxiety also stemmed from the fear of testing positive and its consequences, such as having to isolate or being the source of transmission to others [17].

“

I would panic if I tested positive because I have asthma ... With all the [reports] I hear, I would be intubated. I would die. That would be the end of my life. ID43 University students & staff, focus group [17].

Anxiety was also reported around waiting for PCR test results [17], so it may be inferred that LFD testing represents an avenue to reduce the general anxiety around testing.

### 2.1.4.2 Consequences of testing and reporting a positive result

The main consequence of testing positive for COVID-19 was that the individual would be required to isolate, and the implications of this acted as a barrier to testing [3, 20]. Self-isolation was described in negative terms (see section 2.3.3, Consequences of isolation) and prompted strong emotional responses that reduced engagement with testing [26, 35]. People reported 'I don't want to self-isolate' as a reason not to use the NHS Test and Trace testing programme [12]. A small number of people were concerned about the impact that a positive test result would have on restricting an individual's 'right to freedom, due to self-isolation' [40].

The requirement for self-isolation and the subsequent impact on an individual's life after a positive test result was a barrier to testing for COVID-19 [1, 26, 30, 33, 40, 41], with people reporting that 'a need to avoid self-isolating has led to people not following the guidance' [33] and that the 'potential negative impacts [of testing positive] may have driven refusal to participate in the programme' [40].

“

If I don't know I can carry on as normal. [38].

The experience of isolation was enough to deter people from testing in the future, as it created a 'very real fear of it's just not going to be a good time if you quarantine' [27].

“

They didn't really want to go out of their way to get tested, especially as they'd been through the really severe isolation, they weren't allowed to leave at all, and they don't kind of want to go through that again. FG1, S5 [27].

Isolation was such a negative experience that the attempt to avoid or reduce time in isolation dictated people's decision-making around daily contact testing [39]: if they felt they were likely to test negative, they would participate in daily contact testing, but if they were concerned about testing positive, they would isolate from the start to minimise the risk of testing positive later in the period of testing and need to start the isolation from then [15].

While there was considerable variation in the extent to which 'participants needed, and wanted, to avoid self-isolation and leave their homes' [15], it was recommended that addressing the challenges of self-isolation would be an enabler of asymptomatic COVID-19 testing [26] (see section 2.3.4, Need for support).

To maximize uptake of asymptomatic testing, there needs to be significant support in place to manage the impacts of self-isolation on students' social relationships and mental wellbeing. [26].

Some people had particular difficulties self-isolating, which acted as a further barrier to testing in the first place [3]. This fear of having to isolate undermined the attempts to convince people to test, as "[a]ll the urging in the world won't persuade any who can't afford [sic] to isolate if test is positive" [28]. This was particularly challenging at certain times of year, such as Christmas, when priorities were shifted and people feared missing events [41].

Fear of a positive test result was enough to make some decline to take part; they were concerned that if they had to isolate they would lose income, their employer would be unsympathetic and that a history of infection with the virus might affect their ability to get a mortgage and life-insurance. These people preferred not to know their viral status. [17]

Barriers to testing related to self-isolation were primarily emotional factors [26], including the guilt associated with the implications of testing positive, as well as needing to isolate, on other people. Financial barriers to isolation were also important in the decision to test, as 'many people can't afford to test, a positive test mean no work, no money' [28]. The implications of not being able to work following a positive test result were a barrier to testing in the first place [3, 11, 42], with people reporting 'I can't afford to isolate' [12] and the lack of financial support [28] as key reasons not to engage with testing services.

It was suggested that people may need 'reassurance and social support in dealing with a positive test result' [17]. Entitlement to sick pay was described as an enabler of COVID-19 testing [3, 28], and the Test and Trace Support Payment scheme was described as facilitating testing as it was suggested that 'reductions in these [financial] barriers may have encouraged more people to come forward for testing' [43].

[People] could risk testing, because they knew they could receive financial support if they needed [to] self-isolate. [44].

However, expanding eligibility to the payment scheme did not impact testing rates [44, 45]. This may be because the positive effects of the scheme were only seen as an enabler of testing in certain groups, such as those living in areas of higher deprivation, lower income and of particular ethnicities [20].

While the implications of self-isolation were the main negative consequence of testing positive, there were also concerns that a positive test on record could have more far-reaching consequences, such as jeopardising future mortgage or life-insurance applications.

... that a history of infection with the virus might affect their ability to get a mortgage and life-insurance. These people preferred not to know their viral status. [17].

The detrimental consequences of the requirements to self-isolate were suggested to disproportionately impact those who were most at risk, which may have inadvertently disproportionately reduced their engagement with testing services [40].

#### 2.1.4.3 Consequences of testing and reporting a negative result

People described an alleviation of anxiety upon testing negative, as well as the positive mental health effects of the normality and socialising that testing negative facilitated [27]. The testing programme allowed those who tested negative to create opportunities to be social without breaching COVID-19 restrictions and without having to socialise in an uncomfortable way, such as 'standing outside in the rain talking to people'. There were multiple reports from people about 'being happier', being 'much more relaxed' and life being 'less isolating' [27]. This was particularly the case for university students.

“

Felt nice for normality and to speak to people I'd seen around but never been able to speak to, definitely improved my mental health. S [27].

Testing negative gave people greater confidence to continue their normal routines, including work, socialising and activities such as shopping [31, 41], and people cited meeting family and friends as an increasingly prevalent reason for testing [9, 27, 28]. Facilitation of socialisation was a particular incentive to test at important times, such as Christmas, when people wanted to safely visit family members [4].

“

My partner's grandparents live quite close by. Being able to do the test and know that we didn't have it on the day that we then went to see them and could give them a hug, was an amazing thing. ID15 University staff, interview [17].

The knowledge of a negative result reduced guilt in participating in normal activities [33].

“

I was definitely happy to have it cause it meant I could come home and not feel guilty for being 'a spreader'. FG3, S1 [33].

People described concerns that testing negative would result in riskier behaviours, as people 'may misunderstand this to mean no risk of being infectious, resulting in reduced adherence to guidelines' [46]. For example, there was concern that university parties 'would get out of hand' because testing negative was 'seen by some as a reason to be reckless' [27].

Concern was expressed about the potential of those who received a negative test result to become less vigilant in applying social-distancing and hygiene measures [17].

However, while a small number of people did report that a negative test result would lead to a 'slight relaxation of their behaviour and measures' [31, 39], a negative test did not necessarily lead to riskier behaviour. Most people reported that they did not feel that they could let their guard down, that they should continue to wear a mask and that they did not reduce their worry about social distancing after receiving a negative test result [47]. Even if they understood the guidance in relation to daily contact testing, some people who had been exposed COVID-19 chose to isolate regardless of a negative result because they felt uncomfortable leaving home with a perceived risk of infectiousness [15].

“

Even if the tests that were given to me, the rapid tests allowed me to step out for 24 hours, I decided not to basically do it. Yes, again, I just followed the basic national guidelines, etc., etc., looking at all of that, but just decided to self-isolate. (38-year-old male, Asian, consented to testing). [15].

## 2.1.5 Perception of value and motivation to test and report

### 2.1.5.1 Perceived value of COVID-19 testing

People generally valued regular asymptomatic testing and the testing programme [14, 23, 31, 48] and viewed it as helpful and worthwhile [21, 23]. The intention to test gradually increased over the three COVID-19 epidemic waves [9, 49].

The fact that testing was a 'good cause' appeared to overcome many other potential barriers, such as the additional burden of work [17]. However, some people felt that the value of testing was not sufficient to change existing behaviour [27], and some people did not find value in the testing and reporting programme, with 41% of respondents in one study (2222 adults through YouGov in late 2021) refusing to conduct regular, twice-weekly rapid testing [18]. Some university students reported that the benefits of testing (such as reducing transmission) were outweighed by the detrimental effect (e.g., the impact of COVID-19 measures on social interaction and subsequently mental health) [27].

“

And the incentive wasn't there for them because they'd already been mixing all year, you know, we're always fighting the fight, you know, 'no you've got to split up, no you've got to stay together in your household', so from the start it's been difficult for us that way and there was no massive incentive for them. I, S3 [27].

Greater perceived value of testing tended to frame the consequences of testing more positively, but the reverse was also true [40].

There were mixed reactions, which broadly correlated to the wider feelings about testing. Those who expressed that they felt the programme was a positive initiative were more likely to frame these impacts in a positive manner and have a sense of ownership over the programme. Those who felt the programme was inappropriate or not beneficial were more likely to view staff impacts negatively. [40].

Some people were indifferent about the value of testing, and indifference to the guidance was reported regardless of understanding among certain groups (for example, university students) [27]. The 'pointlessness' of the testing service was ascribed to low or improving prevalence and thus a low perception of risk that reduced the perceived need for regular testing [27, 38]. It was also ascribed to the lack of effective coverage and the lack of enforcement [12].

“

It felt basically the same from my point of view. I think other people did mix more but, yeah, they hadn't really been enforcing the household only mixing beforehand anyway, everyone had just been sitting in the dining room next to each other for a while before, so it didn't feel like it changed that much. FG2, S4 [27].

“

It didn't really make a difference, I don't think, because they've been partying all year so, you know, there have been quite a few incidents round the campus but they have been partying all year. So I don't think it made that much of a difference to them. I, S9 [27].

Complacency was suggested to result from the perception that others were not testing [12], as well as testing fatigue both anecdotally [38] and through survey responses [19]. Some of the indifference to testing also stemmed from people not seeing the point of testing, if the COVID-19 pandemic was something that was going to need to be lived with rather than fought against [38].

“

I don't see the point of testing if I am well, surely we should just be trying to get on with it all now. [38].

There may have also been some disconnect between favourable views of mass testing as a beneficial intervention and individual intentions to personally engage with the testing programme. In one survey (of 3049 people), 62% wanted mass testing to feel safe in their job and 71% to feel safe around people they interacted with regularly, but only 40% were willing to be tested weekly and 6% were willing to be tested daily [3]. However, this study was conducted early in the pandemic, and ONS data referenced by UKHSA found that, in January 2021, more than 70% of respondents would be likely to test [3].

#### 2.1.5.2 Perceived value of reporting COVID-19 test results

There was a discrepancy between tests being taken and tests being reported [7, 31, 50, 51], with low levels of reporting persisting as the pandemic progressed [6]. This could be interpreted to mean that people valued testing more than reporting the result.

A theme emerged through surveys that there was a relatively low intention to report LFD results [50], with this intention appearing to decrease throughout the course of the pandemic. There was a decrease over time in the number of people who reported registering their test results to NHS Test and Trace, with 48% of people in a survey (of 2359 adults in England) in August to September 2021 reporting that they had registered their test result compared with 53% during the first epidemic wave of the pandemic (May 2021) [7].

Not seeing the value of reporting a test result if it was negative was described as the largest single barrier to reporting a test result, by 43% of 630 survey respondents between March and June 2021 [31], and by 39% of 786 adults in England who did not report results surveyed during the second epidemic wave between August and September 2021 [7]. Some said they had no particular reason for not reporting their result, they just did not report it [7]. Complacency was also suggested to result from a lack of knowledge of the importance of reporting, specifically negative results [6, 19], and due to reporting fatigue [19, 38].

#### 2.1.5.3 Sources of value and motivation to test and report

##### 2.1.5.3.1 Keeping others safe

A major driver of testing behaviour was to reduce transmission and keep others safe [3, 15, 17, 27, 32, 35, 52]. In fact, one of the top-three reasons given by students for taking part in a routine testing programme was 'helping to keep campus safe' [53]. Asymptomatic testing was seen by individuals as an 'effective way to increase safety' [3] and know they were not passing on the virus to colleagues, their household, the general public [1] and in particular to vulnerable groups [30, 39].

Participants appeared highly motivated to engage in behaviours that would protect others from the virus. [15].

This influenced the uptake of testing [24], especially at times when people would be travelling to see family and friends, such as the 'end of terms or before holidays, like Christmas', for university students [24].

“

I just wanted to know if I was positive so that I could take steps not to spread it and to kind of know that I was you know at risk and people near me were at risk so that was my main driver. P128, female, academic staff member [53].

##### 2.1.5.3.2 'Peace of mind': personal safety and reassurance

It was recognised that there were benefits to testing that were difficult to quantify, including 'peace of mind' and 'real comfort' [1, 10, 27, 39, 54], and these benefits provided one of the main motivations to test for many people [3, 39].

“

I have opted just to do the testing for my own peace of mind. (P106, female, Yr5, student) [53].

Individuals found reassurance in knowing their COVID-19 status [13-15, 17, 22, 28, 35], especially if they were asymptomatic [55]. This reassurance was described regardless of their result [17] but particularly if it was negative [1].

“

It was just really reassuring to know that I was getting regularly tested and in a way I know you can't directly say that everybody in my immediate family is OK but it was almost like I could act like the canary going down the mine and that there was a certain amount of reassurance as well that if I was negative there was a high chance that my children and my husband were also negative. P124, female, academic staff member [53].

Having LFDs that could be conducted at home gave reassurance of a result before leaving home [31], and while not the intention of the asymptomatic testing programme, the ability to quickly confirm a positive test at home was a benefit that was appreciated [15]:

“

When I first felt ill, I didn't immediately think it was Covid; I was convincing myself it wasn't. I was like, 'Well, I haven't got a temperature, and I haven't got a cough ...' Although I did get a cough, eventually. I was like, 'No, it's not going to be Covid. It's not, it's not; it's just the flu.' No, actually, it was only from having a positive test at home that I knew. (43-year-old female, mixed ethnicity, consented to testing) [15].

People 'heavily relied on the test to feel safe' [24], and all participants in one study highlighted the importance of attending community testing sites for their own safety [1]. The testing programme and communication around it, particularly for specific services such as testing in universities, appeared to give reassurance that testing was prevalent, which in turn provided 'peace of mind' that steps were being taken to address the pandemic and keep people safe [53].

“

It was just kind of nice to know that there is awareness, and it is not just you know social distancing, you are actively trying to help as well I think. P92, female, Yr1, student [53].

People reported feeling safer when testing services were in place, 'knowing that everyone had been tested', and university students reported feeling 'safest on campus [where a testing service was in place] than anywhere else' [27].

“

I really felt the relaxed restrictions during the testing pilot helped um, where mixing between households was inevitable, I felt it was probably a lot safer during the pilot. FG1, S2 [27].

#### **2.1.5.3.3 Support for normal activities**

A major value of the COVID-19 routine asymptomatic testing programme was seen to be its ability to open up society and promote 'near normal' activities, such as having schools, universities, workplaces and general practices open and running [1, 3, 15, 17, 27]. The testing programme was seen as a route to greater social freedom as, through it, social distancing was relaxed, and people were able to socialise more [3, 27]. This incentive of eased restrictions [3] and facilitation of socialisation and daily activities [51] was cited as a reason to engage with testing [27, 32].

“

The world's re-opening, we're seeing more people and I'm doing more tests at home ... I test before and after meet ups ... if it gets us a normal life again I'm all for it [testing], I really am ... I'd quite like to be able to make plans with friends without thinking right ok we can only meet outside and the weather's doing this so yeah I just want that bit more freedom. ID 5, testing [35].

The testing programme provided many with the confidence to carry out their daily activities [17] and was described as a 'pre-requisite for some to more fully re-engage in pre-pandemic activities' [35]. With mass testing in place, people described feeling safer doing activities such as attending classes on campus, as they knew others had tested negative [26], and about half of the 2587 respondents to one survey (of people tested in the workplace or organisations between March and May 2021) reported that they had more confidence to meet other people following a negative COVID-19 test result [47].

#### **2.1.5.3.4 Pride and social cohesion**

People felt proud to participate in the testing programme and 'do their part' to tackle the pandemic [3, 17]. For students, 'contributing to the national effort to control the virus', and 'being involved in COVID-19 research' were among the top four reasons for engaging with a university testing service [53], and some students described how testing meant they were contributing to preventing further outbreaks [28]. Participation in testing was seen as a 'privilege', had reputational benefit for the institution and also helped communities find common cause 'in a way that had not been evident before' [17].



Participants expressed pride in knowing that they were contributing to a programme that was part of the national effort to manage the pandemic. Some viewed this as a privilege and others were excited. [17].

### 2.1.5.3.5 Incentives

Incentives were a complex concept, with no clear perception of their efficacy. Some felt that incentives such as money or food parcels were not sufficient to encourage engagement with testing [27].

“

I don't think the students felt that it [food parcel incentive] was impactful enough for them. They didn't feel like they were getting a lot from it ... They wanted something extra to other students that weren't doing it, so other halls that weren't doing it. I think they wanted to feel like they were getting some more benefit than they actually did get. I, S10 [27].

Others had a moral objection to the concept of providing incentives to perform a test that they say as the 'right' thing to do given the situation.

“

At the end of the day I think it's wrong to incentivise it, because I think that people should be doing it as a norm, and I don't see a problem in doing it, as normality is once a week you do a test. To me that doesn't seem like we're asking anything really hard of anyone to do, but it's a shame that we have to incentivise things in that way. I, S10 [27].

## 2.1.6 Influence of the perceptions of COVID-19 risk on testing and reporting results

People were more likely to perceive a risk from COVID-19 to others (including friends, relatives, and people in the UK more generally) than to themselves [6, 12]. While the majority perceived a large risk to society (81% to 96%) and their friends and family (72% to 97%) [6], between a quarter and a third of people (of 2783 required to isolate in late 2020) saw themselves as vulnerable to COVID-19 [56]. Others felt that the threat of the pandemic had been exaggerated [3].

Personal views on the pandemic and the need for testing also influenced people's willingness to test. Low perceived risk of COVID-19 was described as the main barrier to engaging with testing [3, 28, 52], with those who had low risk perception feeling that they 'did not need to test' [1, 35].

Perception of risk was related to the epidemiology of COVID-19, such as its incidence and the likelihood that symptoms were caused by COVID-19, and the perception of vulnerability to COVID-19, including the perceived risk of contracting COVID-19, the severity of disease and the impact of recent infection on transmission risk [1, 3, 5, 28, 35]. The perception of risk was also related to responses to the pandemic, such as vaccination and the introduction or relaxation of containment measures [1, 3, 5, 24, 28, 35].

### 2.1.6.1 Likelihood of having COVID-19

People were more likely to test for COVID-19 if they had symptoms than if they were asymptomatic, as a lack of symptoms made people feel that they were less likely to have contracted the disease [55] and thus saw these measures as unnecessary [38]. This has particular implications for the uptake of asymptomatic testing programmes.

At the end of 2020, most people who tested positive (in a survey of 1818 people) had tested because they had symptoms (37% to 57%) rather than because they had participated in a mass testing programme (less than 20% over various weeks) [56]. People's reported likelihood to test appeared to be fairly consistent throughout 2021; however, the likelihood to test varied among different testing routes: while most people reported they would be likely to have a test (76% at the end of November 2021), this was higher than the proportion who said they would take part in mass testing (45% at the end of November 2021) or test twice weekly (26% at the end of November 2021) [57].

### 2.1.6.2 Risk of transmission

There was a lack of engagement with twice-weekly testing when individuals felt they had a low risk of contracting COVID-19 [28]. This was particularly true when the local COVID-19 incidence was low [11] or when people were following other pandemic measures [28], as people felt that they were unlikely to contract COVID-19 [35].

Studies of university students in particular reported that 'the risk of virus transmission...was perceived to be low' [27]. People who had been working throughout the pandemic without testing also felt that their circumstances had not changed so they did not need to start testing when it became available [28].

“

I have never had a test and been working away thro this bs n will never take the test. (Facebook) [28].

### 2.1.6.3 Risk of severe disease

Perceptions of low severity of disease increased over time [9] and were based on news coverage [9] and the high recovery rate, which decreased the perceived importance of routine asymptomatic testing [28].

“

Eight tests a month for everyone for a virus 99.7% don't need to worry about ... (Facebook) [28].

Low perceptions of severity were also based on people's beliefs in the strength of their natural immune system, which is 'made to fight anything that makes us ill'. This reduced their perception of the need to test regularly [28].

“

... we're being told that perfectly healthy people need weekly tests and a vaccine for a virus their immune system can already cope with (Twitter) [28].

### 2.1.6.4 Pandemic response

While some were concerned they could 'still catch and spread it even after having the vaccine' [28], COVID-19 vaccination and immunity from recent COVID-19 infection were generally associated with a lower perception of risk of catching COVID-19, transmitting it, and experiencing severe disease, thus reducing the need to test [1, 28, 35].

“

If I hadn't had both of them [vaccinations] I probably would have had more lateral flow tests by now. ID 12 [35].

Perceptions that the testing programme was 'pointless' in comparison to the vaccination programme were described, as tests do not prevent COVID-19. The testing programme was also described as pointless once the vaccination programme was introduced, as vaccines would reduce the transmission and severity of disease, making testing unnecessary [28].

People also perceived low risk and thus low necessity to test when they were 'already abiding by all national COVID-19 guidelines and restrictions in place (e.g., mask wearing)' [1] and weren't interacting with others [28].

“

There's no point in using it as I've not been outside the house since it arrived (news article) [28].

Some people felt that if they had a partner who was testing regularly (e.g., a care home worker), that this sufficiently managed their risk and they did not need to test [11]. Others felt they were applying 'common sense' in weighing up risks and perceived contradictions in guidance, for example the implications of successive vaccinations [29].

## 2.1.7 Social influences on testing and reporting

### 2.1.7.1 The influence of society on testing and reporting

People described a societal responsibility to participate in testing [16, 27] and appeared to be motivated to engage with testing by a 'sense of civic duty to protect society' and ethical obligations to specific individuals in their social network [2, 54]. This sense of responsibility and duty was reported as a primary motivator for testing [11, 39, 51, 58].

“

I see it's a duty of care for everyone to be doing it to stop new outbreaks. (Facebook) [28].

Taking a COVID-19 test and truthfully reporting the result was also 'strongly based on relationships between people in the bubble' [10] and 'seeing the same people everyday' encouraged engagement with testing services [17]. This 'identification with the community' and 'sense of solidarity with others' was described as a facilitator of testing [3]. It was suggested that this could be harnessed to encourage testing by employing 'testing champions' and by creating supportive communities, for example through WhatsApp groups [17].

The need for informed consent and the ethical balance of individual choice with public good in a pandemic situation was noted as an important consideration for encouraging engagement with testing [22]. Social considerations were also highlighted by the fact that social support from peers and colleagues appeared to support engagement with the testing programme:

“

That was probably the main benefit of it was just, you know, just easily being able to text and answer a question. FG7, S3 [27].

Cultural influences on testing uptake were not generally reported, but some participants were concerned that ‘aspects of culture were a barrier to participation [including] language barriers’ [17]. A culturally specific aversion to ‘being told what to do’ rather than being given a choice was described as a sentiment among migrant workers that led to hesitancy to test for COVID-19 [59, 60]. Language was also described as a barrier to testing, because of a lack of understandable official information, and as a barrier to registering test results, as this was required to be in English and necessitated reliance on others for translation [59, 60].

The disproportionate burden of COVID-19 among certain ethnic groups was postulated as being a barrier to testing in these groups. Additionally, socioeconomic status may have influenced engagement with testing. Asylum or refugee status was suggested as a factor that may have made people reluctant to participate in the testing programme, particularly if it was delivered through government portals. Homelessness, substance misuse or incarceration may also limit access to testing [40]. Concern for the impact of COVID-19 on specific demographic groups was cited as a predictor of willingness to test [52].

### 2.1.7.2 The role of authority in encouraging testing

It seemed to be felt that encouragement to participate in testing should come from some form of authority, with some people reporting that they tested because they were told to [54]; three quarters (of 50 workplace staff surveyed in one study) agreed that asymptomatic testing programmes should be mandatory [23]. It was suggested that people in positions of authority, such as employers or senior members of clinical staff, should play a key role in raising awareness and encouraging uptake of testing [1, 21].

A negative test result was a requirement for some activities, thus many tested because they had to in order to participate in those activities that required a negative result [54].

Senior staff not buying in to testing appeared to be a barrier to engagement with testing in the healthcare setting [21]. Conversely, healthcare workers said they ‘would be willing to implement SARS-CoV-2 POC testing if it were issued as part of the guidelines prescribed by authoritative bodies’ [61]. University students said that there was ‘immense pressure to participate’ in testing [27] and that they were influenced to test ‘by the university really pressing us to do it as a good idea’ [53].

“

My reason for taking part is because I had a guy, there was just some guy that was coming round knocking on everyone’s doors saying that we’d be relocated from the Hall if we didn’t participate, so that sort of scared me into doing it. FG4, S4 [27].

### 2.1.7.3 Social pressure to test for COVID-19 and report results

There was strong social pressure from within communities to test for COVID-19 [41] and for those not testing to comply; a testing ‘etiquette’ emerged in the context of cold symptoms [2]. Students reported frustration at ‘complacent attitudes and misbehaviour’ of those not following guidance [27], with a perception that those who were not engaging in the testing may end up being responsible for transmitting the virus [28]. In a survey of workplace staff members, one third of staff felt sanctions on colleagues not taking part in testing was acceptable, and one fifth felt that suspension without pay was acceptable [23].

“

... those that choose not to and go around spreading it can be responsible for someone’s death without even knowing it (Facebook) [28].

The ‘familial atmosphere’ created by smaller communities and pilot studies, where individuals showed an awareness of who was testing among the community, was reported to increase the uptake of testing [11]. People described feeling this pressure from others and testing for COVID-19 because they did not want others to ‘perceive them as “risk taking” by “not following the rules”’ [16], even if there were no explicit sanctions [11]. However, some just felt that it had become a social norm and tested because ‘everyone...was testing’ [27, 53]. Those that did not perceive it to be a social norm, and felt others were not testing, had lower intention to test [12].

“

I did it because all of my flat did it and we just decided that we would do it together. P112, female, Yr1, student [53].

#### 2.1.7.4 Social pressure not to test for COVID-19 or report results

Conversely, there appeared to be stigma associated with testing [3] and with testing positive [3, 16, 17], with testing was described as 'a bit of a taboo' [27]. This stigma created a concern that people would lie about their COVID-19 status, including concerns that patients may be 'omitting to tell crews about COVID-19 symptoms as they feel they won't get an ambulance if they tell the truth' [22]. Some of this stigma stemmed from the fact that a positive result had implications for those in the same household or bubble, who 'might be a little bit miffed' at having to isolate [27].

There were potential impacts not just on the child being tested, but also their family due to the need for isolation, therefore it was felt that some parents refused consent out of fear of the implications of a positive test result. [40].

It appears that normalising engagement with testing and dealing with a positive result reduced the concern of stigma [16]. This could be achieved by using automatic registration and an 'opt-out process for participation' [17], with opt-out processes cited as a facilitator of testing [3].

People described concern for the impact that an individual's positive test would have on the lives of others and social pressure not to cause inconvenience for friends, colleagues and family, which acted as a barrier to testing for COVID-19 [33] and to truthfully reporting results [10].

“

I think um, that a need to avoid self-isolating has led to people not following the guidance and has actually led to people harassing other students. Um, because someone goes and has symptoms and gets a test, it then means everyone's got to self-isolate, so I think there's been pressure to either for people not to test, um, and for people to, or not to share that they've tested. Staff interview 20 [33].

Many people described the sense of guilt that came with testing positive [26]. They were concerned about being the reason that other people would have to isolate and potentially lose income [23] or be unable to go to work, travel or fulfil other obligations [16, 23, 27]. People described not wanting 'to be the reason that the rest of their household has to stay indoors for 10 days and not see anyone or do the things that they've got planned' [27]. Therefore, not wanting to share contact details of others was reported by nearly a fifth of adults in one survey (2029 individuals through YouGov) as a barrier to using the NHS Test and Trace testing programme to take a test and report results [12].

“

Some of my flatmates have labs and face-to-face lectures and I'd feel bad that they'd have to miss that. Also, it's nearly Christmas and a lot of them live away, they'd already booked tickets, so if I was to test positive they would miss that and I wasn't looking forward to telling them, but luckily it was negative. Participant 156, student [16].

There was also 'guilt about the impact of self-isolation on others' that acted as a barrier to testing for COVID-19 [26]. People described conflicting obligations in relation to testing for COVID-19, when the requirement to self-isolate would mean they 'let down friends, family, or employers' [2]. The impact of needing to isolate on people's ability perform their usual roles, such as work or caring responsibilities, was described as a barrier to testing [2, 3, 16, 23, 27, 30].

### 2.1.8 Trust in the test, the reporting platform, and the health system

Trust in the test performance and in the institutions implementing the testing programme played an important role in people's engagement with testing and reporting of COVID-19 LFD results [1, 3, 17, 32, 49].

#### 2.1.8.1 Trust in test performance and accuracy

Trust in COVID-19 tests was not consistent. Some studies reported that most people 'held generally positive attitudes towards the continued use of LFDs' [35] and many remained confident [27, 53] and unconcerned [22] about test accuracy. YouGov reported that 60% of people (2222 adults) responded that they trusted testing 'a fair amount/a great deal' [18], and a Public Perceptions Tracker in the UK showed that 72% of people trusted LFDs to provide accurate results [36]. Most people trusted the tests enough to base decisions on their results, even if they understood that the results were not 100% accurate [23].

Other people described scepticism of test performance and had low levels of trust in the accuracy of the test results [16, 32, 61]. Mistrust was described as a particular barrier to testing and for reporting for disadvantaged groups [7, 20]. While trust varied among populations, it appeared to be consistently low in some studies. Net trust was negative in late 2020 [12], just 20% of respondents (1267 adults in April 2021) trusted rapid tests 'a fair amount' or 'a great deal' [48] (although most appeared to have

moderate trust in tests as just 20% reported little to no trust [48]), and trust in LFDs remained between 36% and 45% throughout the second half of 2021 [57]. A series of YouGov surveys found trust was lower for NHS LFDs (36% to 45% throughout 2021) than for PCR tests (61% to 72% throughout 2021), but higher than for third-party private tests (21% to 27% throughout 2021) [57].

“

While some interviewees who were testing were also concerned about test accuracy, this was cited as a contributing factor to a decision not to test by others who were ‘not convinced these LF[D] ones are accurate’. ID 15, not testing [35].

Some studies reported that even among healthcare workers the confidence in rapid COVID-19 tests was low [22]. Some studies reported that there was concern that the number of false-positive results was higher than the number of true-positive results [35].

“

The false positive rate is between 1/1000 and 3/1000 and people with COVID-19 is 1/600. If you work that out, that is more false positives than true positives. ID 9, not testing [35].

#### **2.1.8.1.1 Consequences of acting on a false-positive or false-negative result**

People were particularly worried about false-negative results [14], while two thirds of participants in a workplace testing programme survey were concerned about false-negative results and half were concerned about false-positive results [23]. This lack of trust in the accuracy of testing had an impact on the uptake of COVID-19 testing [14, 35].

People had ‘concern about the personal consequences of a false-positive result’ [17], particularly about ‘self-isolation as a result of a false-positive result’ [3, 35]. These concerns were cited as a reason for declining to participate in routine testing [17]. Concern was also raised about the impact of false-negatives on the risk of transmission by providing a ‘false sense of security’ [15, 22]. The severity of the potential implications means that people seem to have paid more attention to the accuracy of testing than if the consequences of acting on an inaccurate result had not been so serious.

#### **2.1.8.2 Trust in the health system and the government**

In December 2020, it was found that people tended to agree that the NHS acted in the public interest [12]; however, mistrust in the government [3, 28, 32, 55] and in NHS Test and Trace [12, 18] was commonly reported. The testing programme was described as a ‘political exercise’ [61]. A lack of trust in the health system and the government was reported as a ‘key’ barrier to testing, including twice-weekly mass testing at home [3, 20, 28, 30, 32].

“

Not a chance in hell would I get one of these tests ... corrupt government! [Twitter, 2 November 2020] [32].

Interestingly, trust was greater for local bodies than for national levels of the NHS [3]. This affected the trust in the tests themselves and in the reporting (what would happen to people’s data), and it was suggested that people ‘would have been more likely to take part if the programme was run solely by local organisations’ [17]. However, some people still mistrusted their individual doctor’s advice [52].

[Despite not trusting NHS Test and Trace more broadly] the local NHS Foundation Trust and its partnership with the University and Southampton City Council, however, was trusted; scientific integrity, and as a local organisation, was felt to be answerable to the Southampton community in a way NHS Test and Trace was not. [17].

The public distrusted ‘all aspects of the services and support’ provided by the NHS Test and Trace programme, with one survey (of 2029 adults through YouGov) finding that respondents considered the testing programme to be performing poorly in organising mass/community testing services, making it easy to get a test, providing support upon testing positive, and giving the information needed (on transmission and how to manage life during the pandemic) [12].

The mistrust in the government appeared widespread and was a result of principled disagreements with the impact on civil liberties as well as personal experiences, such as individuals not being reached by NHS Test and Trace when they knew their close contacts were positive [12]. Those who were not vaccinated also mistrusted the level of threat that COVID-19 was said to pose, describing it as ‘exaggerated’, which reduced trust in the testing services [49].



### 2.1.8.2.1 Ineffective management of the pandemic

Being 'fit for purpose, reliable and making a difference in the fight against COVID-19' were reported as key drivers of trust, with suggestions that these should form areas to focus on, to address and increase the public's engagement with testing [12]. Thus, mistrust was promoted by the perception that the government had not adequately handled the pandemic, having 'underestimated the severity of the virus' and that the 'fault is in the government downplaying the virus at the start', therefore having not acted quickly enough or enforced public health recommendations sufficiently [28]. On the other hand, some people mistrusted the government because of their perception that the risk level was 'exaggerated' [49].

The NHS Test and Trace programme in particular was perceived to be ineffective, expensive, unreliable and inconsistent [12]. In one survey (of 2029 adults via YouGov), 52% agreed or strongly agreed that the NHS Test and Trace programme was 'a shambles', and its perceived ineffectiveness in managing the pandemic was claimed to be the largest barrier to using the programme [12]. This perception of ineffectual management was seen as one of the largest barriers to trusting the system [12, 49]. While the perception of ineffectiveness did appear to become less of a barrier over time, it remained an important barrier to engagement with testing [49].

“

I blame the government for a great deal in this. Too much was left too long and the laws on restrictions were too easily ignored. (Facebook) [28].

People shared concerns that the government was unable to implement an effective testing programme, having 'stopped community testing, which let the virus spread rampantly during the summer' [28]. There were also concerns that the government would not handle the implementation of mass testing adequately in the future, based on past mistakes, and that there were ulterior motives for the introduction of universal testing:

“

Soooo they are going to magically be able to test 68mil [people] ... Twice a week now???? Am I wrong in thinking they haven't even come close to been able to test that much for the past year let alone twice a week. (Facebook) [28].

### 2.1.8.2.2 Privacy and use of data

This distrust was particularly strong around the use of people's data, their privacy, and the potential loss of control of their data when reporting a positive test result [3, 12, 17, 49, 55]. Data privacy concerns were reported by one survey (of 2029 adults through YouGov) as the second largest perceived barrier to using the NHS Test and Trace programme [12] and were consistently reported as a reason for not reporting results [7]. In some studies, people stated they were willing to share their and their close contacts' data [6], while 1504 adults in England surveyed during the second epidemic wave between August and September 2021 stated they would be willing to provide at least some personal information when registering test results; however, less than half (41%) were willing to give all of the information requested when reporting a test [7]: 80% were willing to provide their age, 77% their gender, 75% their email and 74% their postcode. While 73% were willing to give their age and gender, only 65% were willing to give their age, gender and postcode. Fewer were willing to report their ethnicity, phone number, occupation, or disability status [7].

Some individuals were also wary that samples for laboratory-based tests were being retained [17] and DNA was being extracted from samples [3]. These concerns were described as a barrier to testing for COVID-19 [3] and may be perceived as a potential enabler of POC testing programmes.

People who had previously lived in countries with a low level of trust in governments (such as international students participating in university testing services) had a lower trust in the testing programme and in reporting test results, with particular concerns around the use of data [17].

“

In, especially Hong Kong right now it's quite scary. If you have the saliva test or swab test right now the testing company or the government might get your DNA. Some of my friends are quite concerned about this part but because I just had to explain to them that the UK is different, they treat privacy very seriously. I try to tell them and reassure them but they are quite worried because in Hong Kong they are scared about the DNA or that the samples are being sent to China. ... But the UK might still have possibility to have accidental leaks if there are like other situations from airline companies, they have glitches in the system, some privacy just leaked out. ... Some freshers coming in this year, they are quite worried about the situation as it's been a long-standing issue there. ID48 University students & staff, focus group [17].

## 2.1.9 Influence of information and communication on the capability and motivation (including perception of value and trust) to test and report and links to other themes

Some factors had an influence on multiple themes, including the understanding of when, where, how and why to test for COVID-19 and report the results, trust in the test and the health system, and the perceived value of testing and reporting results.

### 2.1.9.1 Impact of information on other themes

#### 2.1.9.1.1 Impact of information on knowledge and understanding of testing

While marketing campaigns were reported to have helped to improve awareness of the asymptomatic testing programme during the course of the pandemic [5], advertising, awareness, consistency of messaging and clarity of information were all cited as being inadequate. Furthermore, these factors were explicitly linked to misunderstandings and the confusion people faced in knowing when and where to test, particularly when these factors acted in combination [1, 3, 27, 44]. The confusion about regulations was also linked to non-compliance [1, 27], while ambiguities in testing criteria increased the sense of confusion around conflicting priorities and obligations and led to a 'wait and see' approach in many cases [2].

Rapidly changing government guidance led to confusion in both when and how to test [42] and was considered 'one of the greatest barriers to the implementation of the testing service' [24].

“

If you're changing the goalposts every week, that gives my team a really tough job because you're having to make people understand something new every week and they're just going to eventually switch off because you've only got a few opportunities. I, S6 [27].

The rapid changes also necessitated an 'excess' of communication materials to clarify guidance and this resulted in frustration [27]. Dissatisfaction was ascribed to the perception of 'poor communication around changed procedures' [27], however others reported that the information was 'well communicated, if any changes occurred, we would be notified about these very quickly' [27]. People gave local institutions more leeway in their ability to communicate changes that came from higher up [27].

“

I think the university's messages are really good, it's just that they're having to respond to changes that have come from government. I, S11 [27].

Changing guidance for other COVID-19 measures, such as social distancing, also had an impact on engagement with testing services. For example, staff at universities found it more difficult to get students to test after social restrictions had been eased. They felt that the relaxation of restrictions reduced people's desire to test [24].

“

... when the national regulations were eased off and pretty much scrapped it meant we got less people testing...our sample numbers fell through the floor ... government guidelines definitely hindered the sort of, the input and output of the service. Respondent 10 [24].

Increasing the availability and clarity of information about POC testing was suggested as a means of reducing limited knowledge as a barrier to uptake [61]. People reported wanting to test properly and wanting 'more information on ensuring that they test correctly' [14]. People requested more 'black and white' guidance, with a consistent message [24]. It was also found that communicating residual risk information and behavioural implications in messaging around what to do upon receiving a negative test result improved the understanding of residual risk and facilitated testing [46].

The addition of a single sentence improves understanding of residual risk of infectiousness following a negative test result. "Your coronavirus test result is negative. It's likely you were not infectious when the test was done. But there is still a chance you may be infectious." [46].

Making environmental or structural changes were suggested as ways to facilitate correct testing, such as tubes being marked with an indicator for the amount of sample required [17].

#### 2.1.9.1.2 Impact of knowledge and information on perceptions of the value of testing

Knowledge about COVID-19 had an impact on the perceived value of testing, with the understanding that an individual with an asymptomatic COVID-19 infection could still transmit the infection. This was found to increase the value ascribed to testing and to be a facilitator of testing uptake [62].

### 2.1.9.1.3 Impact of knowledge and information on trust

Trust was influenced by the evidence available on POC test accuracy. Some healthcare workers were sceptical that the available evidence was sufficient or of high enough quality [61].

Their lack of confidence in the accuracy of tests was linked to the mixed body of evidence pertaining to the clinical efficacy and utility of POC tests. [61].

People also reported low confidence in the accuracy of their test results if they were unsure of whether they were conducting the sampling correctly, with implications for onward transmission [14, 15].

“

I didn't feel confident that I would have been doing it properly, if that makes sense ... Because I think, you know when you have to swab yourself, you tend to chicken out sometimes, if that makes sense? Not that you'd do it on purpose ... But you've got to think you could be carrying the virus, whether you've got symptoms or not now, haven't you?" 44-year-old female, mixed ethnicity, self-isolated [15].

Some studies suggested that trust could be built through the transparent and clear communication of information from credible sources 'about the rationale for and design of the programme, about data protection and the accuracy of the tests, and about the progress of the programme' [17, 27]. About two thirds of respondents in surveys conducted in October and November 2021 felt that they could trust information about COVID-19 from the government [6], but trust in the NHS COVID-19 app was consistently low (at about 25% of 1000 adult respondents in a YouGov survey in November 2021) [57]. People in positions of authority, such as employers or senior members of clinical staff, were suggested to have a key role to play in raising awareness and encouraging uptake of testing [1, 21].

The lack of clarity in the media about the accuracy of COVID-19 testing reduced trust in tests [13]. Negative news stories, such as coverage of a particularly large batch of faulty PCR tests, may have influenced trends in negative media recall about testing programmes [57].

There was considerable public debate in the media about the accuracy of lateral flow tests, which may have contributed to concerns. [13].

Trust in LFDs was also influenced by information received through informal networks, and 'some were wary of POC tests because of concerns expressed by colleagues'. [61].

PCPs [primary care physicians] mentioned that different forms of information-sharing between colleagues influenced their perceptions of POC tests. This suggests that PCPs' attitudes are influenced by the type of information exchanged within their professional network. [61].

### 2.1.9.2 Communication of information and guidance

Good communication was reported to facilitate engagement with testing services, and satisfaction with institutional communication was found to be an enabler of engagement with testing [26]. Good communication was described as being transparent, complete and 'motivating in content', achieved by addressing the 'sense of community' and by highlighting the logistical convenience of the testing regime [17]. It was also suggested that communication should be 'a bit more bitesized' and that infographics would be helpful [27]. Transparent information-sharing across levels in the system was considered important, both among participants in the testing programme and local and national stakeholders [17].

Some people reported that there was information missing from emails concerning testing and recommended clearer forms of communication [17].

Participants emphasised the need for open and transparent communication from programme implementers of the reasons they should register for the programme, how to go about registering and why they should stay registered. [17].

Multiple platforms could reach more people, and it was suggested to take into consideration that deprived areas with little internet use [3] and digital exclusion [20] were identified as a barrier to testing. Closely following the news media was found to be a facilitator of willingness to test for COVID-19 [52]. Around one third of people used TV as their main source of news, with another one third using news websites or apps [12]. Negative disinformation and negative campaigning on social media were reported to be deterrents to testing [41, 58].

Volunteers mentioned negative influencers who fabricated and spread stories about how having a test would mean more tier/lockdown measures. [41].

In addition to the formal channels for communicating guidelines, healthcare workers drew information from 'passive information seeking behaviour and incidental exposure', such as the exchange of information within professional networks. This included platforms such as WhatsApp or Facebook.

The information obtained from these informal sources informed their knowledge of POC testing. The type of information shared also influenced healthcare workers' attitudes to LFDs and was often 'not scientific articles and in most cases were linked to news media reports' [61].

In terms of diagnostics, people have talked about it, but I've not really seen any kind of evidence based information in those groups [social network platforms] yet about if there is one available for rapid testing. I mean, people have talked about that, posted articles which have been in the media. GP 10 [61].

This information could undermine the official guidance from authoritative sources, even if healthcare workers generally trusted the guidelines [61].

Training in how to communicate guidance was recommended, and people reported valuing the training they received [14]. Staff engagement initiatives were viewed as 'key interventions' to support engagement with testing and integration of testing processes into workflows [21]. Although healthcare workers have experience with swabbing techniques for other respiratory conditions that require nasopharyngeal sampling, 'there was a general consensus that training support would be beneficial and increase their confidence in testing' [61]. However, this would need to be delicately implemented as healthcare workers were not necessarily amenable to training, and in one survey of senior dental clinicians, 64% said that they would not want training on swabbing [21].

“

All the people that work in the practice can take blood and do swabs, and quite a lot of us do respiratory stuff, spirometry and other breathing things. With simple training, we should be able to manage a point of care test that is simple, and it's making sure it can be done repeatedly and accurately. GP 16 [61].

Training and information dissemination also increased motivation to protect an individual's community [17], while information about the experiences of others had the potential to influence engagement with testing services [32].

In some cases, people shared their negative experiences on social media, for example around queues, disorganization, or delays in getting results; this may have influenced others' decisions in regard to getting a test. [32].

School and university students who took part in more interactive education activities reported 'understanding more about the science involved in managing the pandemic', which in turn increased their motivation to engage with testing and protect their communities [17]. It was also suggested that 'a "toolkit" of instructions and tips for those implementing the programme [would] help manage the expectations of both staff and participants' [17].

Communication from trusted people was reported as a key facilitator of testing [3]. Having 'testing champions' also helped to convey information between students taking part in a testing programme and those who were organising it. This helped clarify the boundaries of what behaviour was acceptable [27].

“

We had champions recruited to help and I think they were great because...it's very important to know what's the view on the ground from their perspective and having those testing champions was a fantastic link to be able to understand what was going on from the students' point of view. I, S8 [27].

Involving voluntary, faith and community sector organisations in the dissemination of public health information to migrant communities was also suggested to be a useful strategy [4, 20, 63]. Information should be framed to avoid culturally specific aversions to 'being told what to do', which was described as a sentiment among migrant workers that led to hesitancy to test for COVID-19 [59, 60]. Migrants tended to rely more on social media and networks for information, as official sources were mainly in English; translation of information was therefore helpful but needed to be accessible and searchable [59, 60].

One study outlined that 'although it may be tempting to use fear-based messaging' that built on the worry people described about catching COVID-19 and transmitting it to others, fear-based messaging should not be used as it may undermine other behaviours that the government wants to encourage, such as people returning to work [64].

Adaptation for different needs was suggested to increase engagement with testing. Translation of guidance to other languages was recommended to increase engagement with testing services [17, 40], as language was described as a barrier to engaging with testing [42]. Translated information was described as difficult to find, particularly if the internet search had to be conducted in English [59, 60]. It was also suggested to use inclusive options for reporting gender, to increase the acceptability of reporting platforms [40]. For those with sight impairment, the 'main pain points were typically

registration, the flatpack box and the instructions booklet', as well as identifying and managing kit components by touch, but these barriers were lessened with experience of the process [65]. Therefore, those who were able to access instructions in a format that worked for them in advance of needing to conduct a test reported a better experience, with reduced anxiety and more confidence in conducting a test [65].

## **2.2 Section 2 Isolation after a positive test result**

Several themes of behavioural influences on isolation following a positive test result emerged from the evidence collected. The individual capability to isolate describes people's understanding of when, where, how and why to self-isolate. The logistics theme outlines the experience and convenience of isolating and the financial resources required to successfully isolate. The consequences of self-isolation on individuals' lives are outlined, along with the experiences and perceptions of support required. The perception of value in isolation, individuals' perceptions of risk, social factors and trust are described, as well as the influence of information on the capability and motivation to isolate. Finally, experiences specific to various settings are described, covering universal testing and equity considerations.

### **2.2.1 Individual capability to isolate**

#### **2.2.1.1 Understanding when, where, how and why to isolate**

Most people understood the guidance around isolation throughout the pandemic, correctly identifying what they were allowed to do in terms of leaving the house to go shopping, to see non-household members, for exercise or for medical reasons, and wearing a mask if leaving the house [37, 56, 66-69]. The evidence suggests that most people complied with the self-isolation requirements [56, 70], but this varied among people and over time, as well as by the level of compliance with the guidance [68].

However, there was particular confusion about whether people were allowed to leave their home to get or return a COVID-19 test, with slightly more than half agreeing that they could leave and just under half disagreeing [56, 71]. Some people were also uncertain about their symptoms, which led to non-adherence with isolation [72].

Understanding of the guidance on self-isolation appeared to decrease over time, as the regulations changed [66]. Vaccination complicated the understanding of the self-isolation guidance, although most people still felt confident they understood the rules that applied once they had been vaccinated [6], and compliance with self-isolation appeared to be similar among those who were vaccinated and those who were not [66].

A lack of understanding of the guidance was described as a barrier to self-isolation for the full required duration [68, 73], with greater understanding of the guidance among those who did self-isolate than among those who did not comply [56]. However, this was not always consistent, and many people who said they did not understand the guidance reported complying with the self-isolation requirements and having limited contact with people outside of their household [74]. Conversely, some people reported that they isolated unnecessarily because of a lack of understanding of the guidance (this was more relevant for daily contact testing) [75].

### **2.2.2 Logistics of isolation**

#### **2.2.2.1 Experience of isolation and intention to isolate**

Isolation was generally described in negative terms, and not everyone adhered to the guidance to self-isolate when required, with one study reporting that even among individuals with symptoms, three-quarters had left their home at some point [64]. However, most people (about 90% in a survey of 2783 people in late 2020 [56] and a survey of 1174 people in late 2021 [66]) were confident that they would be able to self-isolate for the full duration required and confident that they could isolate in an effective way to reduce the spread of COVID-19; however, this was lower among those who did not comply with self-isolation guidance than among those who did [56, 66].

#### **2.2.2.2 Convenience and practical challenges**

The ease of isolating was rated by most people as a 4 or 5 (with 5 being very easy) [56]. Those who complied with self-isolation reported similar levels of ease to self-isolate as those who did not comply [71]. However, it was also reported that adhering to the self-isolation guidance did not imply that people found it easy to self-isolate; some people self-isolated despite difficulties [68]. Conversely, a large proportion of people who were non-compliant with self-isolation agreed that it was easy to self-isolate [68].

Some people reported that they were already used to social distancing and that isolation was therefore not a major burden [15].



“

To be honest with you, working in the home, we've pretty much done isolation since this all began nearly a year ago. 38-year-old female, ethnicity not specified, self-isolated [15].

Many people described challenges with the practicalities of isolation, with 46% of responses in one survey (of 50 people participating in a workplace testing programme) citing practical issues as a concern [23]. Practical challenges included limited access to testing [72], unsafe or unsuitable home environments, and the practicalities of avoiding having other household members become sick [23]. They also included managing childcare and caring responsibilities [66] and the difficulty of managing multiple positive cases within a single household [76]. It appears that many people faced challenges on multiple fronts, and it was this combination of factors that was an important barrier to effectively self-isolating at home [76].

### 2.2.2.3 Financial resources required for self-isolation

Existing financial hardship was reported as a barrier to isolating [76]. In fact, financial inability to self-isolate was reported as the greatest barrier to self-isolation for some [77]. In particular, people with precarious incomes experienced financial challenges and employer issues related to self-isolation [78]. It was suggested that financial support would remove barriers to self-isolation [28], and 60% of people in a London borough-based support pilot said that financial support was the main factor that would enable them to self-isolate [77] (see 2.3.4, Need for support).

## 2.2.3 Consequences of isolation

Self-isolation was described as having economic, social, physical and emotional effects [76].

### 2.2.3.1 Consequences of self-isolation for specific aspects of individuals' lives

#### 2.2.3.1.1 Consequences of self-isolation on work and finances

People described whether they could 'afford to self-isolate' [28]; in addition to existing financial hardship being described as a barrier to isolating in the first place [76], financial hardship was also reported as a consequence of isolating, which in turn acted as a barrier to isolation compliance [1, 30, 42].

“

I think my primary concern would be, obviously everyone I've come into contact with and then also income ... a lot of student work is casual and obviously I can't be furloughed and sick-pay isn't the best with casual contracts. ID63, university student, focus group [17].

One of the ways in which self-isolation impacted individuals' financial security was through its potential for causing a loss of livelihood [1], with people reporting that they were 'likely to either lose their job or miss out on work as a result of isolating' [71]. This affected people in different ways: while two thirds of respondents in one study said they could afford the loss in income, others reported that self-isolation meant they had lost income [69, 77].

The majority of survey participants expressed concern about negative impacts on colleagues who are worried about money or losing wages (58%) or those on short term or temporary contracts (55%). [23].

Those who worked from home or had no need to leave the house were reported as being unlikely to lose money if they self-isolated [77]. On the other hand, the impact of isolation resulting in loss of income was particularly prevalent among migrant worker communities [42].

#### 2.2.3.1.2 Ability to conduct daily activities

Self-isolation reduced the ability to meet family, socialise, and engage in education, work, and other commitments [30, 40]. Self-isolation meant an inability to leave one's house (91% of 2118 survey respondents in March to June 2021), less socialising (95%), stricter use of a face mask outside the house (77%), greater use of online shopping (79%) and reduced use of non-private transport (84%) [31]. Isolation made it difficult to maintain routine domestic tasks [76] such as shopping [79].

People described a lack of control in relation to leaving their house and a lack of control over their responsibilities as reasons for non-adherence to isolation [72, 79].

During the beginning of starting hospital welfare calls, we came across an individual who was meant to be self-isolating. During the call, the case stated he was outside shopping. The case was unaware of the help that was offered by the council and therefore had gone outside to shop for food and essential items. [79].

### 2.2.3.1.3 Impact on mental health

Isolation was described as having a negative impact on individuals' mental health [15, 26, 69]. The impact that self-isolation had on mental health was a barrier to isolation and was described by some as the main barrier to self-isolation [15].

This concern was widespread, with 51% of respondents (50 participants in a work-based testing programme) reporting concern about the impact that self-isolation would have on their mental health [23]. It was reported that 'to stay isolated on your own for ten days, it's not good for anyone's mindset' [15]. About half the students in one study (of 29 international students) 'experienced feelings of loneliness, anxiety, worry, sadness, and low mood when they learnt they had to self-isolate' [80].

“

I think mental health was like my biggest challenge. It was very easy to just feel down and not wanting to do things, not feel motivated to either do work or just get out of bed. Focus group 8, student 5 [80].

Isolation had multiple effects on mental health. Many people in isolation struggled with boredom [76]. Students in self-isolation felt that they no longer had access to their normal coping mechanisms and activities that 'would normally help them to de-stress, such as exercise, and seeing friends and family', and this affected their well-being [80]. It also meant 'an individual being excluded from social events for the isolation period' [40]. Mental health was also impacted by anxiety over finances, and people with precarious incomes in particular experienced mental health challenges related to self-isolation [78].

However, mental health concerns were also seen by university staff as an excuse [33].

“

Almost 100% of those students who were found to repeatedly breach Covid rules, and their letters of appeals to the registrar, cited severe mental health problems as a reason to not adhere to the rules ... and actually we found that almost 100% of the students didn't have significant mental health problems. Staff interview 17 [33].

On the other hand, some individuals found the time in self-isolation gave them a chance to 'engage in new hobbies, talk to family and friends by phone or online' [80]. People also described a positive consequence of self-isolation as making them appreciate their usual lives, as they found that their time in isolation 'fostered a sense of gratitude once self-isolation had ended' [80].

In several cases, students adopted a positive outlook about self-isolation. These students felt appreciative of their normal, everyday lives, and for some, isolation fostered a sense of community with others in the same situation. [33].

### 2.2.3.1.4 Impact on physical health

Isolation was also described as detrimental to physical health, as individuals who did not have alternative support structures could not access required medication [80]. Additionally, self-isolation meant that accessing healthcare was more difficult than usual [40].

“

I tested positive-I myself can't go and I don't have anyone that can pick it up for me and they didn't find a way to send it to my house, so for those two weeks I could not — I didn't have my medication. Focus group 8, student 5 [80].

### 2.2.3.1.5 Impact on household members and other people

People were concerned about the impact their self-isolation had on others [26] and felt guilt about letting others down [2]. In one survey, 60% of respondents (50 participants in a work-based testing programme) were concerned about the impact self-isolation would have on their households, and this was the top reason for concern about self-isolation [23].

People isolating were also concerned about making the other members of their household sick [23]. Others noted concerns that isolation would prevent them from performing their usual roles at work, placing an additional burden on colleagues [30]. Some individuals with caring responsibilities were concerned about the impact their isolation would have on those they cared for [2, 76].

“

I'm a carer for vulnerable adults and would be worried about them receiving care that I could not give if I was isolating. (survey) [23].

### 2.2.3.2 Management of the decision to isolate

Despite motivation to take actions that supported the public good, people needed to weigh up the consequences of self-isolation, i.e., weighing up the benefit of isolation on transmission with their need to perform various activities, to minimise the impact of self-isolation on their lives [15].



You're really fed up of being inside, but at the same time you think if there's a chance that I could be going out too early and spreading it people, of course you don't want to do it. It was a difficult call. (19-year-old female, white, self-isolated) [15].

The impact of isolation also encouraged people to lie about symptoms or hide that they had COVID-19, 'because they cannot afford to stay home' [81].



People are not ... willing to say, oh I've got symptoms, cuz [because] of fear that people are not gonna [going to] come near them, but they would talk about other people, other stories. P7, Asian/British Asian, community service provider [81].

One study noted that the impact of self-isolation on certain groups in society, such as those who are homeless, misusing substances or involved in the criminal justice system, may have been different from that on the wider population and influenced their decision to isolate. They noted that these individuals' circumstances may have made self-isolation more difficult to manage [40].

### 2.2.3.3 Impact on organisations

Organisations were concerned about the impact that identifying positive cases would have on workers taking time off work and subsequently affect staffing numbers [4].

## 2.2.4 Need for support

A lack of support was described as leading to basic needs not being met [80], which led to people breaking their self-isolation to meet these needs [72, 80].



I tested positive — I myself can't go and I don't have anyone that can pick it up for me and they didn't find a way to send it to my house, so for those two weeks I could not — I didn't have my medication. Focus group 8, student 5 [80].

It was suggested that some of the negative consequences of testing could 'be mitigated through the support that was available in the Test and Protect system and Local Authority support measures' [40] and the entitlement to sick pay [3], and that additional support would facilitate adherence to self-isolation requirements [17, 70].

Support was described as particularly important for 'younger people (aged under 30), those with precarious incomes and women' [78], as well as people 'living alone or without existing social connections established in the community' [80].

It was suggested that any support should be personalised, tailored to an individual's specific challenges [17]. For students taking part in one university-based testing programme, most (73% in a survey of 80 people) were at least somewhat satisfied with the support they had been given [27]. However, it was stated that this support had to be clearly communicated and accessible [33]:



I really liked the university doing was they had a lot of sessions about kind of mental health, but one of the problems is you had to search for them, or they were hidden in the, halfway through an email, so it wasn't that the university hadn't provided it, it was that kind of, it was there but you have to go and find the necessary links and kind of do it. FG2, S7 [33].

### 2.2.4.1 Financial and practical support

#### 2.2.4.1.1 Need for support and its impact on compliance with self-isolation

In a London borough-based pilot of additional support for isolation, 60% of isolating participants reported receiving financial support and 40% reported receiving practical support (e.g., shopping, dog walking or collection of medication) as the main enabling factors that supported compliance with self-isolation [77]. Thus, it was suggested that support should be government funded and include financial support, food, medical supplies and other practical support [17, 72].

The Test and Trace Support Payment Scheme was announced in October 2020, to provide financial support for certain groups who were isolating [82]. Support from the community and those outside of an individual's household was also instrumental in helping to 'run errands [that reduced] the need for [people] to leave home' [64], fostering a sense of community [33].

However, the scheme did not consistently improve compliance with isolation [71, 83]. Most people reported that they did not receive financial support when isolating [66]; expanding eligibility for the Support Payment scheme was suggested as a way to increase compliance with self-isolation. This seemed to have mixed effects, with one study in Bradford finding that it was an enabler of self-isolation [45], while another pilot study of the Test and Trace Support Payment scheme conducted in London did not find that relaxation of eligibility criteria for financial support improved compliance with self-isolation, even if it improved engagement with testing in the first place [43].

#### **2.2.4.1.2 Uptake of support offered**

Applying for the Test and Trace Support Package was challenging, as it was lengthy and the process was bureaucratic: eligibility criteria were described as overly stringent and awkward and administrative processes inconsistent and complex [44, 84]. This reduced access for applicants and those using the service [82, 84]; expanding eligibility did not seem to consistently facilitate applications for the scheme [44, 45].

It was also reported that there was limited awareness of the Support Payment scheme and options available for practical support [84], such as council support for shopping and essential items [79]. Those who were aware of the scheme found out about it by 'serendipity' [82, 84]. This led to a low proportion of eligible people applying for support [82, 85] (just 8% of those testing positive in one study [86]). It was suggested that the scheme should be advertised in wider communications and signposted through support call-handlers [84], with evidence that proactive contact of potentially eligible people facilitated uptake and compliance [87].

#### **2.2.4.1.3 Mental health support**

There was a demand for mental health support [17]. Support for mental health mitigated some of the negative consequences of isolation on mental health, and people appreciated the options that were made available to them, for example through universities [33]. Welfare check-in calls were appreciated, particularly for their speed of response, and people reported that these calls made a difference to their sense of well-being [76]. These support calls supported compliance with self-isolation much more than receiving texts did [88].

Activities to support people and distract them were suggested, after students reported 'using distraction as a primary tool to help cope with being in isolation' [33].



I think that what the university wants to say is that it's important to self-isolate, so, and it is also an incentive for them to self-isolate for all the period, not only for the few days and maybe you've got your fever is just disappeared and you're young and so you want to go out. Giving them something to do for seven days, ten days makes them maybe feel that it's really important to do that and it's also an incentive. Staff interview 1 [33].

However, the support that was provided was not always appreciated, with some people describing the numerous support calls that they received from NHS Test and Trace if they had tested positive as 'overbearing' [17], unreliable and of poor quality in terms of comprehensiveness [76]. Receiving too many support calls was noted to be a barrier to testing [3].

## **2.2.5 Perception of value in complying with isolation requirements**

The majority of people isolating (2783 in one survey conducted in late 2020) said that it was very important to follow the isolation advice [56], and three quarters of people in one 2022 survey said that they would continue to isolate even if it was no longer a legal requirement for people who had received a positive COVID-19 test result [37]. Self-isolation was valued for its ability to prevent transmission and protect others [15] and appeared to be a stronger motivator of adherence to isolation than the perception of personal risk [62]. Understanding that asymptomatic COVID-19 can be transmitted was found to be a facilitator of self-isolation while waiting for test results [62], as people were particularly worried about 'the possibility of spreading the virus to others whilst they waited for a test result' [17]. This desire to protect others was suggested as a lever for communication of guidance [62]:

Results suggest that a desire to protect others may be a more fundamental driver of behaviour during the COVID-19 pandemic. Messaging promoting that completing protective behaviours will keep others safe may promote adherence. [62].

However, there was a disconnect between the compliance with self-isolation and the claimed willingness to self-isolate [12]. Additionally, some people felt that there was no benefit to isolating or following the rules, with some reporting it to be a 'waste of time' [12]. This acted as a barrier to adhering with isolation [72]. Low perceptions of risk reduced the perceived value of isolation: some people did not see the value in self-isolation as they did not consider themselves at risk, due to low-risk contact, vaccination or the use of infection control measures. However, this was more applicable to those self-isolating after a positive contact rather than self-isolating after a positive test [89].

## 2.2.6 Influence of the perceptions of COVID-19 risk on compliance with self-isolation

Perceptions of vulnerability to COVID-19 were described as a driver of adherence, with worry linked to incidence [64]. While people's compliance with isolation appeared to be more aligned with their perceptions of risk to the broader community than to personal risk [62], people who complied with isolation guidance still had greater perceptions of personal vulnerability to COVID-19 than those who did not comply [56]. People described being very cautious, particularly early in the pandemic, which facilitated self-isolation [15]. Some felt that the isolation guidance for double-vaccinated individuals was inadequate to keep the public safe, and most described additional measures they took beyond governmental guidance [6].

“

Looking back at it now I felt like I could have done a little bit more, but I was just being precautionary. I only was still going out where I needed to go because for me, it was like even though it's a negative I felt like I still could get it the next day. Even though the test was negative that day, that's not to say that the next day it would be negative. I think that I just felt that I needed to take those extra steps just for my own peace of mind and to make sure that they would be safe. 30-year-old female, ethnicity not specified, consented to testing [15].

People's perceptions of risk and the influence on self-isolation behaviours in turn appeared to be related to their perception of the likelihood of having COVID-19: if it was clear that they had COVID-19, they reported greater compliance with isolation. A greater number of people supported self-isolation if they tested positive (89%) than if they had symptoms (85%) or were a contact of a positive case (71%) [18]. People reported being more likely to isolate if they were symptomatic (84% in January 2021 and 73% in November 2021) than if they were told to by a contact tracer (75% in January 2021 and 65% in November 2021) [57]. People reported not isolating if they were not overtly ill, as they felt it was unnecessary [29, 38].

“

I think not all students take it equally seriously, and I think that's the main thing is that a lot of them just kind of don't see the point, and there's also a lot of misleading information that young people are less likely to get covid badly. FG3, S1 [33].

This has important implications for the asymptomatic testing programme, with people required to isolate only if they test positive (a high likelihood scenario). Concerns that symptoms of COVID-19 were a facilitator of testing, and that asymptomatic testing would therefore not support isolation compared with symptomatic testing, were also not supported by the experience with the mass testing programme [90]. In fact, one study reported that surge testing seemed to be an enabler of compliance with self-isolation [44].

## 2.2.7 Social influences on isolation

Authority had an influence on compliance with self-isolation, with most people (of 2783 people isolating) towards the end of 2020 supporting legal requirements to isolate and legal enforcement of compliance with isolation guidance [56]. However, people's likelihood of complying with self-isolation if told to by a contact tracer decreased over time, with a decrease from 75% (of YouGov survey respondents) agreeing in January 2021 to 65% in November 2021 [57].

People perceived that others had high levels (more than 90%) of compliance with self-isolation towards the end of 2020, but consistently perceived that their friends and family complied better with isolation than the public [56]. Demonstrating via public communications that compliance with self-isolation was the norm and that many people were following the guidance was suggested to facilitate isolation [91].

## 2.2.8 Trust

Distrust in the government was described as a barrier to self-isolation [72]. Trust in the information from the government and the measures it was putting into place to protect the public varied among people and over time, with roughly half of respondents (2783 people required to isolate in late 2020) agreeing or strongly agreeing with government information and measures [56, 66].



A proportion (less than 10%) of survey respondents (965 people required to isolate) were not confident that their details would be handled securely by NHS Test and Trace once they tested positive. This number appeared to decrease over time throughout 2020 but was higher (some weeks more than 15%) among those not complying with self-isolation guidance than those self-isolating when required [56].

## **2.2.9 Influence of information and communication on the capability and motivation (including perception of value and trust) to isolate**

### **2.2.9.1 Information and perceived value, trust, and social influences on isolation**

Providing insight into the importance of compliance with self-isolation, demonstrating that it was the norm and that many people were following the guidance, and reinforcing trust in the government and NHS programmes, were recommended as priorities for communication to the public [91]. It was suggested that adherence to self-isolation would be supported through 'strengthening perceived benefit to self-isolate with messages emphasising its effectiveness' and by 'implementing a two-way information system to support symptoms identification' [72]. It was also suggested that the desire to protect others should be brought into messaging when communicating guidance related to self-isolation [62].

### **2.2.9.2 Communication of information about isolation**

Most people (about one third) reported that the need to isolate was communicated to them via a text from NHS Test and Trace, followed by a quarter who received this information by phone [56]. Good communication was described as an enabler of compliance with isolation [44], and the desire to protect others was recommended as a focus for communication of guidance that could increase engagement with self-isolation [62]. Providing written information in different languages was suggested by people isolating as being an enabler to understanding the information shared with them [76]. It was also suggested that the availability of practical support, such as the core and discretionary Test and Trace Support Payment Schemes, should be advertised more widely, to increase uptake and thus facilitate compliance with self-isolation. Call-handlers should also be supported to offer more signposting to these sources of support, again to encourage uptake [84].

The welfare check-in calls made to individuals while they were isolating had the effect of increasing people's knowledge [76]. However, people were frustrated that data were not managed efficiently, and messaging was described as uncoordinated [17]:

Those who had experienced a positive test result asked for more efficient data management by the testing programme, NHS Test and Trace and their general practice, and more coordinated messaging. [17].

## **Section 3 Programme-specific findings**

### **2.2.10 General programme findings**

#### **2.2.10.1 Value of data to make decisions**

The 'value of having data on infection to manage outbreak hotspots' was seen as a value of the testing programme by administrators of schools, universities, and general practices [17]. Individuals also saw the value in detecting cases early to contain outbreaks quickly:

“

And then with the testing twice a week I suppose if there was a case it would be caught more quickly and then if there was an outbreak it could be contained quicker as well. FG2, S2 [27].

#### **2.2.10.2 Delivery of support programmes**

Pilot studies that had dedicated resources and could 'hit the ground running' were described as an enabler of delivering support. Mobilising housing, environmental health and other parts of the system that did not have dedicated capacity was more difficult [87]. Delivery of support was facilitated by the ability of those providing the support, such as those handling welfare calls, to work in a coordinated way and engage in collective action [76]. It was also suggested that support programmes should be flexible in how they are delivered to respond to the dynamic nature of a pandemic, as the target audience and industries evolve over time. The referral model and the target population must also be adapted as the needs change [87].

#### **2.2.10.3 Reaching disadvantaged groups for service delivery**

One route to accessing vulnerable individuals was to use services that already provide other care for them, such as the Public Dental Service, which is the main provider of dental care for individuals who are homeless or incarcerated [40]. It was suggested that different channels for accessing test kits (e.g., pharmacy, ordering online, testing sites) are more likely to reach certain groups of interest, and that the removal of options would disproportionately affect some groups' willingness to test [7].

Involving voluntary, faith and community sector organisations in the dissemination of public health information to migrant communities was suggested as a useful strategy [4, 20, 63]. Information should also be framed to avoid culturally specific aversions to 'being told what to do', which was described as a sentiment among migrant workers that led to hesitancy to test for COVID-19 [59, 60]. Migrants tended to rely more on social media and other networks for information, as official sources were mainly in English; translation of information was therefore helpful but needed to be accessible and searchable [59, 60].

## 2.2.11 Experience of the delivery of community programmes

### 2.2.11.1 Understanding the guidance

Confusion about guidance was not limited to routine asymptomatic testing programmes. Similar programmes, such as daily contact testing, also faced confusion about the guidance [15].

“

There was a bit of confusion over what they were allowed to do, what they weren't allowed to do, and you've got two security people, you've got university security, you've got [company name] and I'm not sure they were always on the same page and I'm not sure security was comfortable with going in and dealing with stuff. I, S4 [27].

### 2.2.11.2 Logistics

The cost of testing was reported to be an important characteristic of the tests [22], and the programme's cost effectiveness was described as a benefit [17].

Time constraints and the requirement to deliver testing programmes rapidly were reported as one of the main barriers to the delivery of testing programmes by COVID Community Support Officers:

“

If they had more time, they could of been a bit more organised ... sometimes we didn't know who was coming to work on that day ... some staff said they had there other jobs to do that day [or they said]: "I can't come in tomorrow I've got my other job ...", and we were like: "okay we need to find somebody else". If we had known in advance, we could [have] organised the staff to certain days. Internal participant 3 [44].

However, COVID Community Support Officers reported that the programme organisation was generally 'supportive, structured and engaging' [44].

“

I think they supported us quite well ... they were constantly there for us, for example if I was out and about and I ran out of testing kits or leaflets or something like that [they would help us] ... and they would get us whatever we need ... [it was] structured, if somebody had a problem, they would tell me as [job title] and I would escalate it to my supervisor ... we all knew how to go down the line, how to deal with it. Internal participant 3 [44].

## 2.2.12 Experience of the delivery of asymptomatic patient testing programmes

### 2.2.12.1 Understanding the guidance

Healthcare workers generally understood the guidance of when and how to test, but this was not universal. A study surveying dental nursing staff in Scotland who were providing asymptomatic COVID-19 testing to patients reported that staff felt ambivalent about their understanding of the project, with the response of 'I don't know enough about the project' scoring moderately (5.6/10) as a barrier to offering testing; however, they did seem to understand the eligibility requirements, as 'I don't know what the inclusion criteria [are]' scored low (3.8/10) as a barrier to testing [21]. Some healthcare workers also had some trouble with the testing procedure: in one study, a 'lack of confidence' was the second highest-scoring barrier (7.6/10) to nursing staff providing asymptomatic COVID-19 testing to patients, with 'I haven't been given the opportunity to be involved/trained' also scoring highly [21].

### 2.2.12.2 Logistics of delivering asymptomatic testing

#### 2.2.12.2.1 Experience of conducting a test

Healthcare workers expected tests to be uncomfortable for patients and expected them to refuse to do them [22].

### 2.2.12.2.2 Programme costs

The cost of testing was reported as an important characteristic of the tests [22], while the programme's cost effectiveness was described as a benefit [17]. It was suggested that subsidising testing or making funding available to help accommodate it would be necessary to facilitate the uptake and delivery of testing programmes [61]. Healthcare workers in particular pointed out the need to fund the costs (including the costs of test kits and employee time) of integrating asymptomatic testing into healthcare practice patient-care pathways, to avoid '[threatening] the sustainability of primary care' [61]:

PCPs [primary care physicians] anticipated that implementing POC [point of care] tests would threaten the sustainability of primary care if funding was not made available to accommodate the changes. [61].

### 2.2.12.2.3 Convenience

Most healthcare workers felt that routine asymptomatic testing of patients for COVID-19 using LFDs was feasible [22]. For healthcare workers implementing routine asymptomatic patient testing, 'not having enough time' scored the highest (8.8/10 for senior dental clinicians and 8.9/10 for nursing staff) as a barrier to providing asymptomatic COVID-19 to patients [21], with 'operational logistics', including the time taken to test and follow up a result, cited as a concern by staff [34]. However, in one survey of 44 maternity healthcare workers, staff managed to test most patients if they were admitted overnight [34]. This appeared to come at the cost of accommodating additional work in an already busy work schedule, with delays resulting from the finding and use of PPE as well as the process of administering a test and awaiting the results [22]. This 'prompted some strong, negative responses', with the perception from some healthcare staff that COVID-19 testing was just 'something else to do' in an already busy role [22] and would add to existing work pressures [61].

“

But it's been a case of collating the packs for staff, you know, using our time to do that. Creating emails for internal staff to say actually we are going to summarise the booklet ... it's been a bit time heavy. ID09 GP representative, interview [17].

Healthcare workers in particular valued efficiency and convenience in providing routine asymptomatic testing to patients. Having a time to result of less than 30 minutes was described by healthcare workers as one of the most important test characteristics, alongside accuracy, that would influence adoption into clinical practice. Ease of sample acquisition, room temperature storage, size of kits for storage, appropriate location for testing and minimum staff exposure time were also noted as important characteristics [22]. Healthcare workers suggested that accommodations to existing workload and resources (including staff and space) would need to be made to create capacity to integrate routine asymptomatic COVID-19 testing [61].

“

If we're adding something new in ... say there's no new money, which too often isn't, something else has to be taken away. It's just not feasible to carry on doing everything and add in an extra thing. GP 04 [61].

The method of sample collection had an influence on feasibility, with healthcare workers reporting finger-prick blood sampling, followed by nasopharyngeal swabbing then saliva sampling as the most convenient [22].

In implementing routine asymptomatic testing of patients in a healthcare setting, it was suggested that this role should be task-shifted to healthcare assistants:

“

I think it'd have to be a health care assistant specifically trained up to do that ... it's a skill that needs to be learned, but it's quite a simple one. You need someone who's focused on just that one problem. GP 15 [61].

Inferences can be made about other settings where testing programmes are integrated into existing service provision or processes, such as university or workplace testing. This was echoed by senior representatives of school, university and general practice organisations, who were clear 'that the programme gave their staff added responsibilities and added to their workload' [17].

### 2.2.12.3 Consequence of the testing programme on staff workload and patient care

Healthcare workers offering routine asymptomatic patient testing reported that a consequence of the testing programme included an increased workload, longer patient appointments due to the additional time required to test, and additional staff responsibilities [22, 40].

Some healthcare workers also appeared concerned that offering routine asymptomatic to patients would result in a 'misuse of service', with society viewing primary care or ambulance services as a convenient 'a means of rapid testing', as an alternative to community testing or other existing options [22, 61].

“

If testing were to be carried out by ambulances, attempts should be made to keep this away from public knowledge. IC97 [22].

Healthcare workers described concern that ‘their professional identity would change in the eyes of the public if society began to view primary care as an alternative to community testing centres’ [61] and that testing asymptomatic patients would increase demand on services, reduce efficiency and have resource implications in terms of time and staff and staff costs from salaries [22, 61].

It could also result in ‘consequences to care’ such as knock-on delays to service provision [22]. The impact was described both for patients, who could experience delays in care [22], but also on the staff and the service as a whole, such as increased workload and reduced key performance indicators [22, 61].

“

There’s a risk that we will start to get an increased demand of having a doing testing on people who are on have would fit in that category of mild symptoms and not needing a face-to-face appointment and that obviously has resource implications in terms of time and staff and staff costs from salaries. GP 08 [61].

#### 2.2.12.4 Occupational exposure

Healthcare workers expressed concerns about occupational exposure and that the requirement to test asymptomatic patients would increase their exposure time to positive patients and increase the risk of transmission to the staff member conducting the test [22, 61]. An additional layer of concern around occupational risk in healthcare workers was the implication that positive staff members would need to self-isolate and leave the service understaffed [61].

#### 2.2.12.5 Perception of value

##### 2.2.12.5.1 Value of data to make decisions

Data were valued to manage outbreak hotspots [17]. This information was also valued by clinicians to inform clinical decisions, triage patients prior to arrival at a facility, stratify patient risk for decisions on home care and differentiate respiratory diagnoses. LFDs were also valued to rationalise the use of PPE and give healthcare workers the confidence to engage with patients face-to-face during consultations [22, 61].

“

It will make us more confident in face-to-face consultations. We’ve got a huge population with respiratory illness, especially COPD. I think these are the patients who kind of have missed out on getting seen, because any respiratory symptom they have an exacerbation, we really are relying on our clinical acumen and a kind of basic saturation maximum. Because we tend not to bring them in, So, these are the kind of patients especially with respiratory symptoms, who would benefit from a rapid testing, because then we can actually see them, or the patients who have weak symptoms who we don’t know if they have got COVID or not. GP 10 [61].

However, some questioned the value in changing clinical management:

“

Why do we need to test? We treat for what we see. If someone is very ill they go to hospital, if they aren’t they could stay at home and be referred on. A COVID diagnosis doesn’t make a difference. IC94 [22].

##### 2.2.12.5.2 Impact of knowledge and understanding on value

Limited knowledge of the POC testing landscape influenced healthcare workers’ perceived value of asymptomatic patient testing, as they were ‘unable to identify the advantages or disadvantages of implementing POC tests into practice’, which was described as a barrier to their willingness to implement asymptomatic patient testing. However, this was described early in the pandemic [61].

#### 2.2.12.6 The role of authority in encouraging testing

It seemed to be felt that encouragement of participation in testing programmes should come from some form of authority. Healthcare workers in particular said they would implement asymptomatic patient testing if prescribed as part of the guidelines [61].

“

If it was recommended by Public Health England or NICE, I think we would follow the guidelines. And the problem is that they are just changing so quickly, we have to rely on you know, the sources we’ve got available. So yeah, so if I think Public Health England said to us this test is a good test. You’re all using it, and then we’d have to trust it. GP 02 [61].

Authority figures not supporting testing programmes appeared to be a barrier to staff offering testing. For example, senior dental staff not offering their patients routine asymptomatic testing or labelling patients as not appropriate for testing were described as the greatest barriers to junior staff offering testing. Junior staff also described not having the confidence to remind or ask senior clinicians to offer testing and that they were worried that senior clinicians would be annoyed if they took the time to swab patients [21].

#### 2.2.12.7 Trust

Test accuracy was described, along with the time to result, as one of the most important test characteristics for informing decision-making and particularly for healthcare workers to make clinical decisions [22]. A high level of test accuracy was a requirement if tests were to have value, particularly high sensitivity, with a threshold of 90% being recommended for clinical adoption in one study [22].

Healthcare workers were worried that false-positives or false-negatives could lead to 'inappropriate clinical decision making' [22, 61]. Concern was also raised that hospitals would rely on POC testing and not follow up with laboratory-based testing, and that because of the perceived low accuracy of tests, this would lead to continued use of inaccurate results [22]. Additional concerns were raised that false-negative results could lead to erroneous relaxation of the use of PPE [22]. This evidence was, however, from earlier in the pandemic, before people had extensive experience with LFDs.



If it is not specific enough it could lead to clinicians making inaccurate decisions about patient care. IC107 [22].

### 2.2.13 Impact of the rollout of universal testing

The intention to test increased throughout the course of the pandemic [9, 49]. This could be inferred to mean that the introduction of universal testing increased the intention to test or at the very least did not decrease the public's testing intentions.

#### 2.2.13.1 Guidance

Universal testing was scaled at the same time as COVID-19 restrictions were relaxed. This may have reduced engagement with testing, as changing guidance for other COVID-19 measures, such as the relaxation of restrictions, had an impact on testing uptake [24]. Additionally, changing guidance was considered confusing and a barrier to testing [27], so this could be interpreted as the introduction of the universal testing programme as having interfered with previous guidance on testing for existing testing services.

#### 2.2.13.2 Accessibility, convenience, and resources

Tests were considered widely available, particularly during the time of universal testing [28]. People conducting LFDs at home under the universal testing programme also reported that tests were quick and 'well easy' to perform [28]:



Do 2x simple tests and we can all move on. Zero harm, 5mins of your time ... simple (Facebook) [28].

Home LFDs were viewed as easier and more convenient than PCR testing [36]. LFD testing was also appreciated for its shorter turnaround time than laboratory-based testing [27, 35]. Rapid turnaround times were described as a key facilitator of testing [3].



Participants largely found the testing process easy and quick since the roll out of home testing kits, and one participant contrasted this with their previous experience of travelling to a central location in Birmingham to get tested. [35].

#### 2.2.13.3 Alternatives to testing centres

Attending testing centres was not always convenient [17, 27], and people expressed concern that the testing centres themselves were sites of potential infection [17]. This can be interpreted to mean that LFD testing available at home could overcome some of the barriers to testing for COVID-19 that testing centres represented.

#### 2.2.13.4 Peace of mind

Having LFDs that could be conducted at home gave reassurance of a result before leaving home [31], and the ability to quickly confirm a positive test at home was an unintended benefit that was greatly appreciated [15]. Widespread testing was described as giving people peace of mind that the pandemic was being addressed [53]; while this statement was made in relation to university testing services, it has relevance for the universal testing service, which scaled the availability of tests.



### 2.2.13.5 Consequences of testing

The environmental impact of the 'excessive' test kit packaging acted as a barrier to testing, especially during the universal testing period, and 'led to some individuals not wanting to get tested due to the amount of waste the tests will produce' [28].

### 2.2.13.6 Perceived risk

People were more likely to test for COVID-19 if they had symptoms than if they were asymptomatic, as a lack of symptoms made people feel that they were less likely to have contracted COVID-19 [55]. This did not appear to change with the introduction of universal testing, as people's reported likelihood to test appeared to be fairly consistent throughout 2021 [57].

The timing of universal testing being rolled out alongside the vaccination programme may have impacted the uptake of testing, as people described the vaccination campaign as undermining the necessity for testing, both as an alternative to testing to protect the population and because the resulting reduced transmission and severity would negate the need for regular asymptomatic testing [28].

### 2.2.13.7 Trust

The rollout of universal testing did not in itself increase trust in the tests, as people described mistrust of 'the accuracy of the test and lack of trust in stakeholders involved in the delivery of mass testing, such as national and local government, scientists, and Test and Trace' [32].

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## 2.2 Statistical methods

### Estimating COVID-19 case incidence from prevalence time-series

We assumed the following relationship between COVID-19 prevalence (henceforth 'prevalence'; where an individual was defined as infection-positive if their infection was detectable via PCR and COVID-19 infection incidence (henceforth 'incidence'), with both measured on the same scales:

$$\theta_t = \sum_{\tau=1}^{\infty} \omega_{\tau} i_{t-\tau},$$

where  $\theta_t$  denotes prevalence on day  $t$  and  $i_{t-\tau}$  is the incidence on the same day;  $0 \leq \omega_{\tau} \leq 1$  is the probability of being PCR-positive given an infection that began  $\tau$  days ago.

If the set of probabilities denoting PCR positivity  $\{\omega_{\tau}\}_{\tau=1}^{\infty}$  were precisely known, the above equation provides a linear system that can be inverted to determine an incidence time-series  $\{i_t\}_{t=1}^T$ . However, these probabilities are typically determined by using regular testing data from individuals whose date of exposure is known or can be determined with a degree of certainty [1]; these

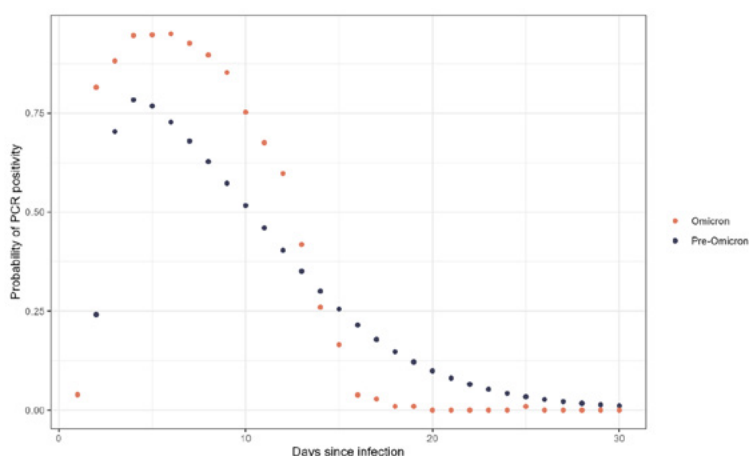
probabilities also likely changed throughout the course of the pandemic with the introduction of novel COVID-19 variants [2]. To account for these imperfections in our knowledge of  $\{\omega_{\tau}\}_{\tau=1}^{\infty}$ , we assumed a probabilistic relationship between incidence and prevalence of the form:

$$\theta_{\tau} \sim N(\sum_{\tau=1}^{\infty} \omega_{\tau} i(t-\tau), \sigma),$$

where  $N(\mu, \sigma)$  represents a normal distribution with mean  $\mu$  and standard deviation  $\sigma$ ; here, we assume that the  $\theta_{\tau}$  were independent random variables, which would likely be violated in the presence of substantial autocorrelation in the misspecification of  $\{\omega_{\tau}\}_{\tau=1}^{\infty}$ ;  $\sigma$  is estimated and characterises the degree of imperfections in our model.

### PCR positivity over time

For the pre-Omicron period (defined in our analysis as the time period before 15 December 2021), we extracted the median posterior PCR positivity (cycle threshold Ct value < 37) up until 30 days since infection from Hellewell et al (2021) [1]. We then updated these using the raw estimates of the probability of PCR detection at given times since the first detection of the Omicron variant of concern, from Hay et al (2022) [2]. As these Omicron estimates represented time since detection opposed to infection, we crudely shifted the Omicron estimates by one day forward and used Hellewell et al's [1] day one estimate of PCR detectability. Figure 1 provides a comparison between the two profiles of PCR detectability up until 30 days since infection.



**Figure 1: Temporal PCR-positivity corresponding to time since infection.** The dark blue and orange points represent probabilities before and after 15 December 2021, respectively. PCR positivity is defined as a Ct value of less than 37.

### Prevalence estimates

Our approach required knowledge of prevalence to estimate incidence, and we used two sources for prevalence estimates, which provided us with separate estimates of national incidence throughout the evaluation period. Using an approach that debiases Pillar 2 PCR data using REACT-1 survey data as a gold standard [3], we estimated weekly prevalence at the lower-tier local authority (LTLA) level throughout the evaluation period (see section below). Using these data, we estimated incidence at the LTLA level throughout the evaluation period, which was then aggregated to produce national incidence estimates. We also used national estimates of prevalence from the Office of National Statistics (ONS) as a comparator. Using these data, we estimated daily national incidence throughout the evaluation period. For both sources of prevalence time-series, the true COVID-19 prevalence was itself estimated with a margin of uncertainty, and we have included this uncertainty in our analysis via a prior probability distribution that links the true prevalence with that estimated. The debiasing approach of Nicholson et al. (2022) [3] estimates mean prevalence along with uncertainty bounds. We back-calculated the standard error from each of the lower and upper bounds for weekly prevalences of each LTLA produced via our debiasing method. We then took the average of these two standard errors and used it as the standard deviation of the specified normal priors for prevalence in our model. As the models we used were formulated at the daily level, we approximated daily prevalence (and its standard error) by linearly interpolating the weekly measures, which likely understates the uncertainty in daily prevalence.

### Positive COVID-19 test results data

We chose to leverage positive test results reported via UKHSA's Pillar 2 PCR data to improve the precision of our incidence estimates. Specifically, we assumed that, within 15-day rolling blocks, the reported PCR positive data were a to-be-estimated constant fraction of the incidence. As the reported PCR positive data had weekly fluctuations, likely due to reporting biases on certain days of the week, we smoothed the daily reported cases data using a 7-day moving average centred on the day under consideration.



## Official cases data

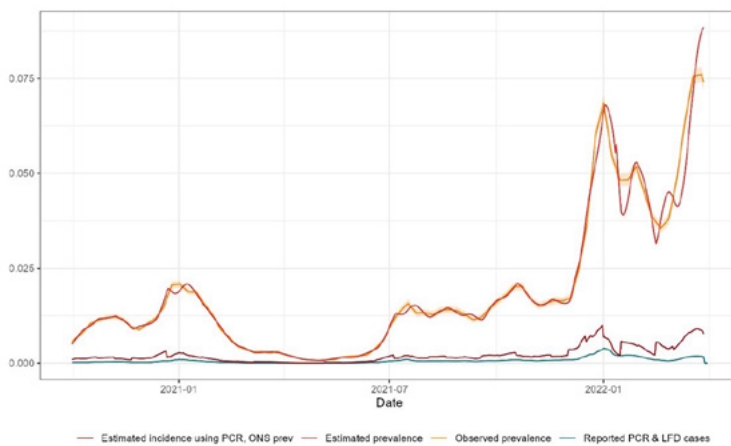
We downloaded the number of cases of COVID-19 in England as reported on the official UK government website for COVID-19 data and insights [4]. These data also showed a weekly trend, so again we smoothed them as described above. These data also showed a weekly trend, so again we smoothed them as described above using a seven day window. The models we used were formulated under a Bayesian prior, so any parameter that was estimated was assigned a prior probability distribution. With the exception of the priors on prevalence, which were highly informative (as described above), the priors on the parameters were vague. The priors on the 15-day reporting fractions were uniform between 0 and 1; otherwise, a prior of  $\sigma N(0,1)$ , constrained to be positive, was used, which was vague, as both prevalence and incidence were coded so as to be on a  $[0,1]$  scale.

## Model fitting

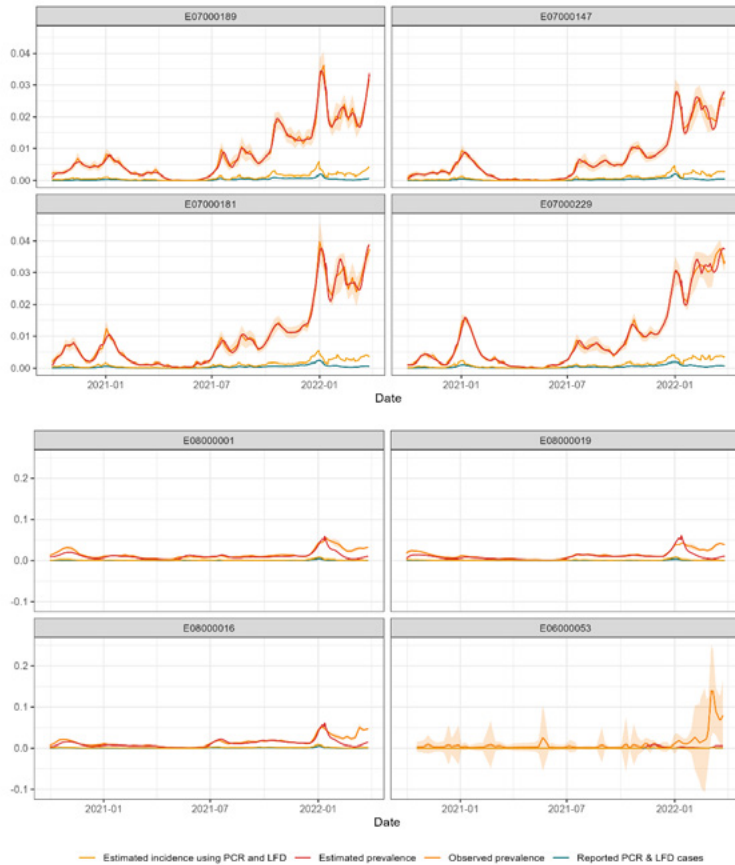
Because of the computational expense of full uncertainty quantification via Markov chain Monte Carlo, we used optimisation to fit our model to data, resulting in a single set of parameters characterising the maximum a posteriori estimates. The model was specified using the Stan language and fitted via their default optimisation algorithm [5], with the highest log-probability estimates among five separate optimisations constituting our parameter estimates. As discussed above, we produced two sets of incidence estimates – one for each source of prevalence data.

We were able to check the fit of our model to the data, by comparing the prevalence estimates determined by our model with those prevalences used to fit it. For the ONS prevalence model, this was straightforward to visualise, and the fit to the data was reasonable (see Figure 2). For the LTLA-

level prevalence model fits, we computed the root-mean-square error (RMSE) in predictions (using the central prevalence estimates from the debiased Pillar 2 prevalences). In Figure 3, we overlay our model-estimated prevalences with the LTLA-level estimates used to fit our model for the four best-fitting and four worst-fitting LTLAs. This showed that, generally, our modelled estimates were a reasonable fit to the data, although there was a general reduction in model performance during the Omicron period – due either to issues with the prevalence estimates used to fit the model or mis-specified  $\{\omega_{\tau}\}_{\tau=1}^{\infty}$  estimates.



**Figure 2: Model fit for the ONS-based prevalence model (at the national level).** Comparing England-wide estimated (red) and observed (orange and light orange for 95% confidence intervals) prevalence from ONS data. The maroon and blue curves are the Pillar 2 PCR and LFD positive tests and estimated incidence, respectively, both as a proportion of the population.



**Figure 3: Model fit for the REACT-based prevalence model at the LTLA level.** Comparing estimated (red) and observed (orange and light orange for 95% confidence intervals) prevalence for the four best-performing (top) and the four worst-performing (bottom) LTLAs, with the lowest and highest RMSEs, respectively. The yellow and blue curves are the Pillar 2 PCR and LFD positive tests and estimated incidence, respectively, both as a proportion of the population.

### Causal debiasing approach for obtaining time varying, unbiased estimates of prevalence at fine-scale resolution

Randomised testing programmes such as REACT and the ONS CIS (ONS COVID-19 Infection Survey) provide a ‘gold-standard’ measure of infection prevalence. They have large sample sizes, from across the nation, and can produce precise estimates of prevalence at the national level. At combinations of fine geographic or other scales (lower-layer super-output area (LSOA) level or LTLA level and age groups), the effective sample size is much reduced, particularly because prevalence was generally low (< 10%). However, understanding the patterns of transmission at these finer scales is crucial to determining targeted and effective intervention strategies, particularly because transmission is thought to respond to local conditions. In this section, we present a method that combines the mass PCR testing data from Pillar 2 with the REACT prevalence survey data, to produce more precise, fine-scale estimates of prevalence, without the costs of constructing a substantially larger randomised testing programme.

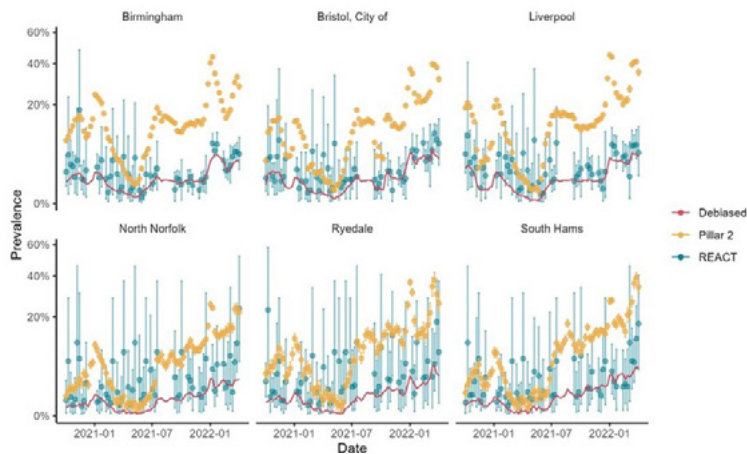
This method provides a robust statistical framework that could be of use in future public health response efforts, by providing accurate real-time estimates of the level of transmission at a fine scale, while minimising expenditure on randomised surveillance such as the REACT programme.

Additionally, these precise estimates of prevalences at LTLA level have been used in all of the service-specific analyses in this evaluation.

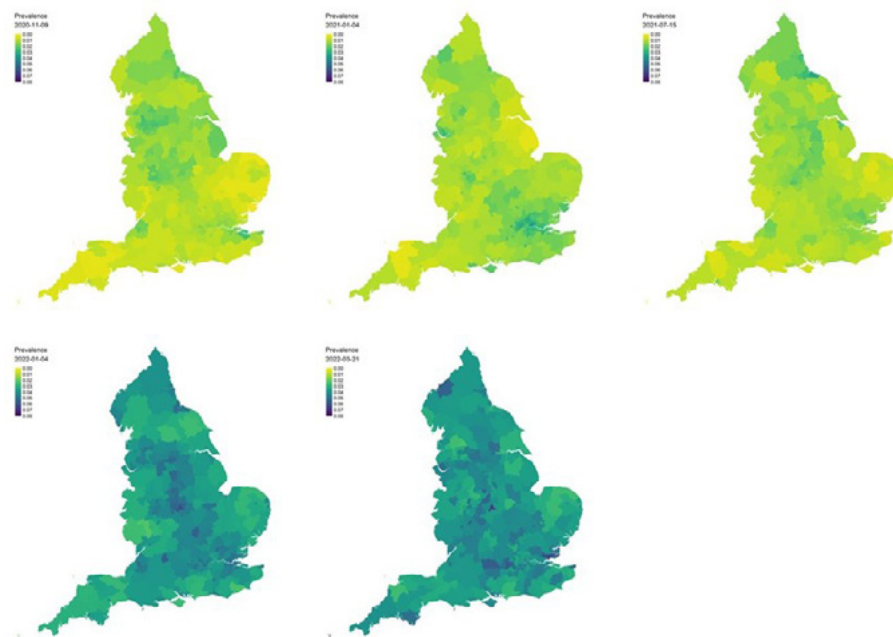
We obtained estimates of weekly prevalence at the LTLA level using the debiasing methodology of Nicholson et al. (2022) [3]. This method combines randomised surveillance data from REACT (low bias but with smaller sample sizes) with targeted PCR testing data from Pillar 2 (biased, but with larger numbers of tests). An ascertainment bias ( $\omega$ ) was estimated at the coarse scale (Figure 8 and Figure 9 with 95% credible intervals), which had sufficient sample sizes from both randomised and targeted surveillance;  $\omega$  refers to the log odds of testing in infected versus not infected individuals. We used the nine regions in England as the coarse level. This bias is then propagated to the spatial level (which has sufficient data from targeted surveillance, but not randomised surveillance) nested within the coarse levels to produce debiased prevalence estimates. This assumes the bias that

is influenced by PCR test-seeking behaviour, testing capacity, and PCR sensitivity and specificity, along with other confounding factors, is homogeneous within a given coarse level. We plotted these corrected prevalences for a selection of LTLAs, along with their corresponding REACT and PCR estimates (Figure 4).

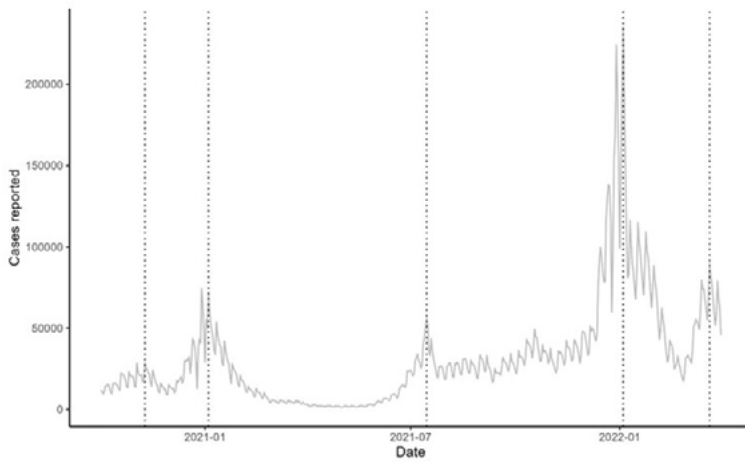
In addition, Figure 5 shows the estimated spatiotemporal prevalence at the LTLA level during weeks that had peaks in reported cases (Figure 6). These weeks also corresponded to times when particular variants were most dominant in the country.



**Figure 4: Weekly prevalence estimates for six LTLAs with the highest (first row) and lowest (second row) average weekly prevalence (from REACT).** The colours correspond to different data sources (purple = REACT, orange = PCR tests) and methods (green = debiasing method) used for estimating the prevalence. The REACT prevalence and PCR positivity are plotted with 95% credible intervals, assuming uniform priors over the proportion positive.



**Figure 5: Weekly debiased prevalence estimates at the LTLA level nested in regions for various time snapshots.** These weeks correspond to peaks in the reported cases over time and were dominated by different circulating SARS-CoV-2 variants: wild-type, Alpha, Delta, Omicron BA.1, and Omicron BA.2, from (A) to (E), respectively.



**Figure 6: Number of cases reported in England.** ‘Date’ corresponds to specimen date, as defined by the data source (source: [4]). The dashed lines shown in this figure correspond to the dates used in Figure 5 for panels A-E.

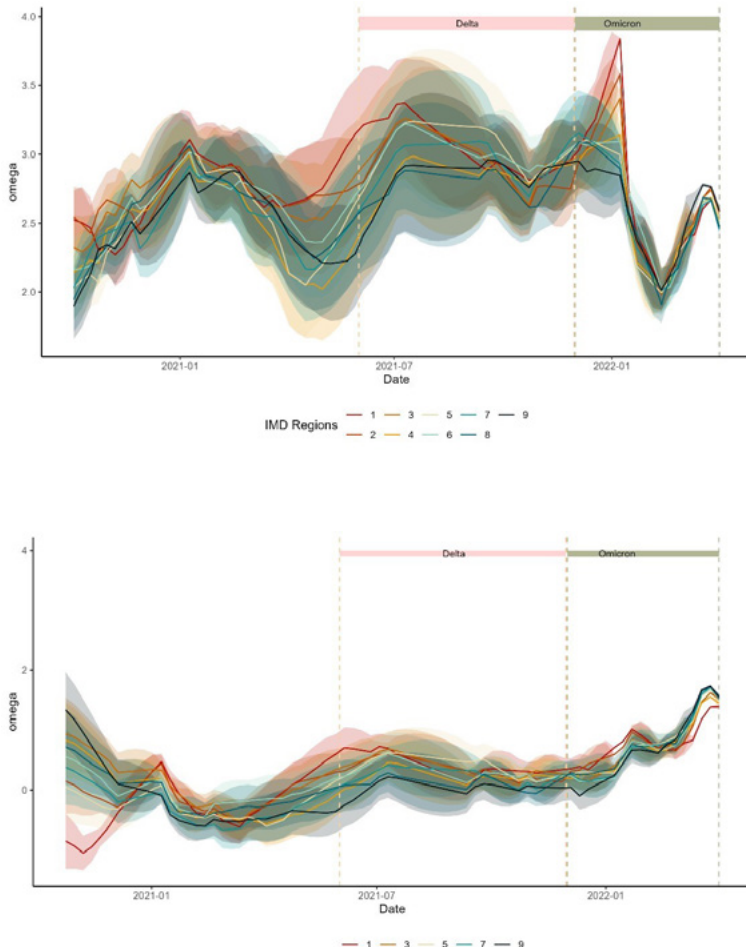
### Model comparison

The model whose results are described in section 2.9.4 involved a coarse-level grouping based on index of multiple deprivation (IMD) (Figure 2-18). This model was a moderately better fit to the data when compared with using administrative regions as the coarse level (Table 1; Figures 8 and 9 show the regional model bias estimates). We also used a coarse grouping based on both IMD and administrative regions; in doing so we used just five deprivation levels (instead of the nine used above) to ensure there were sufficient LTLAs in each category, resulting in 41 coarse groups overall. This model had the highest predictive accuracy (Table 1). In this grouping, the trends in omega were more idiosyncratic, although there were regions and time periods where omega was higher in more deprived areas. For example, during the week of 1 June 2021 (first vertical dashed line in Figures 10 and 11), the estimated odds of testing were  $\exp(3.17) \approx 23$  and  $\exp(1.89) \approx 6$ -times higher in individuals with infection compared with individuals without infection in the most deprived (IMD = 1) and least deprived areas (IMD = 5) in North West England.

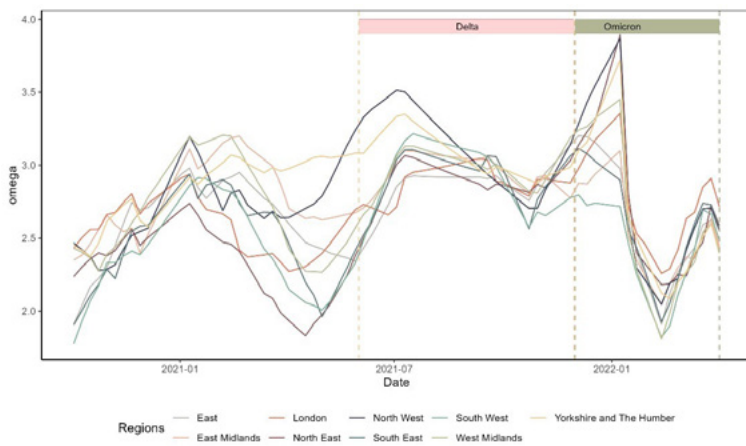
**Table 1: Log likelihoods calculated using prevalence estimates from the debiasing approach described above and the REACT positives and number of tests at LTLA level using a binomial likelihood.**

Coarse level	Log-likelihood
Five IMD regions and nine regions	-106,594
Nine IMD regions	-107,138
Nine regions	-107,330

The models were fit at the coarse level (administrative region, IMD or administrative region and IMD), meaning that the predictions made at the LTLA level were largely independent of LTLA-specific characteristics (apart from the fact they belong to the larger group). However, as the size of the coarse groups becomes smaller there is greater correspondence between the LTLA level characteristics and those of the coarse groups to which they belong. Because of this, our estimate of predictive accuracy between the model fit to 9 administrative regions and 9 IMD regions is likely to be more comparable than the model fit to 41 regions.

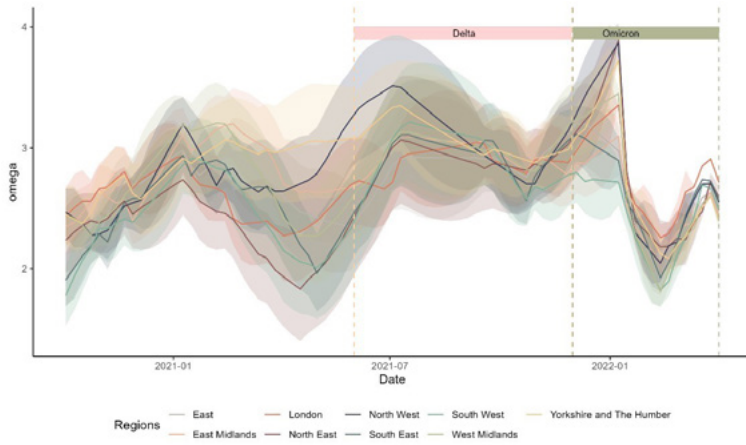


**Figure 7: Estimated mean bias, or omega, i.e., log odds of being A) PCR- and B) LFD-tested in the infected versus uninfected subpopulation by deprivation levels of England over time and their 95% credible intervals. Regions 1 and 9 correspond to most deprived and least deprived regions, respectively.**

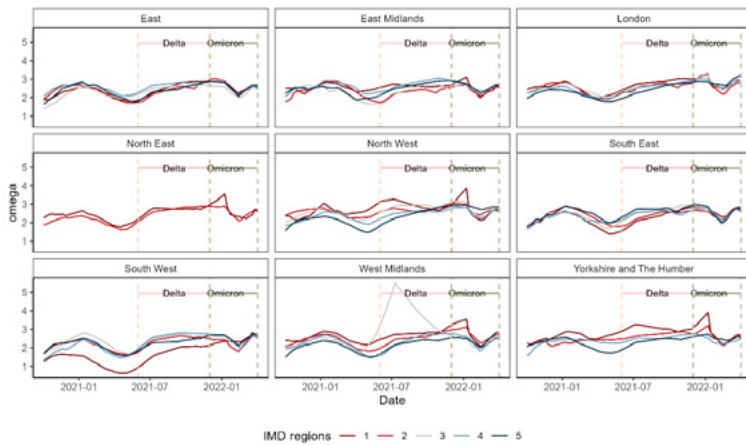


**Figure 8: Estimated mean bias, or omega, i.e., log odds of being PCR tested in the infected versus uninfected subpopulation, by administrative regions of England over time.**

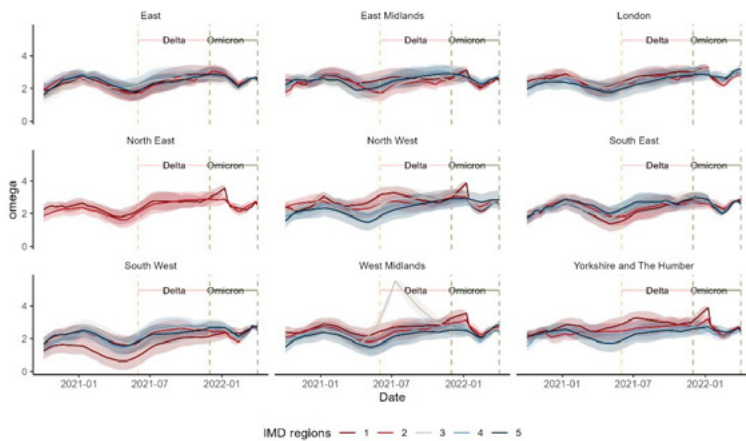




**Figure 9: Estimated mean bias, or omega, i.e., log odds of being PCR tested in the infected versus uninfected subpopulation, by administrative regions of England over time and their 95% credible intervals.**



**Figure 10: Estimated mean bias, or omega, i.e., log odds of being PCR tested in the infected versus uninfected subpopulation, by deprivation levels and administrative regions of England over time.** Regions 1 and 5 correspond to the most deprived and least deprived regions, respectively.



**Figure 11: Estimated mean bias, or omega, i.e., log odds of being PCR tested in the infected versus uninfected subpopulation, by deprivation levels and administrative regions of England over time and their 95% credible intervals.** Regions 1 and 5 correspond to the most deprived and least deprived regions, respectively.

## Impact of the universal testing rollout on LFD reporting

We tested whether IMD (where decile 1 corresponds to the most deprived) was associated with the total number of LFD tests reported before (Table 2) and after (Table 3) the rollout of universal testing (9 April 2021). This was achieved using a generalised linear model (Poisson regression), while adjusting for the population size of a given LSOA as an offset. We also adjusted for the current COVID-19 prevalence using data from the REACT study. Prevalence in the (encompassing) LTLAs was included as a variable in the regression (column (2)) as well as an effect modifier (column (3)).

**Table 2: Regression results, pre-universal testing rollout.**

	Dependent variable:		
	Number of tests reported (adjusted for population size)		
	(1)	(2)	(3)
IMD 2	0.027*** (0.001)	0.048*** (0.001)	0.080*** (0.001)
IMD 3	0.022*** (0.001)	0.051*** (0.001)	0.095*** (0.001)
IMD 4	0.066*** (0.001)	0.082*** (0.001)	0.143*** (0.001)
IMD 5	0.118*** (0.001)	0.127*** (0.001)	0.191*** (0.001)
IMD 6	0.127*** (0.001)	0.137*** (0.001)	0.207*** (0.001)
IMD 7	0.157*** (0.001)	0.163*** (0.001)	0.244*** (0.001)
IMD 8	0.188*** (0.001)	0.197*** (0.001)	0.281*** (0.001)
IMD 9	0.212*** (0.001)	0.223*** (0.001)	0.323*** (0.001)
IMD 10	0.266*** (0.001)	0.278*** (0.001)	0.391*** (0.001)
prevalence		-0.190*** (0.0002)	-0.071*** (0.0004)
IMD 2 * prevalence			-0.057*** (0.001)
IMD 3 * prevalence			-0.081*** (0.001)
IMD 4 * prevalence			-0.111*** (0.001)
IMD 5 * prevalence			-0.120*** (0.001)
IMD 6 * prevalence			-0.136*** (0.001)
IMD 7 * prevalence			-0.165*** (0.001)
IMD 8 * prevalence			-0.173*** (0.001)
IMD 9 * prevalence			-0.222*** (0.001)
IMD 10 * prevalence			-0.270*** (0.001)
Constant	-3.205*** (0.001)	-2.964*** (0.001)	-3.028*** (0.001)
Observations	567,363	412,608	412,608

Note: \*p<0.1 \*\*p<0.05 \*\*\*p<0.01

**Table 3: Regression results, post-universal testing rollout.**

	Dependent variable:		
	Number of tests reported (adjusted for population size)		
	(1)	(2)	(3)
IMD 2	0.164*** (0.0003)	0.158*** (0.0004)	0.171*** (0.001)
IMD 3	0.253*** (0.0003)	0.243*** (0.0004)	0.264*** (0.001)
IMD 4	0.368*** (0.0003)	0.358*** (0.0004)	0.388*** (0.0005)
IMD 5	0.449*** (0.0003)	0.439*** (0.0004)	0.474*** (0.0005)
IMD 6	0.503*** (0.0003)	0.491*** (0.0004)	0.532*** (0.0005)
IMD 7	0.554*** (0.0003)	0.543*** (0.0004)	0.584*** (0.0005)
IMD 8	0.593*** (0.0003)	0.579*** (0.0004)	0.624*** (0.0005)
IMD 9	0.650*** (0.0003)	0.639*** (0.0004)	0.687*** (0.0005)
IMD 10	0.748*** (0.0003)	0.734*** (0.0004)	0.788*** (0.0005)
prevalence		-0.003*** (0.00003)	0.014*** (0.0001)
IMD 2 * prevalence			-0.006*** (0.0001)
IMD 3 * prevalence			-0.010*** (0.0001)
IMD 4 * prevalence			-0.015*** (0.0001)
IMD 5 * prevalence			-0.017*** (0.0001)
IMD 6 * prevalence			-0.020*** (0.0001)

IMD 7 * prevalence			-0.020*** (0.0001)
IMD 8 * prevalence			-0.022*** (0.0001)
IMD 9 * prevalence			-0.024*** (0.0001)
IMD 10 * prevalence			-0.027*** (0.0001)
Constant	-2.932*** (0.0003)	-2.901*** (0.0003)	-2.938*** (0.0004)
Observations	1,707,888	1,092,234	1,092,234
Note:	*p<0.1 **p<0.05 ***p<0.01		

## Appendix 2.2 references

1. Hellewell, J., et al., Estimating the effectiveness of routine asymptomatic PCR testing at different frequencies for the detection of SARS-CoV-2 infections. *BMC Med*, 2021. 19(1): p. 106.
2. Hay, J.A., et al., Quantifying the impact of immune history and variant on SARS-CoV-2 viral kinetics and infection rebound: A retrospective cohort study. *Elife*, 2022. 11.
3. Nicholson, G., et al., Improving local prevalence estimates of SARS-CoV-2 infections using a causal debiasing framework. *Nature Microbiology*, 2022. 7(1): p. 97-107.
4. GOV.UK. Coronavirus (COVID-19) in the UK - Cases in England. 2023 14 February 2023]; Available from: <https://coronavirus.data.gov.uk/details/cases?areaType=nation&areaName=England>.
5. Carpenter, B., et al., Stan: A Probabilistic Programming Language. *J Stat Softw*, 2017. 76.

## 2.3 Economic methodology

### 2.3.1 Costs and volumes

#### 2.3.1.1 Data sources

Both cost and volume data were provided by UKHSA. The Cost Allocation Project (unpublished internal project) conducted by UKHSA for the ONS was used as a starting point for this work. The analysis presents the annual costs for the financial years 2020-21 and 2021-22, for the various testing technologies used. The evaluation consortium worked with staff from the relevant units within UKHSA to understand and apportion the cost and volume data (approach detailed below). Values were verified before proceeding with the economic analyses.

Testing cost data were primarily sourced from the UKHSA general ledgers. Where funds were held by another department (e.g., DHSC), these had either been transferred or were added as an adjustment to the values at the point of analysis. Values included testing costs for England's Pillar 1 NHS PCR testing, which were captured outside of the UKHSA accounts. All costs were apportioned to the various use cases for each technology based on the applicable use case volumes. Test volume data (purchased and distributed) were provided by UKHSA. All costs and volumes used in the evaluation are for England only. Line items for the devolved administrations (DAs) were removed before analysis. The DAs constituted approximately 12% of test volumes for FY21 and 16% for FY22.

#### 2.3.1.2 Financial years

Data were acquired for the financial years 2020-2021 (FY21) and 2021-2022 (FY22). As the evaluation period was from October 2020 to March 2022, only the second half of FY21 was included in the analysis. To reach the final values for the 6-months of FY21 included in the evaluation, the following methods were used:

- ▶ **Test volume data:** Monthly volume data were provided by UKHSA for LFD (purchased and dispatched) and PCR (registered) tests. These were summed for the relevant time period (i.e., October 2020 - March 2021). The vast majority of test volume was captured in the second half of FY21, therefore included in the evaluation. Of the total number of registered PCR tests for FY21, 76% were registered during October 2020 to March 2021. Of the total number of LFD tests, 97.5% and 99.9% were purchased and distributed respectively during October 2020 to March 2021.
- ▶ **Test cost data:** UKHSA provided financial data for October 2020 to March 2022. October 2020 to March 2021 comprised 98.5% of the full FY21 costs. As these data were available monthly and provided actual costs for the period of evaluation, no adjustments were needed for calculating the second half of FY21.
- ▶ **Laboratory set-up costs:** A single value for laboratory set-up costs was provided by UKHSA for each financial year. These covered set-up (build) costs only and excluded operational costs as the latter were captured in the general ledgers. For FY21, the full set-up cost was included as the laboratory was built later in the financial year. Laboratory set-up costs were a relatively small component of total PCR costs, comprising 1.6% of FY21 total PCR costs and 2.5% of FY22 total PCR costs.

- ▶ **Support payment costs:** The amount spent during the evaluation period was estimated by taking the full value of FY22 and of the actual disbursement of funds during October 2020 to March 2021 for FY21 (which comprised 84% of the total value for the full FY21 period). These values were provided by UKHSA (see Table 1 for details).

### 2.3.1.3 Tracing and isolation costs

Costs for contact tracing and surveillance, as well as all application-related costs, were included as either overhead or overhead direct costs. These costs were captured in the overall programme costs and apportioned to the three priority testing services (adult social care, schools, and healthcare). See section 2.3.1.7 Apportioning volumes and costs by service for more detail. Set-up costs for laboratories were also included, but only for the overall testing programme and were not apportioned to individual testing services.

The total costs included support payments made to individuals when isolating, through the Contain Outbreak Management Fund (COMF), the Test and Trace Support Payment scheme (TTSP) and the Practical Support Payment scheme (PSP). COMF and PSP were processed through DHSC and TTSP was processed through UKHSA. The three support payments (COMF, TTSP, PSP) were captured in the total costs for the overall testing programme but not apportioned to the three priority services.

**Table 1. Summary of support payment costs.\***

Coarse level	FY21 (October to March)** (GBP)	FY22 (GBP)	Full evaluation period (October 2020 to March 2022) (GBP)
Contain Outbreak Management Fund (COMF)	1,404,600,000	420,918,300	1,825,518,300
Test and Trace Support Payment scheme (TTSP)	143,469,700	242,543,300	386,013,000
Practical Support Payment scheme (PSP)	12,900,000	109,460,500	122,360,500
Total	1,560,969,700	772,922,100	2,333,891,800

\*Numbers are rounded to the nearest hundred

\*\*This is based on the actual disbursement of funds during October 2020 to March 2021

### 2.3.1.4 Direct, indirect and overhead costs

All costs were broken down into direct, indirect, overhead direct, and overhead costs. Staff costs would be captured across different categories (e.g., staff involved in logistics would be an indirect cost, administrative staff would be an overhead cost). These categories are defined by UKHSA as follows:

- ▶ **Direct costs** relate to the procurement of test kits and the processing of results (example cost centres include Mass Testing for LFD and LAMP, and Labs for PCR).
- ▶ **Indirect costs** relate to logistics, kitting and warehousing, and staff costs associated with delivering the tests (example cost centres include Supply & Logistics).
- ▶ **Overhead direct costs** are those not included in the above two cost-types but are driven by the testing volumes.
- ▶ **Overhead costs** are any other costs not included in the above categories. Overhead costs include the entire UKHSA COVID-19-related programme overheads, which captures the programme's various administrative cost centres and other non-test related areas such as surveillance, trace, and application costs.

### 2.3.1.5 Unit costs (per test dispatched/registered)

The unit costs per LFD test dispatched and PCR test registered were based on the values for the total evaluation period (e.g., the second half of FY21 plus the full FY22). Unit costs were calculated for the English national testing programme as a whole, as well as for each of the three priority services. The calculation is (total cost of the service for the full evaluation period)/(total volume of tests for the full evaluation period). The volume of tests for LFDs is the number dispatched, and for PCR tests is the number registered. Unit costs include the purchase price of tests, as well as all the other direct, indirect, and overhead costs associated with the programme. Unit costs for the three priority services exclude COMF, TTSP, PSP costs and laboratory set-up costs. Unit costs are volume driven.

The average unit cost was GBP 15.10 for FY21 and GBP 3.94 for FY22. This was due to frontloading of costs, the higher initial purchase prices, and the time lag between purchasing and dispatching tests. Costs are based on tests purchased whereas volumes are based on tests dispatched. Many tests purchased in FY21 were only dispatched in FY22 (64%), distorting the unit cost across the

financial-year split. To smooth out these dynamics, we present the average unit cost for the full evaluation period, not by financial year. For the full evaluation period, 90% of all tests purchased had been dispatched.

It is important to note that the total unit costs were not the same for each service (Table 2). Because of the difference in unit costs over time, the unit cost for the full evaluation period for each service depends on the point in time when tests were purchased and distributed for that service. As expected, the procurement or purchase price of the tests decreased over time. For example, for LFDs, the purchase price decreased by more than half between September 2020 and March 2022; thus, services that had a higher proportion of tests distributed later in the evaluation period would have benefited from lower purchase prices and increased technical efficiencies accrued. Although purchase prices are only one component of total unit costs, it demonstrates the reduced purchasing costs over time.

The unit costs for the healthcare testing service had the greatest deviation from the overall programme unit costs. The unit cost for LFDs in the healthcare testing service was substantially higher than other services. This is due to the fact that it had the highest proportion of tests distributed in FY21 versus FY22. In contrast, the unit costs for PCR tests in the healthcare testing service were substantially lower than for other services, as these costs came from Pillar 1, which excluded overheads only attributed to Pillar 2 testing.

**Table 2. Average unit costs for the evaluation period (October 2020 to March 2022).**

	Cost per LFD test distributed (GBP)	Cost per PCR test registered (GBP)
National testing programme	6.06	68.34
Adult social care (care homes)	6.38	78.30
Secondary schools and colleges	7.54	50.06
Healthcare workers	11.68	32.64*

\*The unit cost for PCR tests in the healthcare testing service was substantially lower than for other services as these costs came from Pillar 1, which excluded overheads only attributed to Pillar 2 testing.

### 2.3.1.6 Volumes

For LFDs, volumes indicate the number of tests dispatched (these are shown as individual tests, not kits of multiple tests). For PCR tests, volumes indicate the number of tests registered at laboratories as the laboratory costs were the main cost driver for PCR testing.

### 2.3.1.7 Apportioning volumes and costs by service

Analyses for England's national testing programme used total cost and volume data. For the three priority testing service evaluations, costs were apportioned to each service based on volumes. A limitation in this approach is that it does not account for the variation in logistics or other factors between services. However, given the structure of the financial data, this was agreed in consultation with UKHSA stakeholders as the most feasible approach. Data on distributed volumes were available for the high-level service categories: adult social care, schools and colleges, and healthcare workforce. However, as the evaluation focused on a subset of these services (care homes, 11- to 18-year-olds in secondary schools and colleges, and healthcare workers in NHS trusts), proportions were estimated. The data for tests reported had more granular categories than the data for tests distributed. Therefore, we used the tests reported data to approximate the subcategory volumes for the tests distributed. The following assumptions were made:

- ▶ **General:** There is no reporting bias across the different service subcategories. This assumes that there is no systematic difference in the reporting behaviour of subcategories (e.g., care homes versus other adult social care settings). Although this is a simplification of reality, it is a necessary assumption to be able to allocate volumes and costs by subservice as this granularity does not exist in the original data.
- ▶ **Adult social care:** The reported number of LFD and PCR tests in care homes as a proportion of the reported number of LFD and PCR tests in adult social care was used to apportion the distribution volumes and costs. The data on reported LFD and PCR tests for adult social care were well captured and categorised, with less than 1% of reported tests not assigned a category.
- ▶ **Schools and colleges:** The number of LFD and PCR tests reported under the secondary schools and colleges sub-use case categories as a proportion of the total schools or colleges use case category was used as an estimate for the proportion of tests distributed to schools or colleges that went to secondary schools or colleges. This may be an underestimate as there could be some tests reported through the universal testing service or not captured under school-related data categories.



- **Healthcare:** The proportion of tests distributed for use in NHS trusts was estimated using the Pillar 1 reported data categories linked to secondary care. The proportion of LFD tests for use by healthcare workers was estimated using Pillar 1 LFD reported data. Pillar 1 LFD data were generally well captured and categorised, with only 10% of reported LFD tests labelled as 'other' or 'unknown'. For Pillar 1 PCR test reported data, 73% of reported PCR tests were labelled as 'other' or 'unknown', making these data an unreliable source of estimates. We therefore used a value provided by the UKHSA Demand Modelling Team for the proportion of PCR tests in the NHS that were used for healthcare workers.

Table 3 shows the total cost by test type (LFD and PCR tests only) and by financial year for the England national testing programme and the three priority services described above.

**Table 3. Total financial cost of evaluated testing services in England by financial year (GBP, billions).**

	Test	FY21 (October to March)	FY22	Full evaluation period (October 2020 to March 2022)
England national testing programme*	LFD	5.71	6.35	12.06
	PCR	5.73	5.04	10.77
	Total (excl support payments)	11.67	11.79	23.46
	Total (incl support payments)	13.23	12.57	25.8
Schools (staff and pupils)	LFD	2.23	1.39	3.62
	PCR	0.00	0.02	0.02
	Total	2.23	1.41	3.64
Secondary schools and colleges (staff and pupils)	LFD	1.66	0.91	2.57
	PCR	0.00	0.01	0.02
	Total	1.66	0.92	2.59
Healthcare (staff only)	LFD	1.47	0.17	1.64
	PCR	0.03	0.1	0.13
	Total	1.5	0.27	1.77
Adult social care (all)	LFD	0.85	0.67	1.52
	PCR	1.96	1.34	3.3
	Total	2.81	2.01	4.82
Adult social care (care homes only)	LFD	0.63	0.58	1.21
	PCR	1.46	1.13	2.59
	Total	2.09	1.71	3.8

\*Total cost includes all testing technologies (LFD, PCR, LAMP, antibody, genomics), support payments, and laboratory set-up costs. Priority service costs only include LFD and PCR testing.

## 2.3.2 Overall programme

### 2.3.2.1 Economic model

A static model was developed in Microsoft Excel®. Model inputs included actual prevalence, hospitalisations, and deaths in England from ONS data during the evaluation period (October 2020 to March 2022) [1]. These were used to calculate the actual infection hospitalisation ratios (IHRs) and hospitalisation fatality ratios (HFRs) during the 18-month period. Incidence rates were modelled using the data on prevalence.

Using the above data, a sensitivity analysis was developed assuming reductions of 5% to 35% in new cases due to the testing programme. Infections, hospitalisations, and deaths averted were modelled at these various potential reduction levels, and cost savings from infections averted and hospitalisations including ICU admissions were estimated. Combined with the total cost of the testing service, these were used to estimate the cost per infection averted, cost per hospitalisation averted, cost per death averted, and the cost per QALY gained. QALYs gained for symptomatic COVID-19 infections, hospitalisations, and deaths due to COVID-19 from the literature were used to estimate the cost per QALY gained due to averted infections, hospitalisations, and deaths. Table 4 summarises the input parameters and sources. A sensitivity analysis that tested the sensitivity of the outcome to the QALYs gained from deaths averted from various literature sources was conducted and presented in the graph, figure 2-20, as the shaded area with a minimum and maximum values for QALYs for deaths (Table 4).

**Table 4. Data inputs and assumptions.**

Parameter	Value	Source
Reductions in new infections	5%-35%	Sensitivity analysis
Hospitalisation fatality ratio (HFR)	20.13	Calculated from ONS data (deaths/hospitalisations) [1]
Infection hospitalisation ratio (IHR)	1.07	Calculated from ONS data (infections/hospitalisations) [1]
QALYs for death	6.78 (4.98-8.8)	[2, 3]
QALYs for hospitalisations	0.201	[2, 3]
QALYs for ICU admissions	0.15	[2, 3]
QALYs for symptomatic COVID-19 infections	0.008	[4]
Proportion of hospitalised patients with major manifestations	0.41 ( $\geq 19$ years) 0.2 ( $\leq 18$ years)	Statistical analysis (healthcare)
Proportion of hospitalised patients with pneumonia	0.42 ( $\geq 19$ years) 0.11 ( $\leq 18$ years)	Statistical analysis (healthcare)
Proportion of hospitalised patients with major manifestations or pneumonia in ICU	0.11 ( $\geq 19$ years) 0.9 ( $\leq 18$ years)	Statistical analysis (healthcare)
Cost of hospitalisation (GBP)	2,771 ( $\geq 19$ years) 3,138 ( $\leq 18$ years)	NHS Schedule of Costs [5]
Cost of hospitalisation with major manifestations (GBP)	4,507 ( $\geq 19$ years) 8,606 ( $\leq 18$ years)	NHS Schedule of Costs [5]
Cost of hospitalisation with pneumonia (GBP)	3164 4923	NHS Schedule of Costs [5]
Additional cost of ICU admissions (GBP)	1777 2460	NHS Schedule of Costs [5]

Full results from this analysis are presented in Table 5.

**Table 5. Uncertainty analysis of the cost-effectiveness of the national COVID-19 testing programme in England, at various assumptions of testing effectiveness on reducing new infections.**

Reductions in new infections due to testing	10%	15%	20%	25%	30%	35%
Number of infections averted	5,206,600	7,809,900	10,413,200	13,016,500	15,619,800	18,223,100
Number of hospitalisations averted	55,700	83,600	111,400	139,300	167,100	195,000
Number of ICU admissions averted	6,100	9,200	12,300	15,300	18,400	21,400
Number of deaths averted	11,200	16,800	22,400	28,000	33,700	39,300
Number of life years saved	117,800	176,700	235,600	294,400	353,300	412,200
Number of QALYs gained	119,700	179,600	239,500	299,400	359,200	419,100
Cost per hospitalisation averted (GBP)	463,100	308,700	231,500	185,200	154,400	132,300
Cost per death averted (GBP)	2,285,100	1,518,500	1,135,200	905,200	751,900	642,400
Cost savings from hospitalisations & ICU admissions averted (GBP)	165,263,900	247,895,800	330,527,800	413,159,700	495,791,600	578,423,600
Cost per QALY gained (GBP)*	214,100 [180,000-257,500]	142,200 [119,600-171,100]	106,300 [89,400-127,900]	84,800 [71,300-102,000]	70,400 [59,200-84,700]	60,200 [50,600-72,400]

\*Cost per QALY gained using a value of 6.78 QALYs per death averted (range: 4.98-8.8)

Hospitalisation fatality ratio (HFR) = 20.13; infection fatality ratio (IHR) = 1.07; false positivity = 14%; QALY, quality-adjusted life-year (calculated over the 18-month period)

### 2.3.2.2 Risk analysis

A risk analysis was conducted to assess the impact of a different virulence and severity by varying the IHR and the HFR. The analysis doubled the IHR from 1.07 to 2.14 and doubled the HFR from 20.13 to 40.26.

These were used to estimate the cost per hospitalisation and death averted as well as the cost savings due to hospitalisations averted. QALYs gained for symptomatic COVID-19 infections, hospitalisations, and deaths due to COVID-19 from the literature were used to estimate the cost per QALY gained due to averted infections, hospitalisations, and deaths. Table 4 summarises the input parameters and sources. A sensitivity analysis that tested the sensitivity of the outcome to the various QALYs used for a COVID-19-related death in the literature was conducted and presented in the graphs, in Figures 2-20 and 2-21, as the shaded area with a minimum and maximum weight of QALY for deaths.

Full results from this analysis are presented in Table 6 (increased IHR) and Table 7 (increased HFR).

**Table 6. Risk scenario for increased IHR: uncertainty analysis of the cost-effectiveness of the national COVID-19 testing programme in England, at various assumptions of testing effectiveness on reducing new infections.**

Reductions in new infections due to testing	10%	15%	20%	25%	30%	35%
Number of infections averted	5,206,600	7,809,900	10,413,200	13,016,500	15,619,800	18,223,100
Number of hospitalisations averted	111,400	167,100	222,800	278,600	334,300	390,000
Number of ICU admissions averted	12,300	18,400	24,500	30,600	36,800	42,900
Number of deaths averted	22,400	33,700	44,900	56,100	67,300	78,500
Number of life years saved	235,600	353,300	471,100	588,900	706,700	824,400
Number of QALYs gained	197,800	296,800	395,700	494,600	593,500	692,400
Cost per hospitalisation averted (GBP)	231,500	154,400	115,800	92,600	77,200	66,200
Cost per death averted (GBP)	1,135,200	751,900	560,200	445,200	368,600	313,800
Cost savings from hospitalisations & ICU admissions averted (GBP)	330,527,800	495,791,600	661,055,500	826,319,400	991,583,300	1,156,847,200
Cost per QALY gained (GBP)*	128,700 [104,700-161,700]	85,300 [69,400-107,100]	63,500 [51,700-79,800]	50,500 [41,100-63,400]	41,800 [34,000-52,500]	35,600 [29,000-44,700]

\*Cost per QALY gained using a value of 6.78 QALYs per death averted (range: 4.98-8.8)

Hospitalisation fatality ratio (HFR) = 20.13; infection hospitalisation ratio (IFR) = 2.14; false positivity = 14%; QALY, quality-adjusted life-year (calculated over the 18-month period)

**Table 7. Risk scenario for increased HFR: uncertainty analysis of the cost-effectiveness of the national COVID-19 testing programme in England, at various assumptions of testing effectiveness on reducing new infections.**

Reductions in new infections due to testing	10%	15%	20%	25%	30%	35%
Number of infections averted	5,206,600	7,809,900	10,413,200	13,016,500	15,619,800	18,223,100
Number of hospitalisations averted	55,700	83,600	111,4200	139,300	167,100	195,000
Number of ICU admissions averted	6,100	9,200	12,300	15,300	18,400	21,400
Number of deaths averted	22,400	33,600	44,900	56,100	67,300	78,500
Number of life years saved	235,500	353,300	471,000	588,800	706,500	824,300
Number of QALYs gained	195,800	293,600	391,500	489,400	587,300	685,200
Cost per hospitalisation averted (GBP)	463,100	308,700	231,500	185,200	154,400	132,300
Cost per death averted (GBP)	1,142,800	759,400	567,700	452,700	376,000	321,300
Cost savings from hospitalisations & ICU admissions averted (GBP)	165,263,900	247,895,800	330,527,800	413,159,700	495,791,600	578,423,600
Cost per QALY gained (GBP)*	130,900 [106,300-165,000]	87,000 [70,700-109,600]	65,000 [52,800-81,900]	51,900 [42,100-65,300]	43,100 [35,000-54,300]	36,800 [29,300-46,400]

\*Cost per QALY gained using a value of 6.78 QALYs per death averted (range: 4.98-8.8)

Hospitalisation fatality ratio (HFR) = 20.13; infection hospitalisation ratio (IFR) = 2.14; false positivity = 14%; QALY, quality-adjusted life-year (calculated over the 18-month period)

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# Appendix 3: Schools



# Schools

## 3.1 Introduction and context

### 3.1.1 Introduction to appendices

This appendix has the following structure:

Appendix 3.1 provides a description and context of the schools testing service and establishes the policy timeline.

Appendix 3.2 outlines a Theory of Change, developed to map out the intended design of the testing service and evaluate the intended service.

Appendix 3.3 draws on the results of qualitative research and covers operational findings that emerged from the review of data vaults shared by the UKHSA Secretariat and publicly available information; a rapid review of the behavioural literature, which relied on documents received from UKHSA Secretariat and those found as part of a rapid literature review; stakeholder sessions, where the evaluation consortium tested the feasibility of emerging recommendations with the use of primary research methods.

Appendix 3.4 describes methods and findings from the statistical workstream that are not otherwise detailed in chapter 3.

Appendix 3.5 describes methods and findings from the economics workstream that are not otherwise detailed in chapter 3.

### 3.1.2 Detailed description of the schools testing service

Rapid asymptomatic testing was introduced onsite in secondary schools and colleges on 4 January 2021 [1]. The onsite asymptomatic testing service for schools was initiated in March 2021 over two weeks during the return of all pupils to schools following the end of the third national lockdown. Onsite asymptomatic testing was also implemented on return to schools in September 2021, following the summer holidays and in January 2022. Home self-testing was undertaken for the remainder of each term following the initial onsite tests. The overall schools testing service ended on 21 February 2022; exceptions after this end date included testing during outbreaks of COVID-19 and testing in SEND settings, which ended on 31 March 2022. Local health protection teams may still advise some targeted outbreak testing in residential SEND settings.

Initially, the service was planned for rollout across schools in January 2021, when it was assumed that pupils would return for the start of term; however, due to high rates of COVID-19 infection at the time and national lockdowns imposed, the wider service was pushed back to 8 March 2021. In January 2021, testing was available, through schools, for children of essential workers and vulnerable young people.

### 3.1.3 Onsite school asymptomatic testing site (ATS) model

Stakeholder interviews confirmed that the initial objective of the onsite testing model rolled out in January 2021 was to remove as many positive cases as possible, reduce possible onward transmission and outbreaks in schools. Although this objective was still relevant throughout the testing service timeline (see below for school-specific and general timelines), the objective to increase confidence among pupils, staff and parents to attend education settings became more of a focus, as restrictions on the wider population were eased.

Schools and colleges were advised to set up and commence asymptomatic testing sites (ATSs) within the school setting, using lateral flow devices (LFDs) to test all pupils. Testing was voluntary (albeit strongly recommended), and consent was sought from parents prior to the rollout of asymptomatic testing. If consent was provided, pupils were offered the opportunity to take three tests, over a period of two weeks and spaced three to five days apart, on their return to school and using the onsite testing facilities. Pupils were asked to self-swab at the ATS and assistance was to be provided where required. Processing of the LFD test was conducted onsite by staff trained to assist the ATS. Assisted swabbing was also available from trained staff or with parent/carer support for children with special educational needs. Results were to be reported into NHS Test and Trace (NHSTT). Pupils who tested negative following their first test result were instructed to return to face-to-face education. Pupils who opted out of asymptomatic testing were instructed to attend school in line with their school's phased return arrangements [1, 2].

### 3.1.4 The home asymptomatic testing model

The fourth and subsequent tests were to be taken at home using kits provided by the school. Pupils aged 18 and over were expected to self-swab and report the result to NHSTT with assistance if needed. Adolescents aged 12 to 17 years old were expected to also self swab and report with adult supervision, and where necessary the adult conducting the test if necessary. Children aged 11 attending a secondary was expected to be tested by an adult. Pupils were also asked to share their result, whether it was positive, negative, or void, with their secondary school or college, to help with contact tracing. In practice, some schools switched to requesting only positive results due to a lack of resources within these schools to manage test results. Guidance for pupils advised that testing should be performed on the morning of a school day, with two tests spaced out over the course of the school week to ensure adequate coverage. In January 2021, staff were offered the option to begin twice-weekly testing at home and were encouraged to continue throughout the schools testing service timeline [1].

As home testing was rolled out and continued throughout the school term, the objective of testing at this point became more about increasing confidence among pupils, staff, and parents, to encourage attendance at school.

### 3.1.5 Confirmatory PCR testing

In March 2021, confirmatory PCR tests for positive LFDs were temporarily suspended for tests taken onsite at school. The decision to suspend confirmatory PCR tests after receiving a positive LFD test result at an ATS was justified by DfE (on DHSC's/UKHSA's behalf) as being because tests conducted under supervision usually have a minimal chance of being incorrect and so there is minimal need to further confirm the result [3]. Those testing at home and receiving a positive LFD result were still required to obtain a confirmatory PCR test, within two days of receiving their positive LFD result [4]. From April 2021, confirmatory PCR testing was reinstated for any individual who received a positive LFD result [5]. The requirement for confirmatory PCR testing lasted until 11 January 2022, when it was suspended due to high levels of COVID-19 and the resultant pressure on the NHS [6]. After this date, only certain exceptions were made for those who still needed confirmatory PCR tests; this did not include individuals in school settings.

Department for Education (DfE) guidance initially encouraged staff to take LFD tests regardless of whether they had tested positive by PCR within the previous 90 days. The procedure for pausing LFD testing for 90 days following a PCR test for schools was flagged to the DfE as being contradictory when compared with the guidance for healthcare. As of 9 February 2021, the DfE guidance was aligned with that of healthcare, i.e., LFD tests should not be taken within 90 days of a positive PCR result, unless the individual developed new symptoms (in which case they would be advised to take a PCR test) [7].

### 3.1.6 Setting up the schools testing service

#### 3.1.6.1 Guidance

Press releases, guidance and reports were primarily published and disseminated by DfE and the Department of Health and Social Care (DHSC).

A handbook for schools and colleges was published on 15 December 2020 and subsequently updated on the 23 December 2020; this included information on the testing technology, the purpose of the testing service, relevant policies and guidance, and examples of communication materials and useful documents to promote testing [8]. Other important documents, such as those detailing operational guidance and actions for schools, were also published, and updated throughout the pandemic.

Schools were able to directly access a DfE helpline specifically set up to help answer queries and provide support to schools during the rollout of asymptomatic testing. Schools could also contact the helpline in the event of an outbreak (defined as two or more confirmed cases within 14 days, or an overall increase in sickness absences where COVID-19 was suspected), to escalate the issue to their local health protection team and seek advice if additional action was required [2]. A document-sharing platform was also established so that DfE could share documents directly with schools, with the documents held in a single, centralised location.

#### 3.1.6.2 Site set-up

At the beginning of January 2021, DfE were operationally responsible for the delivery of test kits however NHSTT were asked to oversee the clinical governance function. Schools were provided with testing kits, PPE, guidance, training materials and initial instructional steps [9]. Specific instructions on setting up the testing site included information on key layout requirements, such as using a room where the floor was non-porous, storing tests at a certain temperature and placing a registration desk at the first point where an individual to be tested would enter the test site, and desks that are set up for swabbing, processing and recording results [8, 10].

Schools were asked to consider including different roles within the ATS to ensure workforce requirements were met. There were seven roles/ job types mentioned. Multiple roles could be held by one individual and where necessary additional resource could be requested from the local authority or volunteers within the school network could be drafted in to help, for example retired teachers, parents, community organisations. A team of individuals would also be required to constitute the close contact workforce, whose role was to focus on identifying close contacts of any positive cases and monitoring isolation dates and test results. The size of the workforce for each school and college would depend on the number of staff and pupils, physical space available and time available to complete all tests. A workforce planning tool was available for schools to use to help plan the minimum number of testing bays needed and corresponding staff needed. The tool would also indicate the approximate level of funding that a school/college would be eligible for to cover the testing costs [8].

Funding was provided to schools to support them with costs incurred for testing. A total of GBP 78 million was made available for the schools testing service and retrospectively paid by the Education and Skills Funding Agency (ESFA) to schools and colleges participating in the rapid testing service provided by DHSC. Allocations were made based on the number of test results recorded on a school's or college's account on the test site results service. Specialist educational settings also had access to funding to help with costs, as it was assumed that different staffing levels may have been needed in these settings.

Schools were instructed to retain a small, onsite ATS to offer testing to pupils who were unable or unwilling to test themselves at home [11].

### **3.1.6.3 Staff training**

Videos showing an overview of the testing process as well as online training modules relevant to specific roles at an ATS were made available to staff. The aim of the online training package was to prepare staff to carry out their roles within the ATS. Webinars were held by DfE, to provide additional instructions and the opportunity for individuals to ask questions [8].

### **3.1.6.4 Consent**

Templates were provided to schools to be used to obtain consent for onsite testing. Suggested communication activities were made in the schools and colleges handbook [8] to encourage engagement with the testing service and an opportunity for any concerns to be addressed.

### **3.1.6.5 Test distribution**

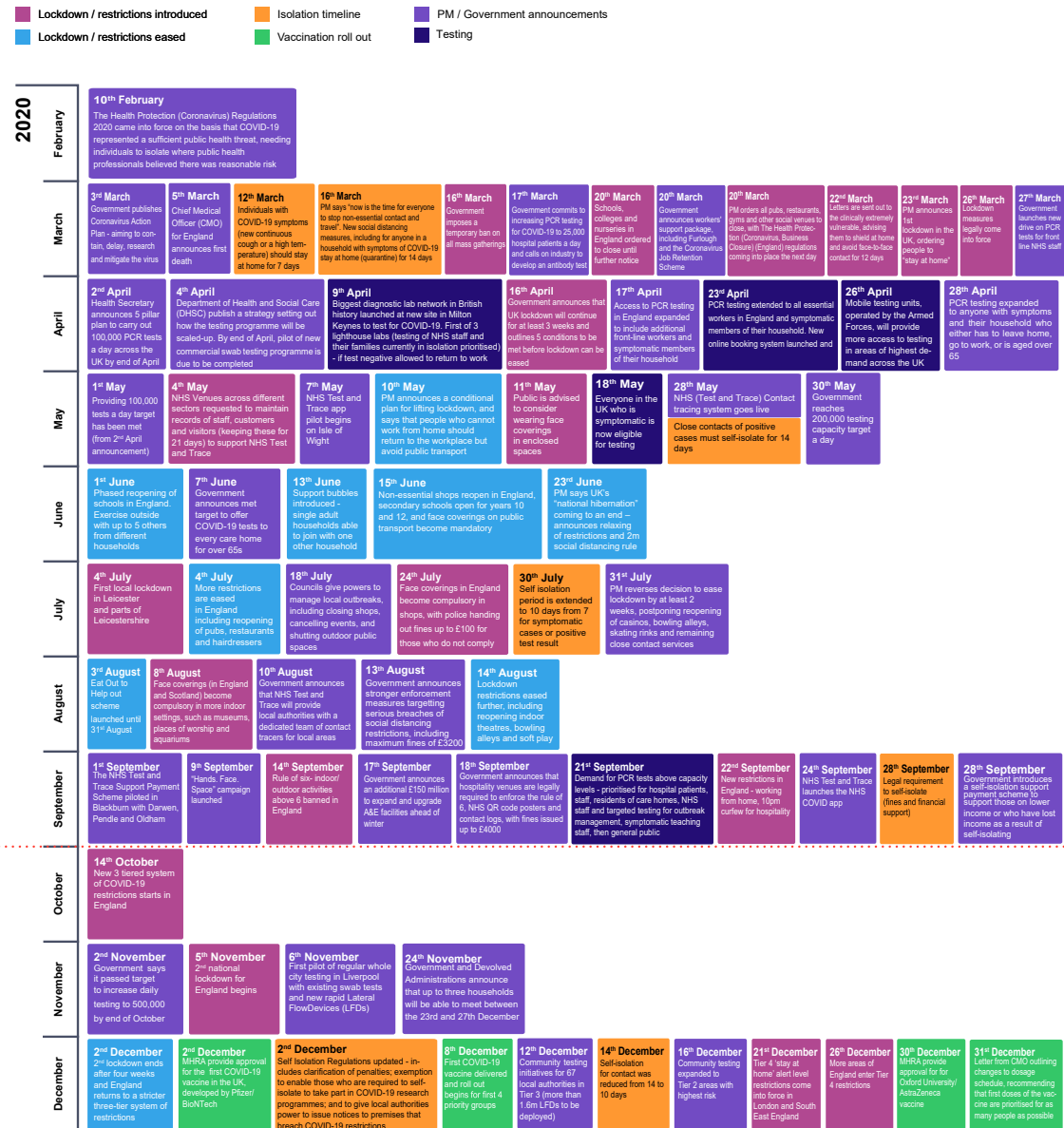
Due to the rapid set up of the testing service, initially, a 'push' methodology was used to manage the ordering and delivery process for test kits for schools, which involved a forecasting approach from DfE and then organising the delivery of kits to schools to cover immediate expected demand; delivery was managed via daily spreadsheet trackers. Subsequently, the move to a 'pull' model was made, whereby schools and colleges could order the test kits they required on an ongoing basis and track deliveries, analyse data and report results via a new IT-based solution [12, 13]; this was also referred to during conversations with DfE stakeholders.

LFD test kits began to be delivered to schools from 4 January 2021. Kits were sent to educational settings in packs of 3, 7 or 25 tests [14]. Schools and colleges were told to expect two deliveries in early January 2021, which would cover the initial testing regimen and then include tests to begin the transition to weekly testing.

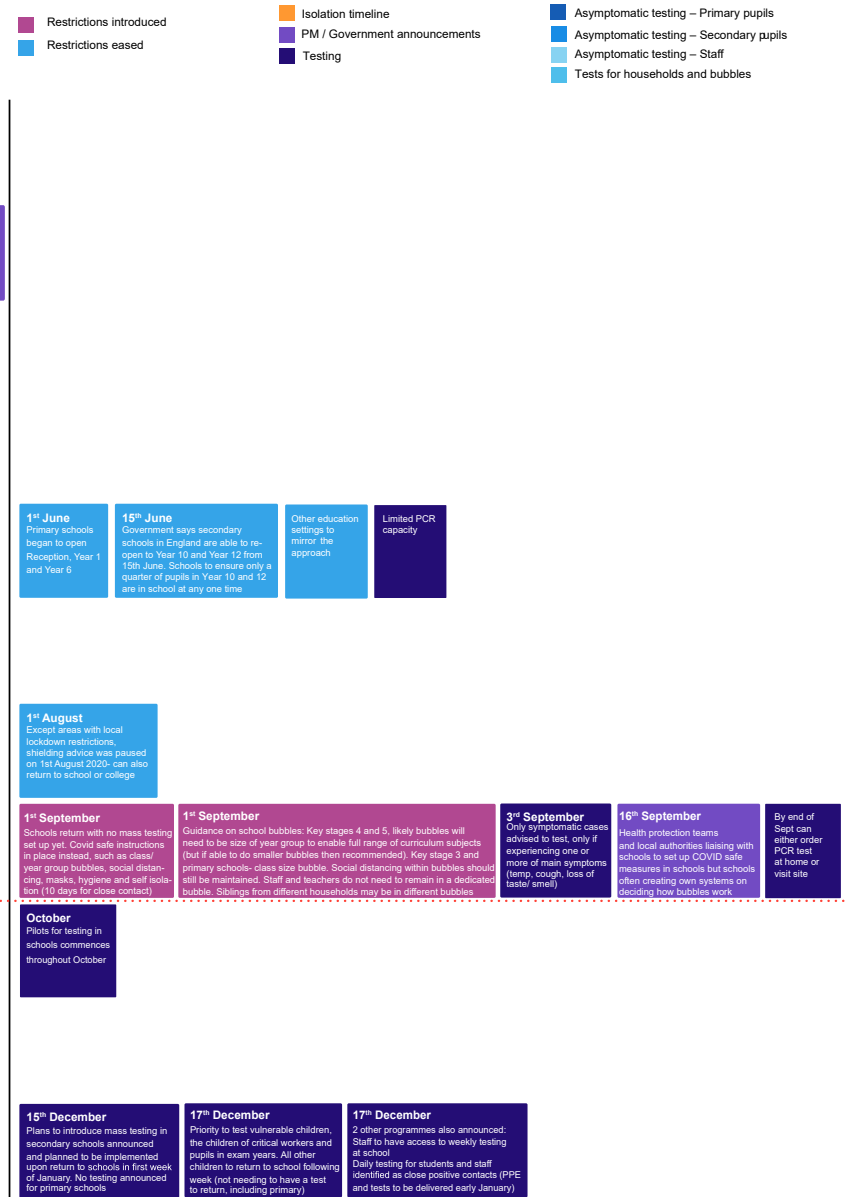
PCR kits distributed to schools and colleges were only to be used in exceptional circumstances, such as when a pupil, teacher or staff member became symptomatic and was unable to access a test elsewhere. Schools were able to order additional PCR tests via an online link. A unique organisation reference number was allocated to each school so that deliveries could be tracked [15].

### 3.1.7 Timeline

#### Generic Policy Timeline



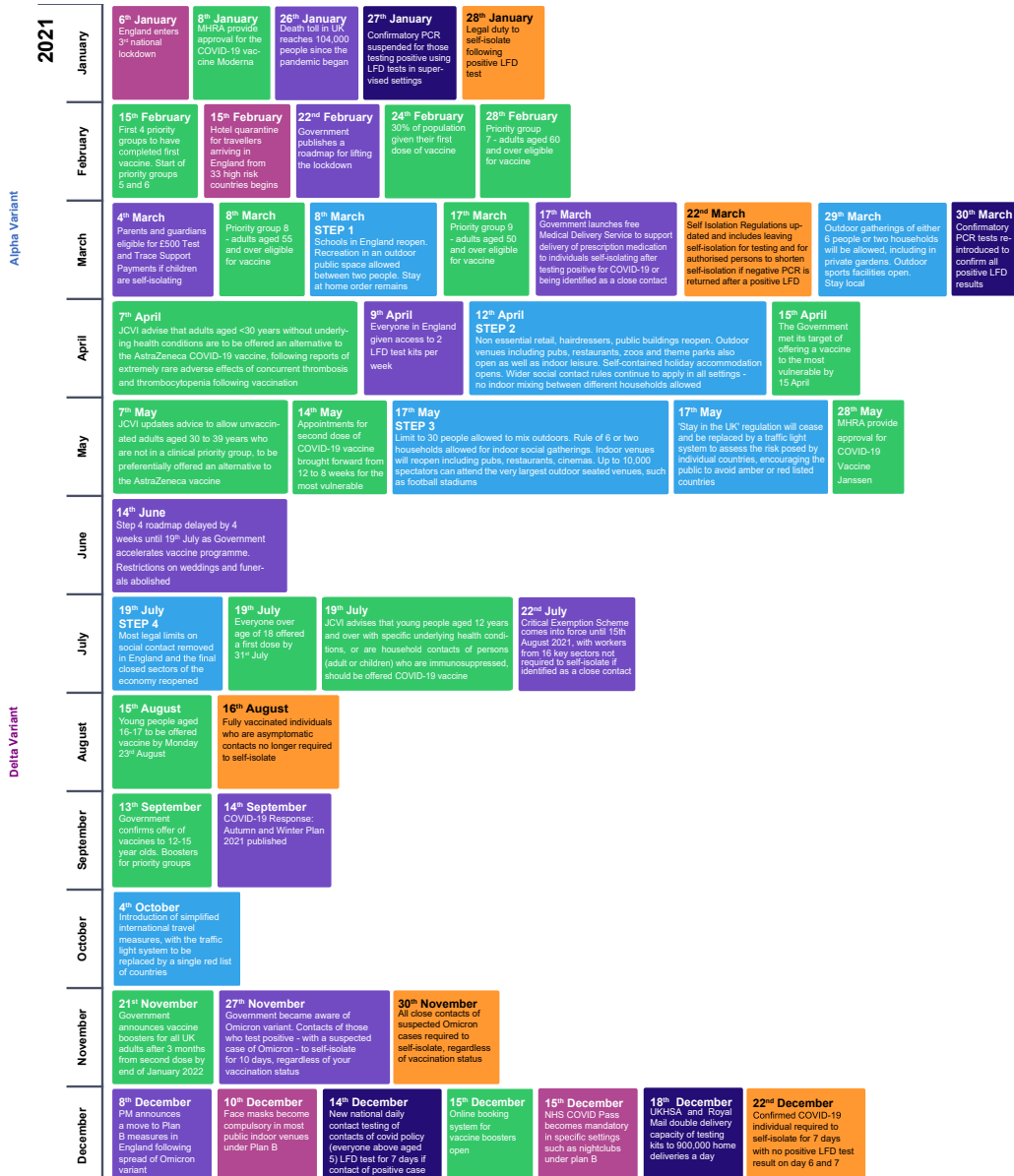
#### Schools Timeline





# Generic Policy Timeline

- Lockdown / restrictions introduced
- Isolation timeline
- PM / Government announcements
- Lockdown / restrictions eased
- Vaccination roll out
- Testing



# Schools Timeline

- Restrictions introduced
- Isolation timeline
- PM / Government announcements
- Restrictions eased
- Testing
- Asymptomatic testing - Primary pupils
- Asymptomatic testing - Secondary pupils
- Asymptomatic testing - Staff
- Tests for households and bubbles



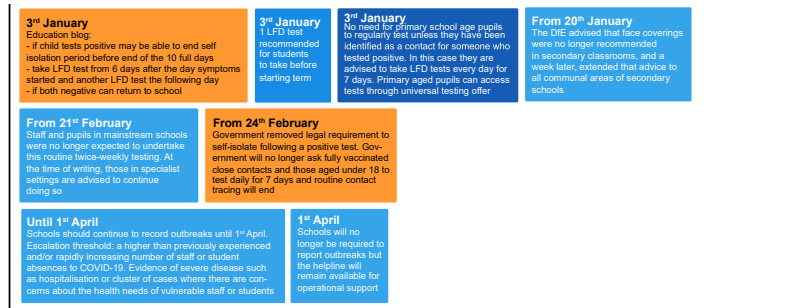
# Generic Policy Timeline

- Lockdown / restrictions introduced
- Isolation timeline
- PM / Government announcements
- Lockdown / restrictions eased
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- Testing



# Schools Timeline

- Restrictions introduced
- Isolation timeline
- PM / Government announcements
- Restrictions eased
- Testing
- Asymptomatic testing – Primary pupils
- Asymptomatic testing – Secondary pupils
- Asymptomatic testing – Staff
- Tests for households and bubbles



### 3.1.7.1 Key policy changes

After the initial roll out of the asymptomatic testing service within schools, further guidance and policy changes took place between March 2021 and February 2022.

- ▶ **April 2021:** Confirmatory PCR testing reinstated for those testing positive by LFD whether via assisted testing or at-home testing [5].
- ▶ **May 2021:** As part of Step 3 in relaxing COVID-19 restrictions, staff and pupils were informed that from 17 May, face coverings would no longer be needed in classrooms or communal areas [16].
- ▶ **June 2021:** On 6 June 2021, the then education secretary urged pupils and their families to take an LFD test at home before returning to the classroom after half-term [17].
  - ▶ Schools were informed by DfE to prepare for the return of on-site COVID-19 testing on return after the summer holidays. Refreshed guidance, test kits and PPE were provided ahead of the autumn term [18].
  - ▶ Schools were also informed that regular asymptomatic testing would be paused in schools and colleges over the summer, except for those that remained open as summer schools, with NHSTT supporting with contact tracing.
- ▶ **July 2021:** From 19 July 2021, England moved to Step 4 of the government's roadmap, which meant for early years, schools and colleges, the expectation to carry out routine contact tracing now sat with NHSTT rather than schools themselves. Year group or class bubbles and social distancing were also removed as part of Step 4 [19].
- ▶ **August 2021:** From 16 August 2021, under-18s and fully vaccinated adults did not need to isolate if they were a close contact of a case, unless they developed symptoms themselves. Instead, they were advised to take a PCR test and attend school as normal [20].
  - ▶ On 26 August, the government launched its 'Back to School' campaign to set out the experience pupils could expect to get back to with restrictions eased. Testing was still reinforced and encouraged, with two tests to be conducted onsite at the start of term followed by regular, twice-weekly testing at home [21]. The campaign included features from public figures such as Dr Ranj Singh, to reassure pupils and families about the return to school.
- ▶ **September 2021:** Children returned to school and conducted two tests onsite, as instructed in earlier correspondence (see the August 26, 2021, campaign).
- ▶ **October 2021:** Although no official onsite testing was to be performed/operated on return from the October half-term, pupils and staff were encouraged to perform an LFD test before returning to school [22]. Following publication of the results of a large-scale, randomised controlled trial of daily contact testing [23], schools were given the option to allow contacts of positive cases to remain in school instead of self-isolating and perform a daily LFD test (stakeholder conversation).
- ▶ **November 2021:** Schools were asked by DfE to prepare for onsite testing once again as pupils returned to school in January 2022. From correspondence on Schools Week, it seems that schools were expected to arrange their own delivery of test kits and ensure enough kits were ordered by 30 November 2021, which at the time was felt to be too little notice [24].
- ▶ **December 2021:** An announcement was made on 8 December 2021, by the then prime minister, on the move to Plan B measures, which included temporarily introducing face masks for pupils and staff in schools from 10 December 2021.
  - ▶ From 14 December 2021, daily contact testing was rolled out for the wider public, and the importance of its use in schools was reiterated. Adults who were fully vaccinated and children and young people between the ages of 5 to 18 years who were identified as a contact of someone with COVID-19 were advised to take an LFD test every day for seven days while attending their school setting, unless they tested positive. Pupils with SEND identified as close contacts were advised to work with their school to agree the most appropriate route for testing [25].
- ▶ **January 2022:** Following the wider policy change on self-isolation at the end of December 2021 [26], on 3 January 2022, DfE updated their Education Hub with information on what to expect for schools and colleges upon return after the Christmas break [27].
  - ▶ On 4 January 2022, the operational guidance was updated to reflect changes to the use of face coverings. Pupils in year 7 and above were advised to wear face coverings both inside the classroom and when moving around the premises [25].
  - ▶ All secondary schools were requested to perform one test per individual onsite at school as pupils returned. Staff were advised to self-test at home before returning [27]. Test kits were sent out before the start of the new term, with coordination by UKHSA.
  - ▶ From 11th January general guidance was released to pause confirmatory PCR testing in the wider population due to high rates of COVID-19 across the UK [6].

- ▶ On 13 January 2022, the then health secretary announced that from 17 January 2022, self-isolation for those with COVID-19 could be reduced further, to end after five full days following two negative LFD tests [28].
- ▶ On 20 January 2022, DfE advised face coverings were no longer recommended in classrooms, followed a week later to extend this to all communal areas of secondary schools [29].
- ▶ **February 2022:** On 21 February 2022, the then prime minister announced the removal of measures put in place during COVID-19, which included no longer recommending regular asymptomatic testing of pupils and staff and, from 24 February 2022, removing the legal requirement to self-isolate following a positive test. Contacts were no longer required to self-isolate or advised to take daily tests, and contact tracing ended.
- ▶ Regular testing was still advised for SEND settings. Staff and pupils in mainstreams settings could still access test kits through the universal testing service [30, 31].
- ▶ Schools were advised to continue to record outbreaks until 1 April 2022.

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## 3.2 Theory of Change

### 3.2.1 Methodology

As per the evaluation protocol [1], this evaluation used a 'Theory of Change' (ToC) approach [2, 3]. Such an approach lends itself to understanding complex interventions with multiple causal pathways [4]. A ToC framework was therefore used to understand the causal pathways and intended and unintended outcomes of the schools testing service, while exploring the effect of context on the service setting's intended outcomes.

Subsequently, these separate insights were used to define outcome and process indicators to determine if and how the combined aims of the testing service were achieved. The ToC was developed retrospectively by the evaluation consortium, presented to UKHSA stakeholders in a participatory manner and iteratively updated based on their feedback.

The key research questions that were used to support the design of the ToC are shown in Table 1.

**Table 1: Key research questions.**

1.	How did the delivery and uptake of the testing service compare with what was planned over time and what factors affected this?
2.	What were the barriers and facilitators to the access, use and delivery of the testing service?
3.	What measurable impacts were there from the testing service in terms of its intended purpose?
4.	What was the cost to the government and the cost-effectiveness of the testing service?
5.	Which aspects of the testing service might be beneficial to consider for future services?
6.	For the testing programme overall, how can the above learnings be used to inform future pandemic preparedness testing strategy for England?

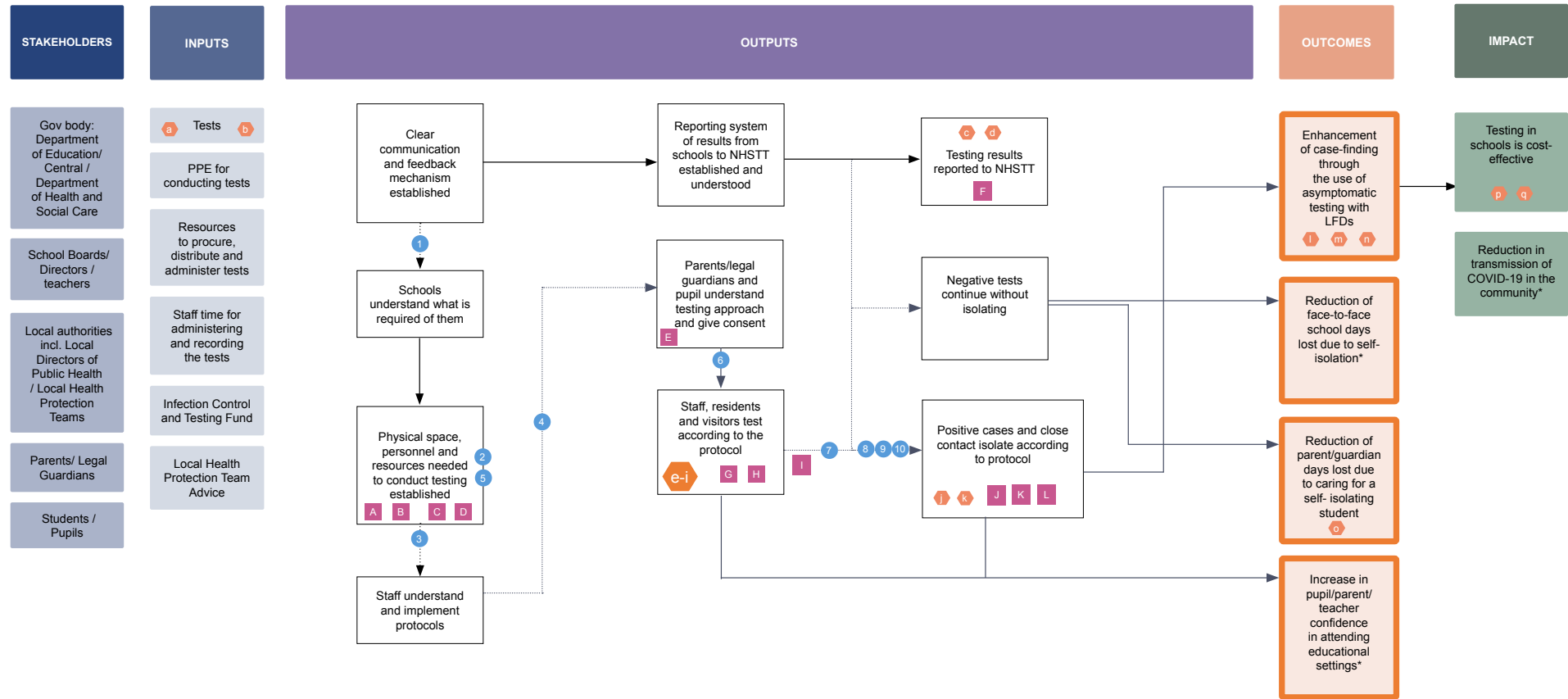
The school's ToC was modelled and designed retrospectively using publicly available information (testing policies and guidance) and insights received from UKHSA Secretariat, to evaluate the complex intervention of asymptomatic COVID-19 testing by predominately LFD and PCR tests across pupils and staff within schools in England between October 2020 and March 2022.

As described by Maini et al (2018) [5], the mapping was undertaken by identifying key activities/ pre-conditions alongside assumptions and interventions that needed to be true for the outcome to be realised. For the purposes of the intended service, activities were defined as the elements required for setting up the testing, with conducting a test and appropriate actions following a test result listed under outputs.

### 3.2.2 Theory of Change diagrams

Based on feedback from UKHSA and evaluation consortium meetings, a high-level ToC was developed and is presented in Diagram 1.

Diagram 1: Schools Theory of Change – high-level view



**LEGEND**

**Precondition**  
 The intended results of the interventions. Things that don't exist now, but need to exist in order for the logical causal pathway not to be broken and the impact achieved.

**Intervention**  
 The different components of the complex intervention.

**Assumption**  
 An external condition beyond the control of the project that must exist for the outcome to be achieved.

**Indicators**  
 Things you can measure and document to determine whether you are making progress towards, or have achieved, each outcome.

**Dotted arrow**  
 When an intervention is needed to move from one outcome to the next.

**Solid arrow**  
 When one outcome logically leads to the next without the need for any intervention.

**Stated objectives of the service**  
 The UKHSA objectives for the testing service stated in published literature.

**INTERVENTIONS**

- DfE use daily bulletin boards and published guidance on gov websites to disseminate information regarding school testing programme
- Onboarding of staff to the programme, with extra resource provided by local authority if needed
- Training of staff on how to conduct testing
- Communication sent from schools to inform parents and students of testing programme for schools and to request consent to be tested within
- Set up of logistics by government organisations to dispatch tests to all schools
- Eligible students identified based on consent and tested as per guidance
- Test processed and results recorded, student / staff informed; NHSTT informed. Communications of tests results includes clear information on how to behave given the result, supported by wider schools advice
- Isolation is required until negative test confirmed by PCR. Once result received, student/ staff to follow instructions on reporting result to school
- Schools identify close contacts and contact local HPT
- HPT carry out a risk assessment and provide definite advice to school on who must be sent home to isolate. School inform close contacts of necessary isolation.

**ASSUMPTIONS**

- Efficient dissemination of tests across Schools to enable testing to be completed within two weeks of term
- Schools provided with enough tests to accommodate collection scheme by students and staff
- Schools reimbursed for any costs associated with setting up ATS sites
- Staff and students able and willing to collect tests to allow for twice weekly testing at home
- Testing regime is understood and acceptable to both parents and students and consent is gained amongst the majority
- School has resources in place to report results from ATS to NHSTT.
- Students and staff conduct test as per guidance
- LFD Technology is operated effectively by non clinical operatives
- Students and staff willing and able to isolate as soon as positive result received on LFD
- Clear lines of communication/ responsibilities known of local director of public health with local authorities and schools
- Individuals follow national guidance on isolation measures and not perform risky behaviours which would impact effectiveness of programme

**INDICATORS**

**PROCESS:**

- Average percentage of LFD tests distributed that were reported over the evaluation period
- Average percentage of PCR tests distributed that were reported over the evaluation period
- Number of LFD tests distributed monthly and over the evaluation period
- Number of PCR tests distributed monthly and over the evaluation period
- Cost per LFD test conducted over the evaluation period
- Cost per PCR test conducted over the evaluation period
- Total financial cost of Schools Testing Service over evaluation period (FY21 and FY22)
- Average number of tests per school-aged child per week
- Average coverage in school-aged children
- Percentage of cases identified through schools testing programme
- Number of school days lost due to false positives

**OUTCOME:**

- Cost savings from hospitalisations averted due to testing at different assumptions of reductions in new cases
- Cost per hospitalisation averted due to testing at different assumptions of reductions in new cases
- Cost per death averted due to testing at different assumptions of reductions in new cases
- Cost of parent absenteeism due to false positives

**IMPACT:**

- Cost per QALY gained due to school testing programme at different assumptions of reductions in new cases
- Cost effectiveness at various levels of testing effectiveness

\* These outcomes and impacts were not measured as part of this evaluation and therefore have no associated indicators

**Abbreviations**

ATS  
Asymptomatic Testing Site

LFD  
Lateral Flow Device

PCR  
Polymerase Chain Reaction Test

NHSTT  
National Health Service Test & Trace

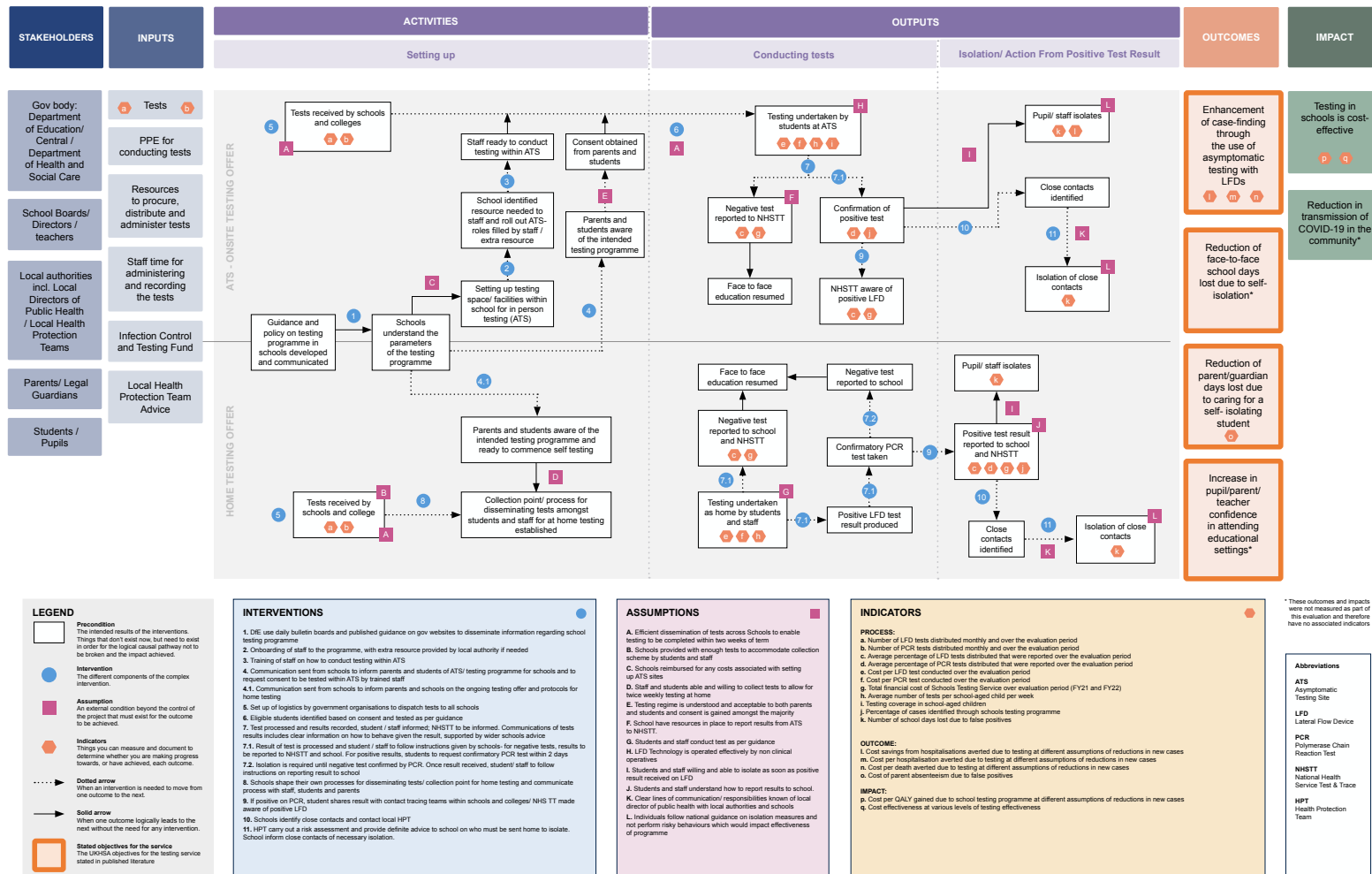
HPT  
Health Protection Team

### 3.2.3 Theory of change – Detailed view

Diagram 2 of the Schools Theory of Change provides additional detail, with clearer process mapping added into the overall process of the testing service.

It must be noted that the policy changes were happening amid the changing national picture in terms of prevalence, emergence of new variants of concern and vaccine rollout, among others. Therefore, the ToC model should be viewed with respect to the continuous changes that the service faced and that the representations presented may not have encompassed all the changes.

Diagram 2: Detailed Schools Theory of Change with process overlay



### 3.2.4 Appendix 3.2 references

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## 3.3 Qualitative methodology and findings

This appendix contains the following sections:

- Behavioural and operational research
  - Narrative review methodology (context and operational insights)
  - Scoping study methodology (behavioural insights)
  - Operational insights
  - Behavioural insights
- Stakeholder engagement
  - Methodology
  - Stakeholder insights

### 3.3.1 Behavioural and operational research

#### 3.3.1.1 Narrative review methodology

To support with an understanding of the policy timeline, the aims and context for each service and to identify information on how each of the services operated, a narrative review was conducted into publicly available data sources. Sources included academic literature and grey literature (e.g., information and guidance published on gov.uk). These sources were collated and analysed to provide context to the evaluation.

#### 3.3.1.2 Scoping study methodology

A scoping study was conducted to provide an overview of existing studies exploring barriers and facilitators to implementing and participating in COVID-19 testing in England. The key activities explored were COVID-19 testing, reporting of results and isolation following a positive result. This study aimed to provide: i) a summary of the research undertaken on this topic, ii) identification of gaps in research efforts, and iii) an overview of key barriers and facilitators for each service setting, as well overall across all service settings.

The findings were also triangulated with the statistical analysis, and then fed back into the developing Theories of Change to refine and explain the assumptions and to make recommendations.

### Methods

#### Study design

A rapid scoping study was conducted to evaluate the barriers and facilitators to engaging with COVID-19 testing, reporting of results and self-isolation in the United Kingdom during the COVID-19 pandemic. A scoping study was selected to synthesise knowledge as there is a large volume of heterogenous literature on this topic [1]. The proposed scoping study was conducted following the 2005 Arksey and O'Malley framework [2], with the adaptations proposed by Levac et al in 2010 [3] and using the 2015 Joanna Briggs Institute guidance on conducting scoping reviews [4].

## Search strategy and selection of the evidence

A wide search strategy was developed with input from a health sciences librarian, using key phrases from relevant articles [2] (see Table 1 for categories and example terms). This was used to identify literature that described behaviour around COVID-19 testing, reporting and self-isolation in the UK during the COVID-19 pandemic. The search strategy was adapted for each database and information source that was searched and was refined according to key words in sources that the search identified.

**Table 1. Search categories and examples of search terms.**

Category	Search terms
<b>COVID-19</b>	COVID* OR corona OR coronavirus OR SARS-CoV-2 OR "SARS CoV 2" OR "SARS CoV-2" OR SARS-CoV2 OR SARSCoV2 OR "Severe Acute Respiratory Syndrome Coronavirus 2" OR "Severe Acute Respiratory Syndrome Corona Virus 2" OR 2019-nCoV
<b>AND</b>	
<b>Key activities</b>	test* OR screen* OR RT-PCR OR PCR OR "polymerase chain reaction" OR "lateral flow" OR "lateral flow device*" OR "lateral flow assay*" OR LFD OR self-test* OR "test and trace" OR "contact trac*" OR surveillance OR POCT OR report* OR self-report* OR selfreport* OR "test positive" OR "testing positive" OR result* OR "self-isolation" OR "self isolation" OR isolat* OR containment OR reopening OR re-opening OR mitigat* OR flatten*
<b>AND</b>	
<b>Behaviour, barriers and facilitators</b>	knowledge OR understand* OR attitude* OR perception* OR perceive OR belief* OR believ* OR expectation* OR trust OR willing* OR intention* OR behaviour* OR behavior* OR practice* OR enact* OR engag* OR adher* OR complian* OR comply OR experience* OR view* OR motivation* OR barrier* OR block* OR challeng* OR difficult* OR facilitat* OR enabl* OR access* OR feasib* OR accept* OR uptake
<b>AND</b>	
<b>Research methods</b>	qualitative* OR interview* OR FGD OR "focus group*" OR survey* OR questionnair* OR mixed-method* OR "mixed method*" OR ethnograph* OR theme OR thematic* OR "grounded theory" OR "content analysis" OR field-work OR "field work" OR selfreport* OR self-report* OR "self report*" OR view* OR experience* OR hermeneutic OR phenomenolog*
<b>AND</b>	
<b>Geographic setting</b>	"United Kingdom" OR UK OR England OR Ireland OR Irish OR Scot* OR Wales OR Britain OR British OR NHS OR "National Health Service*" OR UKHSA OR "United Kingdom Health Security Agency" OR "UK Health Security Agency" OR "Channel Island*" OR London OR Birmingham OR Liverpool OR Manchester OR Cardiff OR Belfast OR Edinburgh OR Glasgow

The databases searched included the following:

1. PubMed: covers Medline as well as other sources relevant for a scoping review on COVID-19 literature, including in process citations, out of scope citations, ahead of print citations and author manuscripts of NIH-funded research.
2. Scopus: covers biomedical and social science research.
3. The World Health Organization COVID-19 Research Database: the literature cited in the WHO COVID-19 Research Database is updated daily (Tuesday through Saturday) from searches of bibliographic databases, hand searching, and the addition of other expert-referred scientific articles. This database represents a comprehensive multilingual source of current literature on the topic. While it may not be exhaustive, new research is added regularly. Databases searched include MEDLINE, Scopus, EuropePMC, Web of Science, ProQuest Central, EMBASE, medRxiv, ICTRP, WHO COVID, and ScienceDirect, as well as the grey literature [5].
4. The search was supplemented after screening to identify key missing studies, by free-text searches on Google Scholar, review of the references of included articles, and through stakeholder consultations [6]. UKHSA Secretariat provided documents formed part of the stakeholder-identified sources for this study.

The search strategy aimed to identify both published and unpublished studies, as well as reports and guidance documentation. Qualitative or mixed methods studies published from 2020 in English were



included. To be included in the review, papers needed to focus on any of the following three behaviours: undertaking a test; reporting a test; or isolating following a positive result, symptoms, or a positive contact (see Table 2 for search limits and eligibility criteria).

**Table 2. Summary of the search parameters and limits as well as the inclusion and exclusion criteria [2], categorised according to the ‘population, context, concept’ search framework [7].**

	Inclusion	Exclusion
<b>SEARCH LIMITS</b>		
<b>Language</b>	Published in English	Published in languages other than English
<b>Dates</b>	Published between the start of 2020 and the search date (the database search was conducted on 07 November 2022 and the UKHSA documents were received throughout September – December 2022)	Published before 2020
<b>Methods</b>	Qualitative or mixed methods studies Quantitative surveys	Quantitative studies reporting only the association between demographic variables and behavioural outcomes
<b>ELIGIBILITY</b>		
<b>Literature</b>	Journal articles, peer-reviewed material, articles under review, published books and book chapters, other academic research, research commissioned by governments, unpublished reports	Opinion or statement pieces, magazine articles, blog posts
<b>Population</b>	England, Northern Ireland, Scotland, Wales, and the islands making up the British Isles. Multi-country studies were included if they included one of these settings	Countries outside the UK, including the Republic of Ireland
<b>Concept</b> (Key activities)	<p>Description of the behaviour, barriers and/ or facilitators of how people did behave regarding the key activities:</p> <ul style="list-style-type: none"> <li>▶ Antigen testing for COVID-19 (with a focus on LFDs but including LAMP and PCR testing).</li> <li>▶ Reporting the test results</li> <li>▶ Isolating (with a focus on isolating due to a positive COVID-19 test result but including isolating after being identified as a close contact of COVID-19 positive case).</li> </ul> <p>The description of behaviours included associations of survey responses with behaviour or intention to test, report or isolate.</p>	<p>Describes testing, reporting or isolation but not the behaviour associated with them (e.g., describes the sensitivity of a specific test)</p> <p>Describes testing for antibodies</p> <p>Describes the barriers or facilitators to isolation in the context of social distancing, isolation if symptomatic or traveller isolation (hotel quarantine)</p> <p>Describes association of demographic factors with behaviour or intention to test, report or isolate</p> <p>Testing, reporting results or isolation after a positive result in the context of other diseases</p> <p>Describes facilitators or barriers to other COVID-19-related behaviours, such as vaccination or social distancing</p> <p>Describes the impact of testing/ reporting/ isolation on behaviour</p> <p>Knowledge, attitudes, or perceptions of COVID-19 itself</p>

As there was less evidence available on isolating after a positive test, the eligibility was widened to include studies that described perceptions or experiences of isolating as a response to a positive contact. This was done across all settings. The information related to testing in these studies was then also included in the analysis (but evidence about contact testing without discussion of isolation was not included, as more evidence was available about routine asymptomatic testing). Our assumption was that the perceptions and experiences of testing and isolating were similar across the reasons for testing (asymptomatic testing programme or in response to a positive contact) and that inferences on asymptomatic testing and reporting behaviours and isolation after a positive result could be made from evidence about testing, reporting and isolating after a positive contact.

There was a paucity of evidence in relation the three priority service settings, therefore the eligibility was made more inclusive for healthcare, adult social care, and schools. For the service-specific settings, evidence was available from before the evaluation period and before LFDs were available. Many of these studies were early, exploratory pilot studies. These sources provided insights into the behaviour around testing, reporting and isolation after a positive test, and inferences could be made regarding LFD testing behaviours. Therefore, evidence focused on LAMP or PCR testing, evidence on symptomatic testing and evidence from before October 2020 was also included for these three service settings (but not for the overall testing programme).

Following the database search, all identified citations were collated and uploaded into Rayyan [8], and duplicates were removed. Following an initial screening pilot, titles and abstracts were then screened by two reviewers for assessment against the inclusion criteria for the review. Following an initial screening pilot, titles and abstracts were then screened by two reviewers for assessment against the inclusion criteria for the review. A sample of  $\geq 20\%$  were reviewed by a third reviewer to clarify eligibility criteria and ensure consistency of inclusion [3]. Once the final criteria were established, each reader applied the clarified criteria to all literature screened, and the inter-rater agreement was calculated for the final list using Gwet's first-order agreement coefficient (AC1) [9]. Potentially relevant sources were retrieved in full and then assessed in detail against the inclusion criteria. Any disagreements that arose between the reviewers at each stage of the selection process were resolved through discussion between them and with an additional reviewer if no consensus was reached.

### **Supplementary data**

UKHSA was identified as the major stakeholder in this study. UKHSA Secretariat identified a repository of data and documentation of potential relevance to the evaluation. Upon commencement of the evaluation, and where review of the documents highlighted further potentially relevant sources, additional documentation was requested by the Evaluation Consortium to support with understanding how the testing services were intended to work, how they were experienced and any prior measurement of their effectiveness. Supplementary documents provided by UKHSA Secretariat included:

- ▶ Testing guidance published by UKHSA
- ▶ Testing process documentation
- ▶ Business cases
- ▶ Primary qualitative or quantitative research (including behavioural studies) with anyone involved in the testing programme
- ▶ Documentation involving reporting, managing, or measuring the testing programme
- ▶ Previous evaluations of testing services

Once the publicly available data had been screened, these stakeholder-identified sources were reviewed for inclusion. The documents were allocated to one of the service settings. The same pair of reviewers that screened the full texts from the database searches reviewed the documents sent by the UKHSA Secretariat for the healthcare, adult social care, and school settings. Six reviewers screened the general setting documents received from the UKHSA Secretariat due to a larger number of documents. The titles and abstracts of the documents were screened, then potentially relevant sources were retrieved in full, and assessed in detail against the inclusion criteria. Repeated discussions (and oversight by one reviewer of the other five for the general setting), helped to ensure consistency of the application of eligibility criteria.

## **Data extraction, charting and synthesis**

Two reviewers per priority service setting extracted the data, with a larger team (of six) extracting the universal testing and 'other' service setting data. The data extracted from each evidence source included study metadata (authors, title, year of publication/dissemination, publication stage, country, participant characteristics and methods), the setting (service setting and key activity), and information about the perceptions, experiences and the barriers and facilitators to each of the key activities (testing, reporting, and isolating). Data were extracted into an Excel template, which was piloted and refined using a handful of included sources. Each reviewer extracted data from two sources that overlapped with another reviewer, to check quality and support discussions to refine eligibility criteria.

Given the rapid timelines and the aim of the work, the articles were not assessed for quality. Once all the data had been extracted, we synthesised the data thematically by identifying key topics within the identified perceptions, experiences, barriers, and facilitators. This was done for each service setting (healthcare, schools, adult social care and general, including universal testing and other non-priority settings). In addition, we compared the findings across all three service settings with the aim of identifying universal as well as service-specific barriers and facilitators.

## **Stakeholder input**

Stakeholder engagement is suggested to be useful for adding methodological rigour to scoping studies [3]. Therefore, stakeholders from UKHSA were consulted to identify additional sources of published and unpublished evidence, sense-check the findings and help frame the results. Additional sources identified through this route were included in the scoping review (PRISMA-ScR) flow diagram as 'stakeholder-identified studies' [6], and insights from these discussions are incorporated into the discussion of the results.

## **Schools rapid literature review**

In total, 22 articles were identified after full text review and included in the schools testing service evidence synthesis (Table 3). Seven were from academic database searches, nine were from grey literature from the stakeholder-identified sources and six were from publicly available government sources. Five studies were interview-based studies (including focus groups), eleven used surveys and three studies used a mixed methods approach. The data collection period covered June 2020 to January 2022, with eighteen studies covering time points within the evaluation period (October 2020 to March 2022). Nine included sources covered 'testing' behaviour only [10-19], ten also covered reporting a test result [11, 20-28] and five covered testing and isolation [14, 15, 29-31]. All but one of the studies were conducted in England, with one study conducted in Wales.

Publication	Methodology			Setting		Context
Reference (Includes authors, title, publication year, journal)	Methods	Description of the sample	Data collection period	Country	Scope	- Time periods - Participants - Other caveats
Woodland, L., Mowbray, F., Smith, L. E., Webster, R. K., Amlôt, R., & Rubin, G. J. (2022). What influences whether parents recognise COVID-19 symptoms, request a test and self-isolate: A qualitative study. <i>PLoS one</i> , 17(2), e0263537.	Interviews	18 parents of school-aged (4 to 18 years) children	30 November to 11 December 2020	England	Testing and isolation	This is about symptomatic testing and Track and Trace
Lorenc, A., Kesten, J. M., Kidger, J., Langford, R., & Horwood, J. (2021). Reducing COVID-19 risk in schools: a qualitative examination of secondary school staff and family views and concerns in the South West of England. <i>BMJ paediatrics open</i> , 5(1).	Interviews and Focus groups	52 (15 secondary school staff, 20 parents and 17 pupils aged between 11-16 years old) from 14 diverse schools	July – September 2020 Conducted during school summer holidays and first week of new academic year	England	Testing and reporting	Contacted schools with relatively higher levels of lower SES and BAME populations. Focused pupil/parent recruitment on year 8 (age 12-13; most had no face-to-face teaching since March) and year 10 (age 14-15; had briefly returned to school campus prior to the summer holidays; faced key exams next year)
Powell, A. A., Ireland, G., Aiano, F., Flood, J., Amin-Chowdhury, Z., Beckmann, J., ... & Baawuah, F. (2022). Perceptions of adolescents on the COVID-19 pandemic and returning to school: qualitative questionnaire survey, September 2020, England. <i>BMC pediatrics</i> , 22(1), 1-10.	Surveys	297 pupils from secondary schools. (Part of UKHSA surveillance 'SKIDS' of primary schools extended to secondary schools) Pupils from 4 secondary schools and one college in North London asked to complete additional short paper questionnaire.	September 2020	England	Testing	Questionnaire was part of surveillance programme which went to schools to take nasal swab, oral fluid and blood samples during first 2 weeks and at the end of each term
Watson, D., Baralle, N. L., Alagil, J., Anil, K., Ciccognani, S., Dewar-Haggart, R., ... & Barker, M. (2022). How do we engage people in testing for COVID-19? A rapid qualitative evaluation of a testing programme in schools, GP surgeries and a university. <i>BMC public health</i> , 22(1), 1-11.	Interviews and Focus Groups	88 staff, pupils, students and household members, from four schools (one infant, one junior, one primary and one secondary)	4 June – 7 November 2020	England	Testing and Isolation	
Marchant, E., Todd, C., James, M., Crick, T., Dwyer, R., & Brophy, S. (2021). Primary school staff perspectives of school closures due to COVID-19, experiences of schools reopening and recommendations for the future: A qualitative survey in Wales. <i>PLoS one</i> , 16(12), e0260396.	Surveys	208 (20 headteachers, 9 deputy headteachers, 106 teachers, 54 teaching assistants, 3 higher level teaching assistants, 9 support staff and 6 Other) Staff at 78 schools across 16 authorities	July 2020	Wales	Testing	

Publication	Methodology			Setting		Context
Reference (Includes authors, title, publication year, journal)	Methods	Description of the sample	Data collection period	Country	Scope	- Time periods - Participants - Other caveats
Aiano, F., Jones, S.E., Amin-Chowdhury, Z., Flood, J., Okike, I., Brent, A., Brent, B., Beckmann, J., Garstang, J., Ahmad, S. and Baawuah, F., 2021. Feasibility and acceptability of SARS-CoV-2 testing and surveillance in primary school children in England: Prospective, cross-sectional study. PloS one, 16(8), p. e0255517.	Surveys	135 children (40 aged 4-7 years and 95 aged 8-11) completed questionnaire. 711 free text comments in the questionnaires from parents (n=640) and staff (n=71)  (Part of sKIDs surveillance in primary schools)	June 2020	England	Testing	
Chantziara, S., LC, A. B., Mccallum, C. H., & Craddock, I. J. (2022). Using Digital Tools for Contact Tracing to Improve COVID-19 Safety in Schools: Qualitative Study Exploring Views and Experiences Among School Staff. JMIR Formative Research, 6(11), e36412.	Interviews	18 staff (4 senior management, 12 teachers, 1 teaching assistant, and 1 behaviour support manager)	4 June to 7 November 2020	England	Other	

Publication	Methodology			Setting		Context
UKHSA Secretariat documents	Methods	Description of the sample	Data collection period	Country	Scope	- Time periods - Participants - Other caveats
Mass testing in schools and colleges, lessons learned. DHSC/ NHSTT. 17 December 2020	Interviews	Pupils, parents and staff across 12 school pilot sites	October to December 2020	England	Testing and reporting	
User Research Insights on COVID Mass Testing: The views of parents/carers on testing primary school pupils. DfE/ YouGov. 26 January 2021	Surveys	263 parents and carers of primary school children	January 2021	England	Testing and reporting	Two survey questions commissioned with YouGov and analysis of free text responses from NHS ongoing survey on Covid-19 testing experience
Educational Settings Re-opening: Evaluation of rapid COVID-19 Testing. DHSC/DfE/ Deloitte. 10 August 2021	Mixture of different sources within one evaluation	Different sources used	February to April 2021	England	Testing and reporting	
Interim Rapid Testing Secondary Insight Report. DfE. 16 April 2021.	Surveys, Interviews, focus groups	Different sources used: Samples include parents, children and school staff	March to April 2021	England	Testing and reporting	Insight and data sources include MI team, Comms insight, REACT, Independent schools team, FE team, DfE UX team, NHS Digital UX team, DfE rapid testing delivery team
Research report- headlines from emerging findings - DPH focus groups about schools' outbreak and contingency strategies. Social Research Team. October 2021	Focus groups	Two online focus groups with a total of 9 staff from schools	October 2021	England	Testing	



Publication	Methodology			Setting		Context
	Methods	Description of the sample	Data collection period	Country	Scope	
<b>UKHSA Secretariat documents</b>						- Time periods - Participants - Other caveats
NHSTT: Parent & School Children Testing. UKHSA. November 2021	Surveys	Parents of primary and secondary school children: 501 asked about their child in primary school 503 asked about their child in secondary school	October to November 2021	England	Testing	
Secondary Schools Research Wave 2 Birmingham. UKHSA. November 2021	Focus groups	Mini groups of parents, teachers, and pupils from a range of schools in Birmingham which either encouraged testing or not	November 2021	England	Testing, reporting and isolation	Focus is on schools where testing is less encouraged, and parents/children are not testing regularly
Secondary Schools Research Wave 1 London. UKHSA.	Focus groups	Mini groups of parents, teachers, and pupils from a range of schools in Birmingham which either encouraged testing or not	November 2021	England	Testing	
School pilots experience research: User research insights and recommendations	Survey, interviews, focus groups	Conducted in-depth interviews with participating school staff, pupils, and parents across 9 schools. 15 in-depth interviews and 796 survey respondents	October to December 2020	England	Testing, reporting and isolation	Study conducted alongside school mass testing pilots

Publication	Methodology			Setting		Context
	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Publicly available government surveys</b>						- Time periods - Participants - Other caveats
COVID-19 School Snapshot Panel Findings from the April survey. IFF Research Ltd/ DfE/Government Social Research, published September 2021	Surveys	Teachers and leaders complete surveys: Primary leaders = 685 Secondary leaders = 344 Primary teachers = 563 Secondary teachers = 567	21-28 April 2021	England	Testing	
COVID-19 School Snapshot Panel Findings from the May survey. IFF Research Ltd/ DfE/Government Social Research, published July 2021	Surveys	Teachers and Leaders Complete surveys: Primary leaders = 662 Secondary leaders = 351 Primary teachers = 527 Secondary teachers = 527	12-19 May 2021	England	Testing and reporting	
COVID-19 Parent and Pupil Panel March findings Report (Wave 8). IFF Research Ltd/ DfE/Government Social Research, published May 2021	Surveys	Parents (from years 1 to 11) and secondary pupils. Parents n = 3084 Secondary pupils n = 1531	22-26 March 2021	England	Testing and reporting	

Publication	Methodology			Setting		Context - Time periods - Participants - Other caveats
	Methods	Description of the sample	Data collection period	Country	Scope	
Publicly available government surveys						
COVID-19 Parent and Pupil Panel May findings Report (Wave 9). IFF Research Ltd/ DfE/Government Social Research, published May 2021	Surveys	Parents (from years 1 to 11) and secondary pupils. Parents n = 5225 Secondary pupils n = 2335	12-17 May 2021	England	Testing and reporting	
COVID-19 Parent and Pupil Panel July findings Report (Wave 10). IFF Research Ltd/ DfE/Government Social Research, published October 2021	Surveys	Parents (from years 1 to 11) and secondary pupils (1537 pupils and 3084 parents)	30 June to 5 July 2021	England	Testing and reporting	
Parent, Pupil and Learner Panel recruitment wave 1. DfE/Kantar Public. Authors: S Hingley, E Edwards-Hughes, W Lane, C Man, A Thornton, N Coleman. March 2022	Surveys	Pupils in years 6 to 10 and parents of pupils in reception to year 10 in the 2020/2021 academic year. Parents n = 4047 Pupils n = 4228	25 November 2021 to 5 January 2022	England	Testing and reporting	

### 3.3.2 Operational findings

The intended design of the schools testing service sits within appendix 3.1; however, below we describe findings relating to the experiences of those setting up and rolling out the testing service.

#### 3.3.2.1 Key activities for the testing service to succeed

##### 3.3.2.1.1 Establishing the testing regimen

Pilot studies of testing were conducted in late 2020 in schools and colleges across different regions in England; these studies demonstrated that mass and serial testing was achievable in a school setting [32]. Ahead of the pilot studies, 'all hands sessions' were held by schools as an opportunity for parents and staff to ask questions about the proposed testing service and to better understand its purpose, implications and value [28]. The pilot studies showed that between 50 and 60 swabs for LFDs could be processed per hour by one trained member of the ATS team, dependent on an efficient process and a maximum of 5 hours of testing across the school day [28].

School staff were instrumental in managing the administration process and the arranging of pupils and staff to be tested, including the registration process and data management [28]. School leaders and teachers surveyed in a large, 'school snapshot panel' survey in July 2021 [33] indicated that a large majority (78%) of secondary school leaders and 36% of secondary school teachers had been involved in some way with the support of testing. School leaders had been involved with supporting home COVID-19 testing for staff (61%) and for pupils (65%), and more than half were also involved in supporting onsite testing for staff (54%) and pupils (59%). Secondary teachers were most likely to be involved in supporting home testing for staff (24%) and pupils (21%). Secondary school leaders spent a median of one hour (in the previous week) supporting testing activities, while secondary teachers spent a median of 20 minutes doing so. However, it was also noted in a previous UKHSA evaluation and by school stakeholders that staff resourcing to oversee the testing process was often cited as a challenge [26].

Support in the form of cross-organisation group meetings, including partners such as the local authority, Directors of Public Health, and parents/carers, was deemed to be extremely useful in overcoming barriers and concerns ([34]; stakeholder interviews).

#### 3.3.2.2 Setting up the site

##### 3.3.2.2.1 Communications

In late 2020, following the pilot studies, recommendations were made about best practice for communications; these included ensuring that the sharing of information occurred in stages and in more digestible formats, including testimonials, and that pupils and parents be adequately prepared for upcoming changes [30]. A later study, focusing on initial experiences with the testing service, also identified certain techniques and initiatives that helped encourage uptake of testing [34]. Recommendations included clear communication that was short and to the point, with reminders to test and report. Different communications channels could be used depending on the target group, while holding classroom discussions about testing was also thought to be helpful.

The above recommendations are in line with feedback received from interviews held with school stakeholders, who mentioned that the timing and content of guidance delivered throughout the pandemic was not optimal, with guidance needing to be delivered with adequate time to operationalise and executive summaries needing to be clear within the documents, to prevent staff having to re-read large amounts of content.

Headteachers and staff felt there was a considerable expectation of them to lead on communicating the purpose and anticipated benefits of the school's testing service, although this was prior to the rollout of asymptomatic testing being implemented [28]. Results from the school snapshot survey in July 2021 found that 46% of school leaders felt the activity that took up the most time was answering parental queries, followed by ongoing communications to maintain or increase engagement in testing (39%), providing advice on testing (38%) and reading daily updates from DfE (38%) [33].

Of note is that local organisations such as NHS trusts and city councils were perceived to be credible sources of information and were described as potentially preferred organisations to run testing services [14]. To facilitate trust and the uptake of testing, participants highlighted the importance of clear and transparent communication about the testing service, including the rationale for it, what it entailed and data protection issues:

“

I would say that communication-wise from school to parents to communities — it has been strengthened ... Our head teachers have been incredibly good with communication. School staff focus group participant [14].

### **3.3.2.2.2 Space**

Having sufficient space to ensure privacy for pupils who were testing and for those who may have needed to isolate was a challenge for some smaller schools [28]. Many schools did not have the capacity to have a permanent testing set-up, and so a daily set-up was needed. In these cases, and in some others, confusion around the configuration of the room ensued. The move to home-based testing addressed some of these difficulties, although there was a decline in participation rates [26].

### **3.3.2.2.3 Logistics**

Dealing with large quantities of delivered items, including test kits and PPE, felt overwhelming to some schools. Difficulties also arose when completing stocktakes of items, as it was found that inventory management was a labour-intensive process and an additional task for a school's workforce [28].

Ahead of the initial planned rollout of testing in January 2021, headteachers and teaching unions were concerned that the plan was 'inoperable' due to the short timeline to set up over the Christmas holidays, when staff were on leave and at a time that many changes to the guidance and wider public policy were in play [35].

Although testing over the summer of 2021 was paused within schools, some schools did open as summer schools; in these cases, NHSTT provided support with contact tracing. Pupils were advised to access tests through their local pharmacy or order tests online if unavailable through their school [36]. Data from a parent, pupil and learner panel (PPLP) survey, published in March 2022, found that around 11% of secondary school pupils attended a summer school, with attendance higher among pupils considered to have SEND [24].

### **3.3.2.2.4 Consent**

Gaining consent from parents and pupils was seen to be time consuming, and it was difficult to obtain signed consent forms, although fewer rural schools noted this to be a challenge [26]. This was particularly difficult when consent forms were in paper format, which was thought to lead to human error and decreased participation, whereas participants who used an electronic consent form found the process simple and easy to access, with no concerns that their child may forget or lose the form.

Some schools only offered home testing to parents/pupils who had consented to onsite school testing; therefore, a large cohort of pupils may not have been aware of the offer to home test [25].

### **3.3.2.2.5 Provision of tests**

By 7 March 2021, the then prime minister stated that nearly 57 million LFDs had been delivered to schools and colleges since deliveries began in January 2021; a further 77 million test kits were planned to be delivered during the next two weeks (the start of the rollout of the asymptomatic testing service in schools) [37].

Certain school settings, such as special schools and independent schools, reported that they lacked sufficient kits to be able to comply with the recommended testing regime [25]. Project teams worked with NHSTT to resolve this, and additional deliveries were made to these schools prior to Easter 2021 [25].

Where there were supply issues, parents were directed to order LFD kits from a pharmacy or online, which for some may have created a barrier to accessing tests [16]. However, during times of outbreak management, when the supply of tests may have dipped, council staff or mobile testing units would sometimes be deployed to schools to ensure testing was easily accessible and available [16].

Local responses to outbreaks were thought to be more favourable than national ones, although it was thought schools may have needed help in distributing kits. Each situation and area had a different level of need, with responses and planning unique to that area. Consensus among members of focus groups was that local control and management of test kit delivery during outbreak management was better than relying on national or central deliveries, especially at times of low supply [16].

Changes in national policy and procedure were not always communicated clearly and efficiently, e.g., the change in LFD kits, from Innova to Orient Gene [16].

### **3.3.2.2.6 Training and comprehension of instructions**

Videos were cited as one of the most engaging methods for training across various platforms, and the use of digital systems to allow pupils and staff to raise issues or concerns was helpful [34]. However, a limitation of online or video training was that it was difficult to have questions answered in real time, with in-person demonstrations considered most helpful by the workforce [28].

Other lessons learned from pilot studies conducted in late 2020 included:

- ▶ There was a feeling that a trained workforce was lacking and there was a lack of remuneration for the additional time and effort involved.
- ▶ The evolution of clinical standard operating procedures (SOPs) made it challenging to remain up to date with the latest clinical guidance.
- ▶ Some schools received swab training provided by Boots, which was deemed helpful despite training focusing on PCR tests; this did however cause difficulties with the packaging and processing element of LFD tests.
- ▶ Using a workforce and training materials that were representative of the community proved beneficial.

It was felt that additional support was needed for special schools or for testing pupils with SEND. A lack of staff resources, the complex needs of the children, and a lack of testing-type options made it difficult to test this cohort of children [26]. There was very little guidance for parents testing children with SEND or other medical needs [27].

#### **3.3.2.2.7 Reporting test results**

Some schools only asked for positive LFD results to be reported, to avoid having to deal with a high volume of negative results [25]. During the initial rollout of the testing service, the high volume of test results being uploaded slowed the system down; there were also comments about technical issues when submitting results [25]. It should be noted that the system or technical difficulties could have been due to the speed of the roll out. Some schools lacked the infrastructure to support the digital process, e.g., where schools did not have the internet accessible in the testing room and therefore cross-checking results or registering results was time-consuming and left considerable room for error. Staff reported taking on extra days' work to manage all the test results, anonymise them and send them off [28].

Some schools experienced difficulties in obtaining reliable contact information for their local Director of Public Health or local authority public health teams to report outbreaks within their schools and therefore lacked clarity over subsequent decision-making [35].

#### **3.3.2.2.8 Post-result behaviours**

For some schools, the active management of 'bubbles' took substantial periods of time, especially when multiple seating charts covering several days had to be examined to identify close contacts, with further follow-up with parents to inform them [28].

A Joint Biosecurity Centre Insight Report noted that a survey of 8000 teachers in England showed that 79% of secondary schools had asked only children who had been sitting closest to a case to self-isolate, while just 11% asked all children in the same class and 5% in the same year bubble [38]. Some schools created their own systems of contact tracing and a system to monitor retesting results, isolation dates, and, at times, the organisation of transport home for pupils [30].

### **3.3.3 Full qualitative behavioural insights**

#### **3.3.3.1 Behavioural insights – Barriers and facilitators to taking and reporting a test**

##### **3.3.3.1.1 Testing participation and factors affecting participation**

Between August 2020 and July 2021, DfE commissioned a COVID-19 Parent and Pupil Panel, which focused on topics related to the pandemic and views and experiences of parents and pupils during that time. A subsequent commission of the Parent, Pupil and Learner panel covered another part of the evaluation period, from November 2021 to January 2022.

Self-reported participation recorded during the collection of Parent and Pupil Panel survey data showed test taking among secondary pupils steadily declining, from 91% in March 2021 [21] to 85% in May 2021 [22], 76% in July 2021 [23], and 68% between November 2021 and January 2022 [24]. Similar figures were observed for parents of secondary pupils when asked whether their child had taken any COVID-19 tests in the previous seven days.

The results showed that compared with May 2021, not only were pupils taking tests less frequently in July 2021, but they were also taking fewer tests overall. It was most common for both secondary pupils (57% versus 68% in May 2021) and parents of secondary p (63% versus 76% in May 2021) to report they/their child had taken two tests at home in that time period.

##### **3.3.3.1.2 Geographical differences:**

Other factors outside the control of the pupil were seen to be potential factors as to whether they were more likely to test regularly. Secondary school children from affluent households were more



likely to test regularly; furthermore, if a child was at a school that encouraged testing and their own parents tested themselves regularly, this increased the likelihood that pupils would test regularly versus children who were in 'urban adversity' households, had parents who did not test, or whose school did not actively encourage testing [19]. More than one in three parents in the last of these groups felt that asymptomatic testing was not important in helping to manage COVID-19; however, 39% of this group were still concerned about the threat of COVID-19 to their child's health.

Other studies have described participants' views of the risk of COVID-19 reducing over time due to vaccine rollout, lower prevalence in the community, and reduction in hospitalisations; as such they felt that testing was less important [17, 20, 31]. This led some to question the efficacy and usefulness of testing for children [18].

“

We have only detected 2 cases through the lateral flow testing. Infections in the community are far lower than they were, and the priority groups of staff based on the government's priority groupings have now had at least their first dose of the vaccine. Leader, secondary school [17].

### 3.3.3.1.3 Logistics and access to testing

The logistics of accessing and undertaking a test were highlighted as crucial barriers or facilitators to testing. These related to several issues. First, (although the study only examined PCR testing for symptomatic illness, it could be relevant to confirmatory PCR testing and therefore considerations for future testing models) parents noted that the availability of appointments and access to testing sites was key [14, 15]. While appointments available locally were greatly appreciated [14], situations where distances to testing sites or drop-off points were long were considered to be stressful or to make the testing process difficult [15]:

“

It was a bit harder to get an appointment. I had to keep checking every hour or so for about. I probably had to check about 18 times before they came up with a space. They kept on recommending that I go to London to do it, which is two hours away. Then finally we found. We got a space near us. (Parent). [15].

Thus, some participants made suggestions to improve access to testing through more accessible drop-off points or postal deliveries of tests [14]. Although it is recognised that this may not be possible within the early stages of a pandemic due to the rapid roll out required.

Second, waiting for the test result (mainly with PCR tests or for pilot LAMP tests) at times created feelings of anxiety [14]. The length of time waiting for the test results also seemed important, with uncertainty around how long one may need to wait for the result seen as difficult. This uncertainty meant that parents reported difficulties in making practical decisions for their households, e.g., in relation to ensuring having food in the house, cancelling social activities, or informing their employer or their children's school about their possible absence [15]. In addition, a short waiting time (within 48 hours) was valued, with longer waiting times making the period of awaiting the test result stressful [11, 15].

Third, in one study conducted at the end of 2020 with a variety of stakeholders, including pupils, parents and staff, suggestions were made to ensure that all participant-facing materials were translated in a timely manner to engage people from ethnic minority groups [14]. In addition, providing clear and transparent communication about the testing service to stakeholders at all levels was also perceived as an important ingredient for engaging with the testing service [14]. It is however noted that translated materials and accessible content was produced by PHE at the time, with links attached within the Schools and Colleges Handbook published in December 2020 [39], although it is possible that pupils, parents and wider school staff may not have been made aware of the additional resources.

Finally, setting up a testing service was perceived to increase staff workload and required time, effort, and substantial resources (both for mainstream schools and special schools) [11, 14, 25, 30, 40]. Some teachers felt that other measures such as social distancing and hygiene were more effective [20]. Teachers felt an excessive amount of responsibility on them to test children and monitor testing performed at home, alongside keeping up with educational activities [17, 31]. School leaders and teachers most commonly reported how difficult it was to control whether pupils and staff were actually taking their tests, with a belief that only a minority were testing [20].

“

I believe that the majority of staff and students are choosing not to use the home test kits that they have been provided with. Therefore, the testing is ineffective in its operation. Teacher, secondary school. [20].

Without external resources and investment, staff felt ongoing testing would be unsustainable [28]. The set-up of the testing site itself, in terms of location and space, was also perceived as a difficulty due to considerations such as the correct temperature of the site and having sufficient room for pupils to test in privacy while also awaiting their test result [28]. Suggestions were made to provide more detailed guidance on how to implement the testing service [14].

#### **3.3.3.1.4 Factors related to testing experience**

While participants expressed their enthusiasm for the testing service, studies also reported that pupils, staff, and parents had concerns around tests being an uncomfortable and painful experience [15, 27, 28, 30]. For some parents and carers, the difficulty experienced while trying to test their children was enough to put them off future testing [27]. For others, however, repeated testing and gaining confidence in the service led to nearly 60% of pupils stating they would be willing to get tested again [28].

Helpful tutorials, with specific, detailed information about the testing service for pupils and staff, as well as training given to staff administering tests, helped ease concerns [27, 28]. In particular, media coverage about schools reopening, involving media personalities such as Dr Ranj Singh and Dr Amir Khan, helped reassure pupils and parents about the testing process [26]. Ensuring pupils and staff had sufficient time to review relevant information was also deemed important, particularly for consenting to participate in the testing service [30].



A link for a child friendly video for children to watch via YouTube before the test would be such a help. It took a long time to keep him calm and get it done. I know not all children are the same, but a lot are terrified of the tests. (Parent/carer). [27].

A further facilitator to testing was knowing that although participating in testing was strongly encouraged, it remained optional; being able to withdraw from testing at any point removed a barrier to participating [30].

Test type seemed to be an important factor related to the acceptability of testing; Aiano et al. and Powell et al. explored pupils' perceptions of undertaking different types of testing before and after testing, as part of PHE's prospective surveillance programme in primary and secondary schools respectively [10, 41] to assess the feasibility and agreeability of large scale surveillance and testing for COVID-19. In primary schools, prior to sampling within the study 81% of primary school pupils reported oral fluid sampling to be acceptable, followed by throat swabs (59%), nose swabs (58%) and blood tests (37%). Thirty-two percent of pupils reported feeling 'very nervous' about blood tests. Older children (8-11 years) were found to be less worried about the tests than younger children (4-7 years), with the exception of blood tests [10]. Similar findings were made in secondary schools, with pupils worrying most about blood tests (24%), followed by nasal swabs (10.8%) and oral fluid samples (3.42%). Notably, in primary schools, most children after completing the test reported the testing experience to be 'better than expected'. When asked about future testing, 54% of pupils indicated willingness to test using nose swabs, followed by 53% using oral fluid, 50% using throat swabs and 37% using blood tests. These preferences were aligned with parents and primary school staff views, with both parents and staff preferring nose swabbing (63% and 54%, respectively), followed by throat swabbing (37% and 43%, respectively), and oral fluid samples (46% in both groups). It is worth highlighting that 42% of parents of primary school children refused blood tests for their child, and just 31% of staff and 11% of parents reported their willingness to engage with blood testing. A qualitative study involving school staff, parents and pupils also highlighted the ease of conducting a saliva test in comparison to the PCR test, and the ease of getting the result. These results were further supported by findings from an NHS survey, where parents would prefer to only use nose swabs or saliva tests for children, especially for children with special needs [27]. The studies demonstrated here demonstrate mainly acceptability factors rather than the specific effectiveness of the different type of testing methods.

Related to comfort and the practicality of the test itself, for staff involved in assisting pupils with their testing, the size of the swab made it difficult when inserting it into smaller noses, therefore a smaller swab and having more than one size in each kit would make swabbing easier, especially among smaller children [27]. The location where testing was conducted also had an influence, with home testing perceived as daunting for some parents and more comforting for others.

#### **3.3.3.1.5 Trust in the test, its result, and the testing process**

Trust was a multi-layered issue, highlighted by various groups. First, some parents, staff and pupils highlighted their trust in the government and that their data would be processed in an appropriate way [15, 30], which helped them to engage with the testing service. In contrast, some participants expressed their concerns about testing services collecting personal data [11]:

“

I understand the need [(to collect data)] but on the same token, it's just that personal data being collected about my child makes me feel very uncomfortable. (Sarah, mum, S4) [11].

Crucially, some participants who declined to take part in the pilot programme involving saliva testing expressed their concern about losing control of their data when the programme passed it to NHS Test and Trace if they tested positive [14]. Some pupils also felt that at times of rapid changes in the guidance, their trust in the government was undermined, not fully trusting why the changes were taking place [30, 31].

“

We were told the testing method would not be invasive — a saliva sample. Last minute, the school sent an email to say it will be an invasive method — throat and nasal swab. This should have been cleared up earlier. Student. [30, 31].

Of note is that participants in the study felt that the local NHS Foundation Trust and its partnership with the local university and council was trusted more so than the wider NHSTT in terms of handling their personal data and being more 'answerable' to the community in a way that NHSTT could not [14]. To facilitate trust and uptake of testing, participants highlighted the importance of clear and transparent communication about the testing service, including the rationale for it, what it entailed and data protection issues [14]:

“

I would say that communication-wise from school to parents to communities — it has been strengthened ... Our head teachers have been incredibly good with communication. (ID46, school staff, focus group) [14].

Second, participants were concerned about the accuracy of the tests and whether self-administering tests could decrease their accuracy [15, 25], as well as worrying about false-positive results [14, 27]. Findings from the COVID-19 parent-pupil panel and school snapshot panel surveys found concerns around false-positive results to be significantly higher in pupils and staff in March compared with the level of concern in April [21, 22]. Conversely, some teachers and school leaders found it hard to believe that so few pupils and staff were testing positive, assuming there must be false-negative results [17, 20]. A lack of understanding on how an LFD works to produce an accurate result may also have led to suspicions.

“

I was suspicious about the accuracy considering the test results came out in 20 minutes. (Student) [30].

Third, some parents, pupils and staff had concerns about theories or messages they had heard in the news or social media about tests being mixed with the vaccine, or that data were to be sent off for misuse. As a way to counteract this, schools sent out their own communications and narratives to parents and so built trust [28].

Similar to other issues, clear communication and information were perceived to be useful in addressing these concerns [14]. In particular, some teachers felt it was part of their role to hold conversations around myths and conspiracy theories and to comfort pupils [18].

Finally, some participants expressed concerns about PCR testing sites and drop-off points potentially increasing their chances of getting infected [14].

### **3.3.3.1.6 Perceived value of testing**

The school snapshot panel survey held in May 2021 [20] found that more than half of secondary school leaders and teachers felt testing to be very important (54%), however this was a considerable decrease from the April survey (60%) [17]. However, 84% said it was at least fairly important, which was in line with the findings of the April survey (86%). Similar results were found when asked about the importance of testing staff.

Seeing the value in testing was an important enabler for several stakeholders. Parents appreciated access to testing [15], and testing was perceived as potentially serving a number of purposes.

First, testing was seen as bringing reassurance through knowing whether they were infected, including that they were not infecting others [14]. In one study, when asked hypothetically about taking part in a monthly testing programme, parents and school staff regarded it as potentially providing a reassurance for pupils, parents and staff about school being a safe environment, which in turn could encourage attendance [11].

“

If there was a risk, we were going to get the virus and it would make everyone safer then I would do it [(regular testing)]. (Pupil, yr 10,) [11].

This was further supported by survey findings conducted during the autumn term of 2021/2022, which suggested 80% of pupils and 74% of parents felt safer at school during the pandemic due to regular testing. Testing of staff was also seen to be important, with a large majority of both parents and pupils (84%) agreeing that staff should also be regularly tested [24].

Thus, some staff highlighted the benefit of showcasing the potential benefits of testing services as reducing the risk of whole-school closures [11], to increase uptake. In fact, additional activities describing the testing service seemed to also increase participants' understanding of the service, which in turn increased their motivation to protect their communities. In addition, finding a common goal was appreciated among various stakeholders [14]. In contrast, a minority of parents and staff were concerned about potential school closures, with consequences for children, parents and school staff due to positive cases being identified [11]. Some parents (a minority) also felt that a testing service of this scale was expensive, too time consuming and a waste of resources [25, 30].

Second, participation in testing services was seen as an activity to be proud of, or even a privilege [14, 28], and felt that testing could enable them to engage with their activities in a safe way [14].

“

I have really enjoyed being involved in this programme as a contribution to society and to science. It has been a privilege to be a part of it. Headteacher/staff – school [28].

### **3.3.3.1.7 Understanding of testing requirements and perceived capability to undertake the test**

When surveyed, 74% of respondents in secondary school settings stated they were aware of the current testing guidance [19]; in another study, 82% of pupils and staff felt the instructions they had been given were easy to understand [30]. For earlier mentions of participants wanting adequate information and guidance, this must be balanced by providing information with sufficient time for individuals to understand the testing requirements, as otherwise this could be overwhelming, as was mentioned by school staff [28].

Any information provided must also be suitable for the reader, as some families for whom English was not their first language were said to struggle with understanding the instructions for the test [27].

Moving from onsite testing to home testing elicited some concern from a minority of pupils; this tended to be more prevalent among certain subgroups, including white pupils, pupils eligible for free school meals, pupils with SEND, and pupils who reported they were exempt from wearing a face covering [26]. Parents also shared some concerns around home testing and whether they were able to perform a test accurately, when they should hear back about results, and how to register results [26].

A prominent point that arose from one study was the issue of responsibility for overseeing home testing. For staff, some questioned why parents were not taking more responsibility with testing rather than leaving it all to schools to manage, whereas for parents, some felt disempowered to enforce their children to test or did not see it as their role [31]. Teachers felt there needed to be a consistent message across all schools in an area, to appear united. The authors felt that when pupils were faced with what they felt to be an abdication of responsibility among parents and/or schools, pupils were left in an 'authority vacuum', with no-one to enforce testing on a regular basis.

### **3.3.3.1.8 Perceived consequences of testing**

First, parents highlighted that having to isolate several times was a factor in considering whether to request a test when their child was experiencing symptoms [OPN survey in March 2021, cited in 15, 26]. This was linked to being concerned about having to request time off work or children missing school for extended periods of time:

“

Yes, because, I mean, a couple of times I've had to have time off work because someone in my daughter's class got tested positive and then again when I had to do a test. About four months ago I had to take time off work, so I'm starting to feel a bit guilty and bad for my employer, so I'm definitely starting to think about it [getting a test] a lot more. (Parent) [15].

Some participants reported worrying about the consequences in case of a positive test result and whether they had unknowingly passed the virus to someone else [14]. Of note was that some participants reported that despite their worries about the consequences of isolation, they intended to prioritise taking a test [15] and that thinking about the altruistic nature of testing helped them to counterbalance their anxieties when waiting for a test result. Consequently, it was highlighted by parents, staff, and pupils that the communication around testing was important and should address participants' sense of community, thus speaking to the altruistic need to engage with testing [14]. This sense of community was also seen at the school management level, with staff highlighting that taking part in the testing service helped to connect with senior stakeholders in their community, and that testing served a good cause [14]. Headteachers also received thanks from parents for their efforts in keeping children at school [28]. Testing was seen by school staff as one way of helping them to feel safe when going back to school, alongside other measures, as some reported feeling vulnerable:

“

As a vulnerable member of staff, I fear going back with a full class and spending the day trying to distance myself. How can I teach properly like that?” (Year 1 teacher) [12].

Although enthusiasm was shared by teachers for the testing service, some felt that testing within schools caused disruption to lessons and led to lost learning time due to children having to leave class to test [30, 40]. Concerns also factored in the possibility that higher levels of testing could lead to an increase in absenteeism, both from more pupils testing positive but also from children who may try to fake positive results, all of which could contribute to poor attendance records or school performance [31].

### 3.3.3.1.9 Social influences

Parents, staff, and pupils felt that a sense of community was an important factor that influenced their engagement with the testing service. Specifically, this seemed to be achieved as a result of schools being small, closely knit communities where pupils and staff saw each other on a regular basis, had opportunities to talk about the testing service and could encourage each other to take part [14, 31]. Opinions about the testing service among peer groups and parents were seen to be influential in personal decision-making to consent to taking part [30]. It was felt by pupils that the more people participated or were seen to be participating in testing, the more likely the service would be effective [28].

In one study, the majority of parents reported their child's secondary school was encouraging children to test at home, which led to a higher likelihood that children would test. Specifically, 77% of children at these schools were testing once a week or more, compared with just 21% of children who were at schools that did not encourage testing [19]. Linked to this was the quantity of correspondence schools shared with parents, whereby a lack of 'news' about COVID-19 within the school gave the impression it was no longer a priority to test; parents suggested that for them to feel motivated to encourage their children to test they needed to feel as if the school remained proactive in this area [31].

Making enrolment in the testing service automatic may have normalised the decision to take part in the service [14]. It was also highlighted that the way test results were received was important, with families noting the need to ensure discretion and anonymity when being notified of positive results [11].

### 3.3.3.2 Reporting of test results

In May 2021, COVID-19 parent-pupil panel survey findings showed a large proportion of secondary pupils and parents self-reporting that they had reported test results in some way (81% and 82%, respectively, with the majority reporting via the gov.uk portal, followed by informing the school or other education institution) [22]. However, findings from July 2021 showed a reduction in reporting of test results, which was observed among both pupils and parents (73% and 74%, respectively). There was also a higher proportion who did not report their results at all (16% for both pupils and parents in May 2021 versus 23% for both pupils and parents in July 2021) [23]. This decline was also observed by school leaders, although it is not clear whether this was due to a lack of testing or a lack of reporting.

“

At the beginning, it provided confidence for staff/students/parents — it maybe still does but there has been a significant decline in the number of reported tests. Not clear if this means they are not doing it or not reporting it? (Leader, secondary school) [20].

Previous reports indicated that some subgroups were less likely to report their test, including older pupils in years 11 to 13, pupils from Black, Asian and minority ethnic groups, and pupils eligible for free school meals [23].

The use of different platforms to report results was cited as confusing and time-consuming by some parents of secondary school children [25]. Some pupils who were awaiting their result from the schools testing service wanted to know their result even if it was negative; they subsequently wished to receive information and guidance on what to do with that result [25, 30].

#### **3.3.3.2.1 Logistics of reporting a test**

Logistical issues with the schools testing service were raised around the initial communication between DfE, local authorities' public health teams and schools, with a lack of understanding of roles and responsibilities creating difficulties for decision-making, as mentioned in a report from the Institute for Government [35]. However, conversations held with school stakeholders suggested that relations improved with local health teams and in fact became a vital support network, particularly for the school leadership team [stakeholder interviews]. School leaders were able to establish a system to report outbreaks (positive test results) to their local health teams and receive support and advice rather than relying on UKHSA or DfE [stakeholder interviews]. Comments were made about the additional burden and time needed to manage test results and issues with the system itself for uploading results, which increased during times of bubble testing [25, 28].

Parents and carers also found reporting results to be an additional burden, especially when having to report positive results for multiple children in the same household, which would subsequently result in multiple calls for contact tracing [27]. It should be noted that households in which only parents were testing or with one child were more likely to express having a positive experience [25]:

“

Once results were announced we received countless phone calls asking the same information. Can there not be a cross-reference for phone calls? I know it's important, but it was repetitive at a time my children were very poorly and I was very unwell. (NHS survey respondent) [27].

“

When a whole household test positive, the household members should be able to be linked somehow to prevent having to go through a 20–30-minute phone call for each household member for track and trace (especially children). (NHS survey respondent) [27].

#### **3.3.3.2.2 Perceived consequences of reporting a test**

For families and staff asked about the prospect of reporting a test to schools or NHSTT, many of them anticipated that there would be an element of under-reporting [11]. At the time that study was conducted (July to September 2020), some participants, especially individuals who were members of an ethnic minority, felt there was a stigma around contracting COVID-19, and they anticipated negative comments from others. A lack of reporting results could also have been due to a fear of missing out on work or school [11, 27]. Parents surveyed in a different study also felt that schools might not want to admit that COVID-19 was in their schools and would be reluctant to communicate this type of data [18].

Conversely, from a school staff perspective, the same level of stigma was not anticipated due to the understanding of COVID-19 among a diverse school population; however, it was appreciated that there may be individuals within a school who 'love to joke and point a finger' [11].

#### **3.3.3.3 Barriers and facilitators to isolating**

##### **3.3.3.3.1 Overview of themes in relation to isolation**

Within the key focus of the section, namely the barriers and facilitators to isolation behaviour, we identified a number of sub-themes. These are summarised in Table 3, which also identifies the studies reporting these sub-themes. We describe them in turn below, with supporting quotes.

##### **3.3.3.3.2 Experience of isolating**

Not only was the experience of isolating reported to be difficult for families and school staff to complete but the steps taken to identify close contacts to isolate was also deemed as labour intensive and at times inaccurate [29], potentially leading to unnecessary isolation. Isolation was described as something that could be prepared for; if that was not the case, support from employers or close social connections was needed to adhere to guidelines [15].

##### **3.3.3.3.3 Trust in contact tracing**

Before the school testing service was rolled out, reported inconsistencies in communications with NHSTT left parents feeling that the service was unreliable. On one hand, parents who were expecting to be contacted by NHSTT due to being a close contact of a known positive case were not then contacted, thereby reducing future engagement with the service [15]. On the other hand, when contact was made from NHSTT, parents felt bombarded from the repeated number of conversations they had to have and



the need to provide similar information to multiple individuals, especially at a time when they may have felt unwell [15]. Parents therefore felt less motivated to engage with the system overall.

“

It was a bit too much. When someone's not that well and you're phoning every day, sometimes you're getting your phone call two or three times a day. Then, next day, another two calls. Then, another call. You're saying the similar thing, by the way. (P02) [15].

For staff in schools, similar concerns of inconsistencies were raised with the technology used to identify individuals who may have been in close proximity to a confirmed positive case. Concerns revolved around the possibility of false proximity alerts, which would cause staff to self-isolate unnecessarily [29].

In a similar vein, parents were also concerned that if their children frequently needed to isolate due to being a close contact, this could impact their education further after having missed school during closures [15].

It is therefore important to ensure that contact tracing is as accurate as it can be and, where possible, reduce the need to isolate on multiple occasions.

#### **3.3.3.3.4 Logistics of isolating**

The logistics of isolating, both within the household and in terms of being unprepared for isolation, were described as a barrier to adhering to the guidance at the time. For parents with younger children or for those who lived in large, family-shared households, maintaining distance or isolating in different parts of the house was not feasible; there was an expectation due to this close proximity that all members of the household would contract COVID-19 [15, 30].

“

I think it's unrealistic to isolate within the household. If my daughter gets it, it's unrealistic for her to stay in her room and not come out. Parent [30].

Parents and staff also felt that isolating as a family in one house could affect family harmony, with particular risks for the mental health of pupils who were away from their peers, education and outdoor activities [30]

For parents who may have been less prepared for the possibility of isolating, personal judgements were made as to whether to break isolation for activities deemed to be 'essential'. For example, dropping children off at school or buying sufficient food shopping for the family was deemed acceptable during the period when waiting for a test result [15].

“

The time between being ill and waiting for that test result to come back, I did go out and about. I did limit it, because I was thinking, I'm waiting for a test result — but there were some certain things that I had to do and, unfortunately, as a mum, you still need to go to the shops, and you still need to do things. (Parent 11) [15].

Other families however, described always being prepared for the possibility of self-isolation, which had been gained from previous experiences of similar lockdown events and therefore had enough supplies to stay at home.

“

I was aware that this could happen at any moment in time, more in actual fact during the winter time we had snow up here in the North of England where we got cut off for a few days, I've had flu before so I've always got lots of soup, things in the freezer, it's kind of an eventuality so I didn't even have to ask somebody to go shopping for me, I just said right we're on lockdown until the test comes back so we had five or six days in the house where we just stayed at home. (Parent 4) [15].

#### **3.3.3.3.5 Social influence on logistics of isolating**

A key facilitator for families was the reliance on additional support outside of the household to help with essential activities and obtaining supplies but also receiving support and flexibility from employers to work from home while self-isolating [14, 15].

“

It's very difficult but, when we told people, we got a lot of help. We are very lucky. We've got an amazing support system in our life. We've got friends. We've got families. Obviously, people wanted to help us out; 'We'll bring some food for you guys.' (P02) [15].

Reliance on social support during isolation requires people to feel as if they can ask for help; for the participants of one survey, there was a feeling that they may experience stigma for testing positive and may therefore be less likely to ask for or receive help [14]. The authors suggested that these individuals would need reassurance and social support when dealing with a positive test result.

#### **3.3.3.3.6 Logistics of identifying close contacts of positive cases**

During the time when schools were asked to identify close contacts of positive cases, various methods were used to achieve this, including digital and manual seating plans; interviews with pupils, parents, and staff; reviewing CCTV footage; and using mobile proximity tracking. A barrier associated with many of these methods was the labour intensive nature of identifying contacts, but also maintaining consistent accuracy when pupils may have changed their allocated seat, if updates were not made to seating plans, or if there was misremembering of their close contacts [29].

Although accuracy was a concern for some participants, others felt that accuracy could be increased by the use of digital solutions rather than manual identification, for example by scanning QR codes on desks or using mobile systems that could measure and track proximity between pupils and teachers [29].

When using technological solutions, concerns revolved around privacy violations, particularly the fact that pupils would be 'monitored' and therefore there would be a need to obtain consent and the anticipated difficulty in obtaining consent from everyone who may have appeared in the footage [29].

Contact tracing for primary schools was deemed a simpler process due to each class forming one separate bubble and all of the pupils isolating in the event of a positive case, rather than relying on young children to identify their close contacts [29].

#### **3.3.3.3.7 Understanding of requirements to isolate**

Understanding the self-isolation guidance, particularly around when to begin isolation and for how long, was a barrier to isolating effectively for some pupils [30]. This was further compounded when guidance around the duration of isolation and close-contact protocols changed [31].

#### **3.3.3.3.8 Consequences of isolating**

For some parents, the anticipated difficulties they may have faced with their employers or the burden on family members due to self-isolation was a barrier to testing in the first instance. This was especially the case for parents who had children who may have been asked to isolate on a number of occasions [15].

“

Yes, because, I mean, a couple of times I've had to have time off work because someone in my daughter's class got tested positive and then again when I had to do a test. About four months ago I had to take time off work, so I'm starting to feel a bit guilty and bad for my employer, so I'm definitely starting to think about it [getting a test] a lot more. (Parent 15) [15].

“

I couldn't go into work for two days until I got my test results back when I had my test, so that was not particularly great. It meant that I couldn't drop my kids off at school. My husband had to leave for work late because he had to do that because I wasn't allowed to leave the house. Yes, I definitely would double check that there's definitely something wrong with them before I think about making it official and getting tested. (Parent 15) [15].

For pupils in particular, there was a concern that self-isolating from school may cause them to miss out on studies and engagement with teachers and classmates [30]. Staff also found it difficult to communicate and teach remotely when having to self-isolate [30].

#### **3.3.3.3.9 Derivation of value from isolation**

Taking the decision to isolate after being in contact with someone who had COVID-19, even if not instructed to do so, was perceived as a way to protect others [15]. However, it was also a way to avoid increasing the risk of either catching or spreading COVID-19 at a testing site.

Despite the earlier barriers mentioned regarding the consequences of isolation, such as impacts on education, parents still saw the value in testing and isolating when needed: 'health comes first' [15].

## 3.3.4 Stakeholder engagement

### 3.3.4.1 Methodology

The key objectives of engaging with external stakeholders (who were part of school leadership teams, local authority public health teams or who had played a large role in policy/operations during the COVID-19 pandemic) were to discuss this evaluation's initial findings, understand their perspectives, and test some of the emerging recommendations via semi-structured interviews. A further objective was to identify dependencies and test whether the proposed recommendations would help meet the intended objectives of the testing service. Discussion guides were developed to support the semi-structured interviews.

Following receipt of relevant ethics approval, an initial introductory email was shared by internal UKHSA stakeholders with their contacts across schools and local authorities, informing them of the opportunity to engage in the interviews. Once a stakeholder had informed the team of their interest in participating, consent forms were signed and collected. The results of these discussions informed the recommendations chapter of this report (chapter 3.10).

In total, we spoke to 13 individuals who were either school leadership team members, local authority public health team members, education leads or internal UKHSA stakeholders. All participants were actively involved in the sector during the pandemic. The sessions were conducted remotely (via Microsoft Teams), lasted approximately 60 minutes and, for transcribing purposes, were recorded. Each participant had submitted their signed consent form and verbally agreed to the recording. At the culmination of this evaluation, all recordings and transcripts will be deleted; all quotes used in this report have been anonymised.

### 3.3.4.2 Stakeholder insights

As part of the stakeholder sessions, we tested several key findings that came out of this evaluation. Please see below for the themes that were collated against each.

#### **Key finding 1: There was a significant gap between number of tests distributed to schools and the number of tests reported**

##### **Sub-theme 1: Enabling parents to report results directly to the school**

Schools endeavoured to make the reporting process as straightforward as possible for parents, particularly when reporting positive results. Some schools used their own websites to set up an extra page for parents and pupils to report their results. Often, a set of specific questions would accompany the section for reporting a result on the school's website, which would also help schools to identify close contacts. Schools varied in terms of their requests for both positive and negative test results to be reported, with communication sent to pupils and parents on the importance of reporting results. However, there was often a lack of understanding of why reporting test results was important, and stakeholders felt that clearer explanations from the government would have helped. (It should be noted that DfE did release communications via the Education Blog that reiterated the importance of reporting results [34]). Negative test results that were not reported by parents or pupils were not followed up due to limited resource within schools, which makes assessing the true impact of the testing service challenging.

So, for the home tests, we asked the parents to log it on the NHS site as well as submitting it into our school website. But because the collection of the data at our side wasn't essential, we didn't follow it up. We didn't have the capacity to follow up those home test results. (Interviewee, stakeholder workshop).

They could click on the online form, which would record in school and next to that was a link for the NHS website so they could also record for the NHS. I don't think many parents recorded them from the NHS because there were a number of questions that you had to get through when you did it on your mobile app. There's probably about 10 questions that you have to keep answering in order to record a positive or negative and people just gave up. (Interviewee, stakeholder workshop).

Stakeholders felt that considerations could be made to simplify the reporting process, emphasising the rationale for reporting at the very start of testing, and suggestions for data access and sharing among stakeholders.

##### **Sub-theme 2: Enabling schools and local authority public health teams to be able to record accurate data and have visibility of local and national data in real time**

Associating test results to particular schools was attempted at the beginning of the rollout of testing by recording each school's unique code against the tests conducted onsite; however, over time this became too burdensome, and schools used their own methods to record positive cases.

Positive cases and outbreaks were reported to local authority public health, who used their own databases to record the information, which was then communicated to the regional teams at UKHSA. There was mention of Microsoft Dynamics, which was deemed to be particularly helpful for registering outbreaks across different schools. Similarly, SharePoint portals were used to collect information and extract data in various ways.

The issue of data sharing was brought up both by local authority public health teams and by school leaders, due to the limited visibility, in real-time, of local-level data about positivity versus national-level data. If teams had visibility of data in adjacent regions, this would have aided them to be better prepared for upcoming outbreaks.

“

We're all signed up to the same stuff, but people just don't share. I can't see their system. They can't see mine. I think a lot of time was wasted with UKHSA saying, have you heard anything about this school? We've had an outbreak reported. Well, yeah, we logged it three days ago. You know, they could have just gone in the system and looked. (Interviewee, stakeholder workshop).

“

Up-to-date information would have been really useful because locally we had up-to-the-minute information about how many cases there were, but when you looked at the national data, it went back, you know, sort of seven to 10 days. So that then you can quickly see the pattern that's happening as and when. (Interviewee, stakeholder workshop).

Stakeholders felt that considerations could be made to ensure there are clear measurable end points and data sharing agreements in place to ensure data is easily accessible amongst the different stakeholders involved for a school testing service.

**Key finding 1a: The quality of the school attendance dataset the evaluation consortium had access to was not sufficiently robust for extensive analyses**

The stakeholders largely agreed that collecting and recording data on school absences during the pandemic was one of the easier aspects of data collection, due to there being existing systems and resources in place to facilitate the process. Schools used their own management information systems to track attendance and DfE would request certain data, which were extracted from the system and sent to DfE. A suggestion was made to standardise the way schools enter attendance data by using the same system and ensure DfE requesting the same information from each school.

“

I think some of the anomalies may come from the individual management information systems that the school uses. So, all schools used to use predominantly two systems, now the market is huge. And all our attendance is recorded in different systems. (Interviewee, stakeholder workshop).

Data sharing between DfE and UKHSA could be improved, which would enable easier analysis and subsequent policymaking for similar evaluations in the future.

**Key finding 2: The target testing rate for school children was set at two tests per child per week. However, the data showed that the rate of testing per child in each LTLA (lower-tier local authority) was approximately 1 at the highest point**

The stakeholders agreed that testing coverage was higher during onsite testing, but continuation of onsite testing was logistically very difficult, largely due to limited resources to operate testing while also resuming face to face education.

When the move to home testing commenced, schools could only encourage continued testing through communications with parents and pupils. Despite this, it was evident that pupils were perhaps testing less and less as time went on.

“

Only thing we could have relied on would have been a test in school every week because we knew the other measures weren't happening, but no one had the capacity to deliver that, the NHS couldn't have put people into run those testing centres and we didn't have the people to do it. Plus, you get half your class consenting to doing it, the other half are just sitting in the classroom together waiting for them to come back. (Interviewee, stakeholder workshop).

Suggestions were made by the various stakeholders on how to conduct school-wide onsite testing by either receiving support from a 'crack team' of testers who would come into the school, test all pupils, and repeat with other schools in the local area, or look to have other sites where pupils could go to get tested specifically for school. However, the feasibility of the former suggestion was met with concern due to the logistics of transporting children to a separate site outside of school hours.

**Key finding 3: The purpose of the schools testing service was multi-faceted and at times conflicting. On the one hand identifying asymptomatic cases and isolating contacts to reduce the likelihood of an outbreak was important, but on the other hand continuing testing to increase confidence and reassure pupils, staff, and parents to return to face-to-face education**

The stakeholders felt that the majority of parents and staff felt reassured and comforted that schools were conducting and monitoring testing of their pupils, with the aim of keeping all involved safe.

“

We'd often get emails, you know, thanking us for doing the testing. (Interviewee, stakeholder workshop).

Only a minority felt that testing increased anxiety for some, due to having the knowledge that cases were being identified within schools, which would cause some parents to withhold their children from attending.

At the beginning of the testing rollout, there was a sense of camaraderie among staff and pupils, with the feeling that it was a shared responsibility to look out for each other and enable them to return to school. However, as time went on and the testing moved to home testing, it was felt that this sense of 'togetherness' was reduced, due to a feeling of distrust among families.

“

We've lost our 'all in it together', because the responsibility went back to individuals, and they couldn't cope with that because they didn't trust that family. (Interviewee, stakeholder workshop).

From a local authority public health perspective, it was suggested that the testing service worked more effectively when there were wider societal control measures in place, as it was easier to rationalise schools' continued efforts in identifying cases.

Overall, it was felt that the schools testing service was useful in reassuring the school community and would likely be needed again if there were to be a future pandemic. Recommendations have been geared towards a lower-intensity testing regime if children were to remain at low-risk from disease outcomes.

**Key finding 4: Involvement of local authorities and in particular local health protection teams may vary from region to region.**

The stakeholders involved in the interviews felt that the relationship built between their local authority public health teams and school leadership was one of the most successful aspects that arose from the schools testing service. Support was provided to schools for interpreting and operationalising the guidance, while 24/7 support was also provided if an outbreak occurred during term time.

**Sub-theme 1: Interpretation of guidance**

All the stakeholders from schools and local authorities mentioned that one of the greatest difficulties in managing the testing service was receiving guidance at short notice, with many pages of documents to sift through to begin creating their action plans or communications materials to disseminate among the school community. Often the school leadership and local authority public health teams would work together to interpret the guidance, come to an agreement on how to operationalise the guidance and provide adequate support where necessary.

“

As you know, government guidance changed at 11:24 PM on a Sunday night for implementation at 9:00 o'clock on the Monday morning. How on earth could a head teacher who was then expected to manage a school to read, interpret and implement that guidance with so few hours? And what we didn't want was our parents and children across the [county] having different experiences with such a large geographical authority. (Interviewee, stakeholder workshop).

The stakeholders suggested improvements, such as the dissemination of guidance in a timely manner, before any televised or public announcements, to allow sufficient time for schools to interpret the guidance. It was also suggested that guidance should include a summary of any changes that is easy to navigate within the document, as well as a rationale for why the guidance may have changed.

**Sub-theme 2: Schools are seen as part of the community**

School leadership team members often sought reassurance and guidance from their local authority public health teams rather than from DfE or UKHSA directly, due to the difficulty in getting through on the dedicated phone lines. It was felt that a locally led approach was much more suitable for the community, as there was a greater understanding and respect for how the community or school operated.



I don't think people realise what a school does in a community ... It's always there. Everything else comes and goes. It's still standing and that's when you realize there's a head teacher. You are a public figure. You are as important to that community of how you conduct yourself and how you present yourself to the rest of the world. (Interviewee, stakeholder workshop).

It was also evident that the local authority teams were able to rapidly acquire detailed information about all the schools within their region, which meant that more targeted support could be offered, without having to wait for advice or action from DfE or UKHSA.

It is recommended that local authorities be supported to maintain their close relationships with the schools in their region and to maintain a minimum level of upskilled employees so they can mobilise a team to deal with future pandemics.



We needed a level of upskilling and I think for any future pandemic, there's a real danger right now that now the money's gone and we're going back to business as usual. We'll lose that level of knowledge and understanding. (Interviewee, stakeholder workshop).

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## 3.4 Statistical methods

This appendix contains the following sections:

- Overview of regression modelling
- Estimation of false-positive LFDs by PCR among those with positive LFD test results
- Test coverage distribution
- Limitations

### 3.4.1 Overview of regression modelling

**Population:** The population included in the modelling was school-aged children (11-18 years). Using the Pillar 2 LFD database, the testing data were aggregated weekly at the lower-tier local authority (LTLA) level. That is, the number of positive tests reported, the number of total tests reported, the number of void tests reported, and the number of negative test results reported, were each aggregated weekly at the LTLA level. The unit of analysis was LTLA per week, as we were not able to link individual schools present within the Pillar 2 database to other school-specific characteristics, such as the number of students enrolled within each school or further absenteeism information at the school level. The calculation of a key metric of interest, test coverage (number of tests taken per young person per week), required information regarding school size (number of young people per school) and the attendance. It was not possible to estimate this at individual school level as linking data reported in pillar 2 (that had had site names and school names) to other databases with specific school characteristics was deemed not feasible as the site id was null / not recorded in a proportion of rows of the testing data, although the individual was recorded to be of school age. Because of this, we were concerned that calculating testing coverages at school level (if this were possible via matching) could substantively underrepresent true coverages. Further key covariates that needed to be adjusted such as: community prevalence, vaccination coverage among 11-18-year-olds, and the proportion of different variants in circulation were also available at LTLA levels. For all these reasons, schools analyses were carried out LTLA level rather than individual school level.

**Exposure:** The primary exposure variable of interest was the total number of LFD tests reported per week per LTLA. For the regression modelling, natural logarithm transformation was applied to this variable was scaled by dividing it by 1000 per LTLA in a week. Data were used only from LTLAs that reported at least 100 tests per week.

**Outcome:** The outcome variable for the regression model was the natural logarithm (ln) of the number of LFD positive tests reported in a LTLA at a given week. For weeks when there were zero positive test results reported, the ln-transformation was carried by adding 1 (logarithm of 0 is undefined).

**Time period:** The dataset was divided into four time periods, with separate models applied to each time period, reflecting the underlying changes in the testing service or the natural breaks in the school calendar. This included the onsite asymptomatic sites (ATSs) at school phase (March 2021), the start of the testing service until the summer break (April to July 2021), the return to schools from summer holidays until the Christmas break (September to December 2021), and finally, the re-opening of schools until the end of the evaluation period (January to March 2022). As the data were aggregated weekly, data from the week commencing on 29 March 2021 were considered part of the ATS period.

Table 1 presents a summary of the reported numbers of positive tests along with total test volumes reported across the various time periods.

**Table 1. Summary of Pillar 2 LFD data used for regression models in school children aged 11 to 18 years.**

	Time period (1): March 2021	Time period (2): April to July 2021	Time period (3): September to December 2021	Time period (4): January to March 2022
Number of observation-weeks	1545	5253	5251	4016
Total number of tests reported	20,868,814	26,794,559	18,019,182	9,865,446
Total number of positive tests reported	18,291	127,466	403,722	757,256

**Regression model:** A hierarchical linear model on the reported number of positive LFD test results (ln-transformed) was fitted with random intercepts on LTLA and week. Models were fitted separately across each of the four time periods. Competing models were compared using the Akaike information criterion (AIC) (a smaller AIC indicates a better model); the details of the competing model formulations and comparisons are presented in the 'Model comparison' section. Outputs from residual analyses were examined.

**Adjustment set:** The following variables constitute the adjustment set in the regression models: debiased COVID-19 prevalence in a given LTLA for a given week estimated from the REACT prevalence survey; the proportions of Alpha, Delta and Omicron variants in circulation per week; the cumulative proportion of school-aged children receiving first and second doses of COVID-19 vaccinations; the Income Deprivation Affecting Children Index (IDACI); and the proportion of the ethnic minority population in the LTLA. The cumulative proportion of young people receiving the first (second) dose of COVID-19 vaccination was calculated by dividing the total number of individuals who had taken the first (second) dose in each week divided by the total population size of individuals aged 11 to 18 years in a given LTLA.

### Model comparison

We compared a range of model structures to determine an appropriate choice of covariate transformations, interaction terms and types of random effects to include. The four model structures considered for the fixed-effect covariates were as follows:

**Fixed-effect covariate structure 1:** no transformation was applied to the primary exposure of interest (total number of LFD tests reported per week per LTLA) or COVID-19 prevalence and no interaction terms between these two were included. In addition, the model contained the following variables: proportions of Alpha, Delta and Omicron variants, IDACI, proportion of ethnic minority population within an LTLA, and cumulative vaccine coverages for first and second doses.

**Fixed-effect covariate structure 2:** no transformation was applied to the primary exposure of interest (total number of LFD tests reported per week per LTLA) or to COVID-19 prevalence and an interaction term between these two factors was included. In addition, the model contained the following variables: proportions of Alpha, Delta and Omicron variants, IDACI, proportion of ethnic minority population within an LTLA, and cumulative vaccine coverages for first and second doses.

**Fixed-effect covariate structure 3:** an ln-transformation was applied to the primary exposure of interest (total number of LFD tests reported per week per LTLA) and to COVID-19 prevalence with no interaction terms included. In addition, the model contained the following variables: proportions of Alpha, Delta and Omicron variants, IDACI, proportion of ethnic minority population within an LTLA, and cumulative vaccine coverages for first and second doses.

**Fixed-effect covariate structure 4:** an ln-transformation was applied to the primary exposure of interest (total number of LFD tests reported per week per LTLA) and to COVID-19 prevalence and an interaction term between these two factors was included. In addition, the model contained the following variables: proportions of Alpha, Delta and Omicron variants, IDACI, proportion of ethnic minority population within an LTLA, and cumulative vaccine coverages for first and second dosages.

**Table 2. Description of the variables for the four fixed-effect parts of the model.**

Model structure	Variables included in the model
Model structure 1	<ul style="list-style-type: none"> <li>▶ Total reported volume of LFD tests taken per week in each LTLA</li> <li>▶ Community prevalence (using REACT survey) per LTLA per week</li> </ul> <p><b>Other variables</b></p> <ul style="list-style-type: none"> <li>▶ Median Income Deprivation Affecting Children Index (IDACI)</li> <li>▶ Proportion of Alpha variant in each LTLA per week</li> <li>▶ Proportion of Delta variant in each LTLA per week</li> <li>▶ Proportion of Omicron variant in each LTLA per week</li> <li>▶ Cumulative proportion of first dose of COVID-19 vaccination within each LTLA among 11-18-year-olds</li> <li>▶ Cumulative proportion of second dose of COVID-19 vaccination within each LTLA among 11-18-year-olds</li> <li>▶ Proportion of ethnic minority population residing within each LTLA</li> </ul>
Model structure 2	<ul style="list-style-type: none"> <li>▶ Total reported volume of LFD tests taken per week in each LTLA* community prevalence (using REACT survey) per LTLA per week</li> <li>▶ All other variables are the same as model structure 1</li> </ul>

Model structure	Variables included in the model
Model structure 3	<ul style="list-style-type: none"> <li>▶ Ln (total reported volume of LFD tests taken per week in each LTLA)</li> <li>▶ Ln (community prevalence (using REACT survey) per LTLA per week)</li> <li>▶ All other variables are the same as model structure 1</li> </ul>
Model structure 4	<ul style="list-style-type: none"> <li>▶ Ln (total reported volume of LFD tests taken per week at each LTLA) * ln Community prevalence (using REACT survey data) per LTLA per week)</li> <li>▶ All other variables are the same as model structure 1</li> </ul>

\*Indicates interaction between the two variables; Ln = natural logarithm transformation; community prevalence (using REACT survey data) per LTLA per week for the entire population and not restricted to young persons

For each of these four fixed-effect covariate structures, two separate random effects were considered: with LTLA as the only random effect, and with LTLA and week as random effects. The comparisons were conducted across each of the four time periods, and the results are shown in Table 2. Within each time period, the model that best described the data is indicated in bold font. Within each time period, the model with independent random effects for LTLA and week had a smaller AIC than the model with random effects for LTLA only. The model with ln-transformation for the primary exposure of interest (total number of LFD tests reported per week per LTLA) and ln-transformed prevalence was the best fitting model for the first and third time-periods. For the second and fourth time-periods, the model with an interaction between ln-transformation for the primary exposure of interest (total number of LFD tests reported per week per LTLA) and prevalence was the best fitting model, although in general the differences in AIC between the models that included interaction between prevalence and the primary exposure of interest was relatively small. Similarly, further non-linear transformations were explored for the primary exposure of interest (total number of LFD tests reported per week per LTLA) using restricted cubic splines; the model AICs between with and without spline transformations were similar.

Considering model parsimony, results from the model without the interaction term and without splines transformation were presented. To assess the effect of choosing an ln-linear distribution on the outcome, the best-fitting model identified in Table 2 within each time period was compared with Poisson and negative binomial regression models of the same structure with population size as an offset term; however, this did not improve model fit (based on the AIC).

**Table 3. Comparison of competing model structures for fixed and random effects.**

Outcome: ln (number of positive LFD tests reported per LTLA per week)	Total observation weeks	Structure of random effects	Fixed effect structure	Model AIC <sup>1</sup>
Time period (1)	1282	LTLA	Structure 1	2,885
	1282	LTLA	Structure 2	2,893
	1282	LTLA	Structure 3	2,687
	1282	LTLA	Structure 4	2,692
	1282	LTLA + week	Structure 1	2,420
	1282	LTLA + week	Structure 2	2,429
	1282	LTLA + week	Structure 3	2,328
	1282	LTLA + week	Structure 4	2,331
Time period (2)	3,632	LTLA	Structure 1	7,089
	3,632	LTLA	Structure 2	6,938
	3,632	LTLA	Structure 3	6,661
	3,632	LTLA	Structure 4	6,541
	3,632	LTLA + week	Structure 1	6,652
	3,632	LTLA + week	Structure 2	6,540
	3,632	LTLA + week	Structure 3	5,967
	3,632	LTLA + week	Structure 4	5,955

Outcome: In (number of positive LFD tests reported per LTLA per week)	Total observation weeks	Structure of random effects	Fixed effect structure	Model AIC <sup>†</sup>
Time period (3)	4,776	LTLA	Structure 1	5,946
	4,776	LTLA	Structure 2	5,892
	4,776	LTLA	Structure 3	5,760
	4,776	LTLA	Structure 4	5,701
	4,776	LTLA + week	Structure 1	3,994
	4,776	LTLA + week	Structure 2	3,991
	4,776	LTLA + week	Structure 3	2,951
	4,776	LTLA + week	Structure 4	2,956
Time period (4)	3,878	LTLA	Structure 1	7,203
	3,878	LTLA	Structure 2	7,090
	3,878	LTLA	Structure 3	5,213
	3,878	LTLA	Structure 4	4,974
	3,878	LTLA + week	Structure 1	2,608
	3,878	LTLA + week	Structure 2	2,608
	3,878	LTLA + week	Structure 3	551
	3,878	LTLA + week	Structure 4	509

<sup>†</sup>Smaller AICs indicate better fitting models; highlighted cells indicate the best fitting model within each time period

### 3.4.2 Estimation of the number of false-positive test results among those with positive LFD results with a confirmatory PCR test

A sub-sample of data for LFD-positive schoolchildren within the 12- to 17-years age group for whom confirmatory PCR tests were performed within 3 days of a positive LFD test was made available by UKHSA. This dataset was used to estimate the conditional probability of testing positive using PCR if a young person reported a positive LFD test result (termed the 'positive proportion' or the positive predictive value (PPV)).

The complement of the positive proportion (1-positive proportion) was used as a correction factor to estimate the proportion of false-positive LFD test results among all positive LFD tests. The correction factor presented in Table 3 was applied to aggregate data from each week for a given LTLA.

**Table 4. Summary of data on subsequent PCR results within 72 hours of a positive LFD result among schoolchildren aged 12 to 17 years.**

Week date	Evaluation week	Period	Number of LFD positives that were true positives by PCR	Number of LFD positives (with paired PCR test results available)	Overall proportion of the LFD positives that also tested positive by PCR	Median proportion of the LFD positives that also tested positive by PCR	Proportion of the LFD positives that also tested positive by PCR (2.5th)	Proportion of the LFD positives that also tested positive by PCR (97.5th)
23/01/2021	16	Pre-ATS	4	4	1.000	0.871	0.478	0.995
30/01/2021	17	Pre-ATS	5	6	0.833	0.772	0.421	0.963
06/02/2021	18	Pre-ATS	7	9	0.778	0.741	0.444	0.933
13/02/2021	19	Pre-ATS	2	3	0.667	0.614	0.194	0.932
20/02/2021	20	Pre-ATS	1	1	1.000	0.707	0.158	0.987
27/02/2021	21	Pre-ATS	1	3	0.333	0.386	0.068	0.806
06/03/2021	22	Period I: ATS	44	99	0.444	0.445	0.350	0.543
13/03/2021	23	Period I: ATS	214	466	0.459	0.459	0.414	0.505
20/03/2021	24	Period I: ATS	448	703	0.637	0.637	0.601	0.672
27/03/2021	25	Period I: ATS	1144	1656	0.691	0.691	0.668	0.713
03/04/2021	26	Period I: ATS	795	1044	0.761	0.761	0.735	0.786
10/04/2021	27	Period II	379	478	0.793	0.792	0.754	0.827
17/04/2021	28	Period II	233	375	0.621	0.621	0.571	0.669

Week date	Evaluation week	Period	Number of LFD positives that were true positives by PCR	Number of LFD positives (with paired PCR test results available)	Overall proportion of the LFD positives that also tested positive by PCR	Median proportion of the LFD positives that also tested positive by PCR	Proportion of the LFD positives that also tested positive by PCR (2.5th)	Proportion of the LFD positives that also tested positive by PCR (97.5th)
24/04/2021	29	Period II	238	468	0.509	0.509	0.463	0.554
01/05/2021	30	Period II	345	565	0.611	0.610	0.570	0.650
08/05/2021	31	Period II	412	646	0.638	0.637	0.600	0.674
15/05/2021	32	Period II	348	573	0.607	0.607	0.567	0.646
22/05/2021	33	Period II	459	683	0.672	0.672	0.636	0.706
29/05/2021	34	Period II	617	815	0.757	0.757	0.726	0.785
05/06/2021	35	Period II	472	518	0.911	0.910	0.884	0.933
12/06/2021	36	Period II	18	56	0.321	0.326	0.214	0.452
19/06/2021	37	Period II	21	37	0.568	0.565	0.408	0.714
26/06/2021	38	Period II	629	691	0.910	0.909	0.887	0.929
03/07/2021	39	Period II	4170	4827	0.864	0.864	0.854	0.873
10/07/2021	40	Period II	5058	5829	0.868	0.868	0.859	0.876
17/07/2021	41	Period II	5850	6537	0.895	0.895	0.887	0.902
24/07/2021	42	Period II	3567	3840	0.929	0.929	0.920	0.937
31/07/2021	43	Period II	931	989	0.941	0.941	0.925	0.954
07/08/2021	44	Summer Break	582	623	0.934	0.933	0.912	0.951
14/08/2021	45	Summer Break	529	562	0.941	0.940	0.919	0.958
21/08/2021	46	Summer Break	698	734	0.951	0.950	0.933	0.964
28/08/2021	47	Summer Break	985	1055	0.934	0.933	0.917	0.947
04/09/2021	48	Period III	3068	3453	0.889	0.888	0.878	0.899
11/09/2021	49	Period III	5093	6155	0.827	0.827	0.818	0.837
18/09/2021	50	Period III	7218	8275	0.872	0.872	0.865	0.879
25/09/2021	51	Period III	11770	13693	0.860	0.860	0.854	0.865
02/10/2021	52	Period III	11684	13762	0.849	0.849	0.843	0.855
09/10/2021	53	Period III	11806	14307	0.825	0.825	0.819	0.831
16/10/2021	54	Period III	14474	16107	0.899	0.899	0.894	0.903
23/10/2021	55	Period III	13187	14249	0.925	0.925	0.921	0.930
30/10/2021	56	Period III	5463	5743	0.951	0.951	0.945	0.957
06/11/2021	57	Period III	4212	4878	0.863	0.863	0.854	0.873
13/11/2021	58	Period III	5183	5894	0.879	0.879	0.871	0.887
20/11/2021	59	Period III	5985	6755	0.886	0.886	0.878	0.893
27/11/2021	60	Period III	5825	6594	0.883	0.883	0.875	0.891
04/12/2021	61	Period III	6157	7028	0.876	0.876	0.868	0.884
11/12/2021	62	Period III	4896	5737	0.853	0.853	0.844	0.862
18/12/2021	63	Period III	5399	6084	0.887	0.887	0.879	0.895
25/12/2021	64	Period III	3691	3943	0.936	0.936	0.928	0.943
01/01/2022	65	Break	3643	3885	0.938	0.938	0.930	0.945
08/01/2022	66	Break	13986	16482	0.849	0.849	0.843	0.854
15/01/2022	67	Period IV	7325	8335	0.879	0.879	0.872	0.886
22/01/2022	68	Period IV	5515	6219	0.887	0.887	0.879	0.894
29/01/2022	69	Period IV	5567	6294	0.884	0.884	0.876	0.892
05/02/2022	70	Period IV	4006	4657	0.860	0.860	0.850	0.870
12/02/2022	71	Period IV	1933	2275	0.850	0.849	0.834	0.864
19/02/2022	72	Period IV	709	850	0.834	0.834	0.808	0.858
26/02/2022	73	Period IV	389	458	0.849	0.848	0.814	0.879
05/03/2022	74	Period IV	586	669	0.876	0.875	0.849	0.899
12/03/2022	75	Period IV	1085	1211	0.896	0.896	0.877	0.912



Week date	Evaluation week	Period	Number of LFD positives that were true positives by PCR	Number of LFD positives (with paired PCR test results available)	Overall proportion of the LFD positives that also tested positive by PCR	Median proportion of the LFD positives that also tested positive by PCR	Proportion of the LFD positives that also tested positive by PCR (2.5th)	Proportion of the LFD positives that also tested positive by PCR (97.5th)
19/03/2022	76	Period IV	1355	1534	0.883	0.883	0.866	0.898
26/03/2022	77	Period IV	1340	1495	0.896	0.896	0.880	0.911
02/04/2022	78	Period IV	650	745	0.872	0.872	0.847	0.895

95% credible interval (2.5th and 97.5th posterior quantile) for the probability of PCR positivity conditional on LFD positivity was obtained using uniform prior (beta (1,1) prior distribution).

These results can be compared against theoretically expected positive proportions for a given value of sensitivity and specificity of LFDs via:

$$PPV = \frac{\text{sensitivity} \times \text{prevalence}}{(\text{sensitivity} \times \text{prevalence}) + (1 - \text{specificity}) \times (1 - \text{prevalence})}$$

where PPV indicates the positive predictive value of an LFD. If the LFD sensitivity and specificity are assumed to be 40% and 99.8%, respectively [1], then at 5% disease prevalence, one would expect the PPV to be 91.3%. For the same sensitivity and specificity, at 0.5% and 1% disease prevalence, the expected PPV would be 50.1% and 66.9%, respectively.

The complement of the positive proportion (1-positive proportion) was used as a correction factor to estimate the number of false-positive LFD test results among all positive LFD tests reported. The correction factor presented in Figure 2 was applied to aggregate data for each week for a given LTLA. (Table 4).

**Table 4. Estimated number of false-positive LFD results among young people aged 11 to 18 years.**

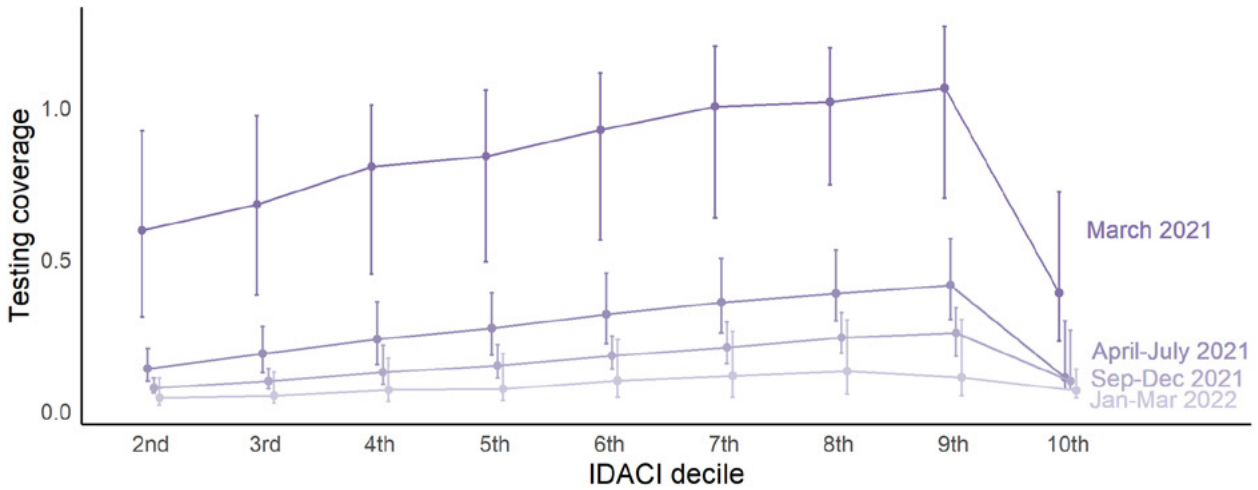
Time period	Evaluation week	Total number of reported tests	Number of positive LFDs reported	Estimated number of false-positive LFDs	Estimated number of false-positive LFDs (lower bound)	Estimated number of false-positive LFDs (upper bound)	Proportion of LFDs positives that are false-positives
Period 1	22	1505354	1063	606	465	708	57.0%
Period 1	23	6193733	3006	1633	1434	1773	54.3%
Period 1	24	5309583	3926	1415	1296	1567	36.0%
Period 1	25	4697492	6367	1965	1830	2137	30.9%
Period 1	26	3162652	3929	924	827	1051	23.5%
Period 2	27	2168161	2123	435	386	492	20.5%
Period 2	28	2320343	1971	757	656	841	38.4%
Period 2	29	2924036	3081	1468	1361	1660	47.6%
Period 2	30	2497350	2832	1107	992	1203	39.1%
Period 2	31	2128559	2746	993	903	1097	36.2%
Period 2	32	1988420	2477	972	865	1062	39.2%
Period 2	33	1784061	2506	822	730	898	32.8%
Period 2	34	1557484	2836	663	604	778	23.4%
Period 2	35	689542	2714	228	156	305	8.4%
Period 2	36	1418547	3982	2694	2179	3149	67.7%
Period 2	37	1300591	5911	2547	1693	3513	43.1%
Period 2	38	1338906	9214	832	646	1039	9.0%
Period 2	39	1347143	15222	2068	1934	2227	13.6%
Period 2	40	1266064	18698	2475	2316	2643	13.2%
Period 2	41	1061305	24166	2547	2362	2722	10.5%
Period 2	42	675238	16852	1193	1064	1346	7.1%
Period 2	43	328809	10135	599	461	758	5.9%
Period 3	48	1843535	16187	1790	1644	1984	11.1%
Period 3	49	3469947	18175	3139	2964	3306	17.3%
Period 3	50	1386120	20716	2643	2499	2803	12.8%

Time period	Evaluation week	Total number of reported tests	Number of positive LFDs reported	Estimated number of false-positive LFDs	Estimated number of false-positive LFDs (lower bound)	Estimated number of false-positive LFDs (upper bound)	Proportion of LFDs positives that are false-positives
Period 3	51	1178595	32853	4620	4428	4812	14.1%
Period 3	52	1041488	32776	4952	4747	5146	15.1%
Period 3	53	939538	33388	5834	5631	6053	17.5%
Period 3	54	899600	38096	3863	3686	4050	10.1%
Period 3	55	798760	36242	2695	2548	2862	7.4%
Period 3	56	387836	19429	951	855	1060	4.9%
Period 3	57	820677	13501	1853	1718	1972	13.7%
Period 3	58	729763	15823	1901	1778	2048	12.0%
Period 3	59	702109	18706	2124	1997	2287	11.4%
Period 3	60	700429	18503	2159	2016	2294	11.7%
Period 3	61	779445	20187	2496	2356	2672	12.4%
Period 3	62	769742	17518	2572	2412	2735	14.7%
Period 3	63	929052	23228	2609	2434	2817	11.2%
Period 3	64	642546	28394	1807	1609	2045	6.4%
Period 4	66	2855429	72591	10989	10599	11397	15.1%
Period 4	67	1266650	71378	8649	8167	9157	12.1%
Period 4	68	1169822	109166	12370	11522	13251	11.3%
Period 4	69	1121625	128032	14784	13811	15828	11.5%
Period 4	70	1006258	103882	14519	13523	15591	14.0%
Period 4	71	780690	57506	8641	7837	9527	15.0%
Period 4	72	430800	28899	4792	4131	5565	16.6%
Period 4	73	290887	15297	2302	1854	2846	15.0%
Period 4	74	197485	17266	2139	1749	2603	12.4%
Period 4	75	193633	33984	3537	2999	4157	10.4%
Period 4	76	219474	47417	5541	4809	6342	11.7%
Period 4	77	207186	45320	4700	4045	5439	10.4%
Period 4	78	125507	26518	3394	2792	4068	12.8%

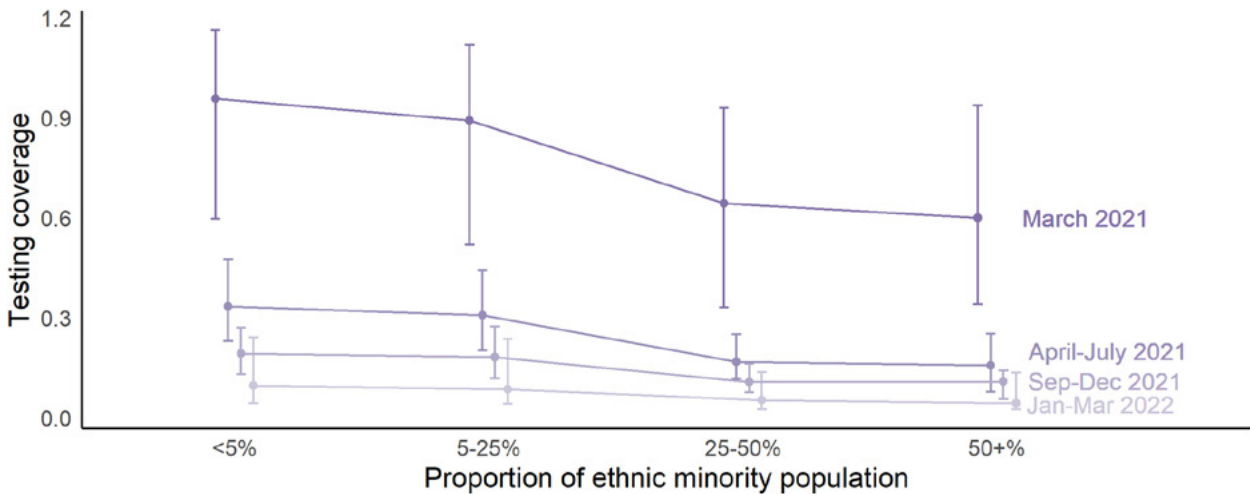
The estimates in Table 4 should be interpreted with the following limitations taken into consideration: Factors that can affect the performance of LFD tests, such as viral concentration and symptomatic status, could not be considered. If there was a selective behaviour towards taking an LFD only when an infection became symptomatic, then this will impact the accuracy of the test results. It is also possible that the 72-hour window between a positive LFD result and subsequent PCR test could have been sufficient for the infection to have been cleared.

### 3.4.3 Test coverage distribution

Test coverage is defined as the number of tests reported per week per young person at a given LTLA. This was calculated by dividing the total number of reported LFD tests per week per LTLA by the population size of young people aged 11 to 18 years. The following figures presents the distribution of test coverage by the IDACI and by the proportion of the ethnic minority population within a given LTLA.



**Figure 1. Test coverage by median IDACI decile.** IDACI = the Income Deprivation Affecting Children Index. Median test coverage values are shown along the 25th and 75th percentiles. Data on the 10th decile were available for <50 observation weeks across all the four time periods.



**Figure 2: Test coverage by proportion of ethnic minority population within each LTLA.** Median test coverage values are shown along the 25th and 75th percentiles.

### 3.4.4 Limitations

Data used for this modelling were aggregated at the LTLA level rather than at any specific school level. Therefore, the results presented in the models should be interpreted as the model among young people (rather than specific to school settings only). It was further assumed that children within an LTLA would attend schools within that LTLA.

For the analysis of the primary exposure variable of interest (total number of LFD tests reported per week per LTLA), efforts have been made to address the measured confounders and to avoid conditioning on any potential colliders when estimating the effect of this primary exposure on reported number of positive LFD test results, as informed by the directed acyclic graphs (<http://dagitty.net/mBrv8SI>). However, the coefficients derived from the regression model should not be interpreted as causal effects. Some of the associations are susceptible to bias due to reverse causation, hence all the relationships presented in the regression model should be interpreted as associations between the covariates of interest and the outcome (reported number of positive LFD test results) and not as causal effects.

Similarly, the outcome used for modelling was the reported number of positive LFD cases in a given LTLA in a particular week. This may not reflect the number of true-positive test results, or the true number of any LFD tests undertaken, as these could be influenced by the presence of selective reporting bias. In addition, the relationship between reported numbers of positive tests and actual numbers of cases is unknown and may be a many-to-one association.

From a statistical perspective, for count data such as the number of positive test results reported, a Poisson or a negative binomial regression would have been an alternative modelling approach. However, the observed overdispersion meant that a reasonable count model could not be identified. Based on the comparisons of the model fit statistics (using AIC), a linear regression with ln-transformed count was found to be an adequate fit to the data and had a smaller AIC for the same model fitted using Poisson or negative binomial regression. The model diagnostics (residual plots and comparison of the observed and predicted distribution) pointed towards a model with a reasonable fit. Finally, the relationships between test volume and the number of positive cases reported were assumed to be linear (on a log-scale) only within the range of the test coverage observed in this analysis. This was based on a comparison of linear associations against potential non-linear associations based on restricted cubic spline transformation. Overall, there was no substantial difference in the AICs between models that had linear term or the restricted cubic splines term. However, caution should be exercised when extrapolating beyond the range of the observed data, as this may not capture the true nature of the relationship between the total number of LFD tests reported per week per LTLA and the detection of positive cases.

Finally, the estimation of the number of false-positive LFD test results utilised available data among those aged 12 to 17 years for whom a confirmatory PCR test was taken within the next 72 hours. This age range that was available was not exactly the same as that considered in our overall evaluation (11-18 years), potentially leading to bias. There were also weeks when the total number of positive LFD results with subsequent confirmatory PCR test results were small. For example, there were fewer than 100 paired LFD and PCR test data for one week in period 1, and for two weeks during time-period 2. Such small samples might have introduced errors and hence any estimation of false-positivity could be either over- or under-estimated; this bias is difficult to quantify and remains beyond the scope of this current evaluation. Similarly, other factors that can affect the performance of LFD tests, such as viral concentration and symptomatic status, could not be considered in this evaluation. It is also possible that the 72-hour window between the LFD positive result and subsequent PCR test could have been sufficient for the infection to have been cleared. Future work could consider shorter time-windows.

### 3.4.5 Appendix 3.4 references

1. Bird, S.M., Covid tests in secondary schools: A statistical cause célèbre. *Significance*, 2021. 18(3): p. 42-45.

## 3.5 Economic model for the impact of the testing service in schools

A static model was developed in Microsoft Excel®. Model inputs included actual prevalence, hospitalisations, and deaths in England from ONS data during the evaluation period (October 2020 to March 2022) [1]. These were used to calculate the actual infection hospitalisation ratios (IHRs) and hospitalisation fatality ratios (HFRs) during the 18-month period. Incidence rates were modelled using the data on prevalence.

Modelled incidence rates from actual prevalence data and actual hospitalisation and death data for the evaluation period (October 2020 to March 2022) were used to calculate the actual infection hospitalisation ratios (IHRs) and hospitalisation fatality ratios (HFRs) during the 18-month period [1]. A sensitivity analysis was developed, assuming reductions in new cases of 1% to 5% due to testing in secondary schools and colleges. These values were selected based on the values obtained from the Covid-SMART study, conducted in Liverpool which analysed the impact of voluntary rapid asymptomatic community testing for the SARS-CoV-2 antigen on COVID-19-related hospital admissions from November 2020 to January 2021. It found that testing led to a 25% (11% to 35%) reduction in COVID-19-related hospitalisations [39]. Given that these reductions were observed in a smaller, controlled, quasi-clinical trial of community-wide testing, where the intensive testing was conducted with military assistance, we used smaller reductions in hospitalisations of 1-5% for testing schoolchildren only as a plausible range.

Infections, hospitalisations and deaths averted were modelled at these various potential reduction levels. Cost savings from hospitalisations and ICU admissions averted were estimated. Combined with the total cost of the testing programme, these were used to estimate the cost per infection averted, cost per hospitalisation averted, cost per death averted and cost per QALY gained. The analysis was run separately for the fully costed service (GBP 2.59 billion) and for the marginal cost of the service (GBP 1.4 billion), which includes only the direct and direct overhead costs (not using indirect and overhead costs).

Table 1 summarises the input parameters and sources. A sensitivity analysis that tested the sensitivity of the outcome to the QALYs for death was conducted and presented in figure 3-7 in Chapter 3 as the shaded area, with a minimum and maximum value of QALY for deaths (Table 1).

**Table 1. Data inputs and assumptions for the testing service in schools.**

Parameter	Value	Source
Hospitalisation fatality ratio (HFR)	20.13	Calculated from ONS data (deaths/hospitalisations) [1]
Infection fatality ratio (IFR)	1.07	Calculated from ONS data (infections/hospitalisations)
Number of false-positive cases identified		Statistical analysis (schools)
QALYs for death	6.78 (4.98-8.80)	[2, 3]
QALYs for hospitalisations	0.201	[2, 3]
QALYs for ICU admissions	0.15	[2, 3]
QALYs for ICU admissions	0.15	[2, 3]
Proportion of hospitalised patients with severe manifestations	0.41 ( $\geq 19$ years) 0.2 ( $\leq 18$ years)	Statistical analysis (healthcare)
Proportion of hospitalised patients with pneumonia	0.42 ( $\geq 19$ years) 0.11 ( $\leq 18$ years)	Statistical analysis (healthcare)
Proportion of hospitalised patients in ICU	0.11 ( $\geq 19$ years) 0.9 ( $\leq 18$ years)	Statistical analysis (healthcare)
Cost of hospitalisation (GBP)	2,771 ( $\geq 19$ years) 3,138 ( $\leq 18$ years)	NHS Schedule of Costs [5]
Cost of hospitalisation with severe manifestations (GBP)	4,507 ( $\geq 19$ years) 8,606 ( $\leq 18$ years)	NHS Schedule of Costs [5]
Cost of hospitalisation with pneumonia (GBP)	3164 4923	NHS Schedule of Costs [5]
Additional cost of ICU admission (GBP)	1777 2460	NHS Schedule of Costs [5]
Productivity lost (parent) per isolation (GBP)	236	Calculated from average salary of parents per day (115.38), proportion of parents that can work from home (46%), average working days lost due to isolation (4.16), proportion of parents that are employed (75%), productivity of parents working from home (75%) $= (115.38 * 4.16 * 0.54 * 0.75) + (115.38 * 4.16 * 0.46 * 0.75 * 0.25) = \text{GBP } 235.80$

## Appendix 3.5 references

1. Zhang, X., et al., Impact of community asymptomatic rapid antigen testing on covid-19 related hospital admissions: synthetic control study. *Bmj*, 2022. 379: p. e071374.
2. Sandmann, F.G., et al., The potential health and economic value of SARS-CoV-2 vaccination alongside physical distancing in the UK: a transmission model-based future scenario analysis and economic evaluation. *Lancet Infect Dis*, 2021. 21(7): p. 962-974.
3. UK Health Security Agency (confidential internal document), Review of the Value for Money of Test, Trace and Isolate. nd.
4. Department of Health and Social Care, et al. Direct and Indirect Impacts of COVID-19 on Excess Deaths and Morbidity: Executive Summary. 2020 30 January 2023]; Available from: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/918738/S0650\\_Direct\\_and\\_Indirect\\_Impacts\\_of\\_COVID-19\\_on\\_Excess\\_Deaths\\_and\\_Morbidity.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918738/S0650_Direct_and_Indirect_Impacts_of_COVID-19_on_Excess_Deaths_and_Morbidity.pdf).
5. NHS England. National Cost Collection for the NHS. nd 17 March 2023]; Available from: <https://www.england.nhs.uk/costing-in-the-nhs/national-cost-collection/>.



# Appendix 4: Healthcare



# Healthcare

## 4.1 Introduction and context

### Introduction to appendices

This appendix has the following structure:

Appendix 4.1 establishes the policy timeline of the testing service for healthcare staff and presents the context of the adjacent interventions for the general population.

Appendix 4.2 outlines a Theory of Change, developed to map out the intended design of the testing service and evaluate the service.

Appendix 4.3 draws on the results of qualitative research and covers operational findings that emerged from the review of data vaults shared by the UKHSA Secretariat and publicly available information; a rapid review of behavioural literature, which relied on documents received from UKHSA Secretariat and those found as part of a rapid literature review; and stakeholder sessions, where the evaluation consortium tested the feasibility of emerging recommendations with the use of primary research methods.

Appendix 4.4 describes methods and findings of the statistical workstream that are not otherwise detailed in chapter 4.

Appendix 4.5 describes methods and findings of the economics workstream that are not otherwise detailed in chapter 4.

### The healthcare asymptomatic testing regimen

In November 2020, the NHS published guidelines for the rollout of asymptomatic staff testing using LFDs [1]. This was aimed at all patient-facing staff, starting in 34 trusts, benefitting 250,000 staff [2], to later be expanded to cover all 1.3 million NHS staff [3], working in 209 NHS Trusts and Foundation Trusts (hereafter referred to as 'trusts') throughout England and covering four types of trust:

- Acute general and acute specialist trusts
- Mental health, learning disability, and combined mental health and learning disability trusts
- Community trusts
- Ambulance trusts

In January 2021, the rollout of regular COVID-19 asymptomatic testing was expanded to cover all 400,000 patient-facing primary care staff working in dentist surgeries, GP practices, optometry practices, and pharmacy practices [4].

On 9 November 2021, DHSC set out regulations that required workers in the NHS and the independent healthcare sector (both primary and secondary care), aged 18 years and over, who had direct, face to face contact with service users to provide evidence that they had received a complete course of an MHRA-approved COVID-19 vaccine, subject to limited exceptions, by no later than 1 April 2022 [5]. The requirement for mandatory vaccinations for health and social care staff was revoked on 15 March 2022.

In January 2022, the requirement for a confirmatory PCR test following a positive LFD result was suspended [6]. This change applied to all staff. From 11 January 2022, any staff member receiving a positive LFD result for COVID-19 was required to self-isolate immediately but was not required to take a confirmatory PCR test. This was because most people receiving a positive LFD result would have had COVID-19, due to its high prevalence at the time. LFDs were to be used by individuals who did not have COVID-19 symptoms; anyone who was symptomatic was expected to self-isolate, even if they received a negative LFD result, and obtain a PCR test as soon as practicable.

### Set up of the healthcare testing service

#### Provision of tests

From the onset of the asymptomatic testing service, Innova brand testing kits, with 25 kits per pack, were ordered and distributed to staff by trusts for twice-weekly self-testing at home. These kits comprised swabs, a small bottle of buffer solution, and the LFD. When testing, staff members had to follow instructions that were different from the manufacturer's instructions.

From April 2021, asymptomatic testing was made available to all members of the public, which meant that all NHS staff (not just patient-facing staff) could order LFDs and report them via a gov.uk website. However, an updated SOP for secondary care only came out in July/August 2021, announcing the move from a 'push' to a 'pull' model for ordering tests. This officially announced to all NHS staff the access to

ordering and reporting of tests via the universal testing offer. This meant that instead of trusts ordering tests in bulk based on their staffing levels, the responsibility for ordering tests moved from trusts to individual staff members.

Once members of staff had depleted the available supply of Innova 25s remaining at trusts, they could start ordering packs of seven LFD tests for home delivery. Several manufacturers supplied tests to the NHS (following an assessment and confirmation of their eligibility for inclusion in the testing programme), involving a variety of brands and with different instructions for swabbing. The following kits were provided [7]:

- 5-18 July 2021, Innova 7s
- 19 July-8 August 2021, Orient Gene
- 9 August 2021 onwards, ACON FlowFlex

Following an announcement from the then prime minister on 16 October 2020, LAMP testing for saliva samples was rolled out in healthcare settings affiliated to the LAMP programme. LAMP tests were made available for those healthcare workers who were unable to perform the LFD test, for whatever reason, if they were available to the local NHS organisation [8].

The LAMP rollout initially involved eight sites that would provide saliva-based LAMP testing for staff from surrounding trusts. LAMP testing required additional laboratory capacity; therefore, it was rolled out once new laboratories serving NHS trusts and other settings were established. By the end of 2022, the LAMP testing offer was available in more than 70 trusts, with many trusts undertaking a mixture of LFD and LAMP testing. It should be noted that there were several types of LAMP tests available, and not all of them have been described in this evaluation.

If an individual member of staff received a positive test result, they were required to take a confirmatory PCR test and self-isolate according to government guidance at the time. A positive confirmatory PCR test would trigger tracing through NHS Test and Trace (NHSTT). Many trusts also conducted their own tracing of their staff, to control the spread of SARS-CoV-2 locally.

### **Training and instruction in self-testing**

In NHS organisations, the general recommendation for NHS staff was to conduct their tests at home, unless they 'wish to have the opportunity to be observed by a trained colleague the first time they take the test' [1]. In this case, NHS organisations had to identify staff trainers and facilities to enable staff to be observed if required when they collected and used a device for the first time. Otherwise, NHS staff were considered competent to self-test from the outset of the asymptomatic testing service (November 2020), either with an LFD or LAMP. Every test came with detailed manufacturers' instructions; however, NHS staff used the test in a slightly different way; therefore, they were advised to follow different guidance specifically developed for NHS staff. MHRA agreed to allow a derogation from the LFD test instructions to facilitate home testing. The point of allowing self-testing was to permit staff members to test at home before their shift to avoid creating additional workload during shifts.

Unlike for the adult social care testing service, there was no exam for NHS staff that aimed to check their capability to test, due to their familiarity with such testing.

### **Reporting test results**

From the onset of asymptomatic testing for NHS staff workers, it was a statutory duty that all test results had to be reported, whether they were positive, negative or invalid/void. This was required every time an LFD test was completed.

When trusts began asymptomatic testing, boxes of Innova 25s were delivered to each trust, enabling them to distribute tests to their staff according to their level of staffing and the demand. At that point, there was no central result reporting system in place that would return results to trusts, there was only generic reporting; therefore, it was suggested that trusts build on their existing point-of-care testing capability. Thus, each individual trust developed their own system for reporting results and uploaded the data to PHE, in line with the legislation relating to notifiable diseases. Some did this by uploading it in large Excel files, some would send a list of surnames and the numbers of tests conducted via email, while others built apps to enable a more convenient way to report. UKHSA established a data cleaning team to ensure the data were collected correctly.

Once asymptomatic testing had been rolled out in primary care, the tests were ordered via a 'pull' model, where every practice had to input their data into a central ordering system to request tests. By that time, NHS Digital had built their digital solution that allowed the reporting of test results via the gov.uk portal. NHSTT was responsible for collating the results into a central database.

On 2 July 2021, a new version of the guidance for NHS trusts replaced the previous SOP used in acute trusts and primary care settings. This guidance allowed organisations to follow an established local reporting procedure, whereby results were meant to be submitted by each individual to their organisation, which then had to collate and submit all results on a weekly basis to NHS Digital's Strategic Data Collection Service (SDCS). Alternatively, staff could report their results via gov.uk. Staff had to report via one route to avoid duplication. NHS Digital had a separate team to identify and delete duplicate entries. However, the proportions of trusts submitting results on behalf of their workforce and trusts where staff were reporting directly were not readily available.

LFDs were initially reported through Pillar 1 only, while from the week of 16 January 2021 some tests were reported through Pillar 2. In acute trusts, the majority of tests were reported in Pillar 1 during the entire evaluation period, but from January 2022 between 39% and 49% of tests were reported via Pillar 2. A similar pattern of reporting was observed in mental health trusts. In ambulance trusts, from the week of 18 December 2021, most tests were reported in Pillar 2 (53-66%), while in community trusts, most tests were reported in Pillar 2 from the week of 25 September 2021, reaching 80% or more of reported tests by the week of 29 January 2022 onwards.

LAMP tests were processed by laboratories; therefore, reporting did not require any effort from the staff members' perspective and happened automatically.

Confirmatory PCR tests were assisted tests that were conducted either at a trust testing site or at one of the NHSTT sites. The recording of test results was automatic and did not rely on the person taking the test to confirm the result of their positive LFD with a PCR test.

## Post-result behaviours

In line with Step 4 of the government's roadmap out of lockdown, on 19 July 2021, DHSC announced that double-vaccinated frontline NHS staff in England were permitted to work if they had been contacted as a close contact of a positive COVID-19 case by NHSTT or advised to self-isolate by the NHS COVID-19 app. According to COVID-19 vaccine uptake data (for frontline healthcare workers in all NHS England Trusts) from December 2020 to August 2021, by that time 75% of healthcare workers were double-vaccinated [9]. This measure was introduced to alleviate pressure on NHS services and was meant to be contingent on staff members only working after having a negative PCR test, taking daily negative LFDs for a minimum of 7 days and up to 10 days, or completion of the identified self-isolation period [10]. However, as set out a follow-up letter from NHS England and NHS Improvement (NHSEI) about the changes to PHE's guidance on self-isolation and return to work following a COVID-19 contact, from 16 August 2021, fully vaccinated staff who had been identified as a contact of a positive COVID-19 case were expected to return to work subject to provision of subsequent, daily, negative LFD antigen tests for a minimum of ten days before commencing a shift.

Healthcare workers were among the four priority groups to receive COVID-19 vaccinations [11], starting in early December 2020, and this may have been one of the contributing factors that drove the uptake of testing and reporting after this period. Healthcare workers, as well as the general population, shared the perception that vaccination alongside falling prevalence decreased the risk of contracting and spreading SARS-CoV-2. An Italian study demonstrated that the perception of COVID-19 risk decreased after vaccination [12], thus the vaccine rollout may have reduced the perceived value of testing.

An evaluation of a pilot study of daily contact testing of healthcare workers in NHS acute hospital and ambulance trusts estimated that a total of 729 potential days of healthcare workers' work absences were averted, representing 88% of the maximum available (828 days). Of these, 91% (n ¼ 660) were for clinical staff. The estimated running cost per potential day of work absence averted was £50 [13]. However, daily contact testing was never implemented in the NHS.

For this policy to be effective, every trust needed to be aware of the vaccination status of their employees. However, some staff members received their vaccinations at vaccination centres other than at their workplace. Therefore, they had to inform their employer about this as this did not take place automatically.

## Policy timeline

Government testing policies affecting healthcare staff in England evolved throughout the course of the pandemic, in response to increased prevalence of COVID-19, the availability of new diagnostic devices (LFDs, LAMP tests) and the emergence of variants of concern.

# Generic Policy Timeline

- Lockdown / restrictions introduced
- Isolation timeline
- PM / Government announcements
- Lockdown / restrictions eased
- Vaccinations
- Testing

2020	February	10 <sup>th</sup> February The Health Protection (Coronavirus) Regulations 2020 came into force on the basis that COVID-19 represented a sufficient public health threat, needing individuals to isolate where public health professionals believed there was reasonable risk
	March	3 <sup>rd</sup> March Government publishes Coronavirus Action Plan - aiming to contain, delay, research and mitigate the virus
		5 <sup>th</sup> March Chief Medical Officer (CMO) for England announces first death
	April	2 <sup>nd</sup> April Health Secretary announces 5 pillar strategy to carry out 100,000 PCR tests a day across the UK by end of April
		4 <sup>th</sup> April Department of Health and Social Care (DHSC) publish a strategy setting out how the testing programme will be scaled-up. By end of April, pilot of new commercial swab testing programme is due to be completed
	May	1 <sup>st</sup> May Providing 100,000 tests a day target has been met (from 2 <sup>nd</sup> April announcement)
		4 <sup>th</sup> May NHS Venues across different sectors requested to maintain records of staff, customers and visitors (keeping those for 21 days) to support NHS Test and Trace
	June	1 <sup>st</sup> June Phased reopening of schools in England. Exercise outside with up to 5 others from different households
		7 <sup>th</sup> June Government announces meet target to offer COVID-19 tests to every care home for over 65s
	July	4 <sup>th</sup> July First local lockdown in Leicester and parts of Leicestershire
		4 <sup>th</sup> July More restrictions in England including reopening of pubs, restaurants and hairdressers
	August	3 <sup>rd</sup> August East Out to Help Out scheme launched until 31 <sup>st</sup> August
8 <sup>th</sup> August Face coverings in England and Scotland become compulsory in more indoor settings, such as museums, places of worship and aquariums		
September	1 <sup>st</sup> September The NHS Test and Trace Support Payment Scheme piloted in Blackburn with Darwen, Pendle and Otham	
	8 <sup>th</sup> September Hands, Face, Space' campaign launched	
October	14 <sup>th</sup> October New 3 tiered system of COVID-19 restrictions starts in England	
	2 <sup>nd</sup> November Government says it passed target to increase daily testing to 500,000 by end of October	
November	5 <sup>th</sup> November 2 <sup>nd</sup> national test target for England begins	
	6 <sup>th</sup> November First pilot of regular whole city testing in Liverpool with existing swab tests and new rapid Lateral Flow Devices (LFDs)	
December	2 <sup>nd</sup> December 2 <sup>nd</sup> lockdown ends after four weeks and England returns to a stricter three-tier system of restrictions	
	2 <sup>nd</sup> December MHRA provides approval for the first COVID-19 vaccine in the UK, developed by Pfizer/BioNTech	

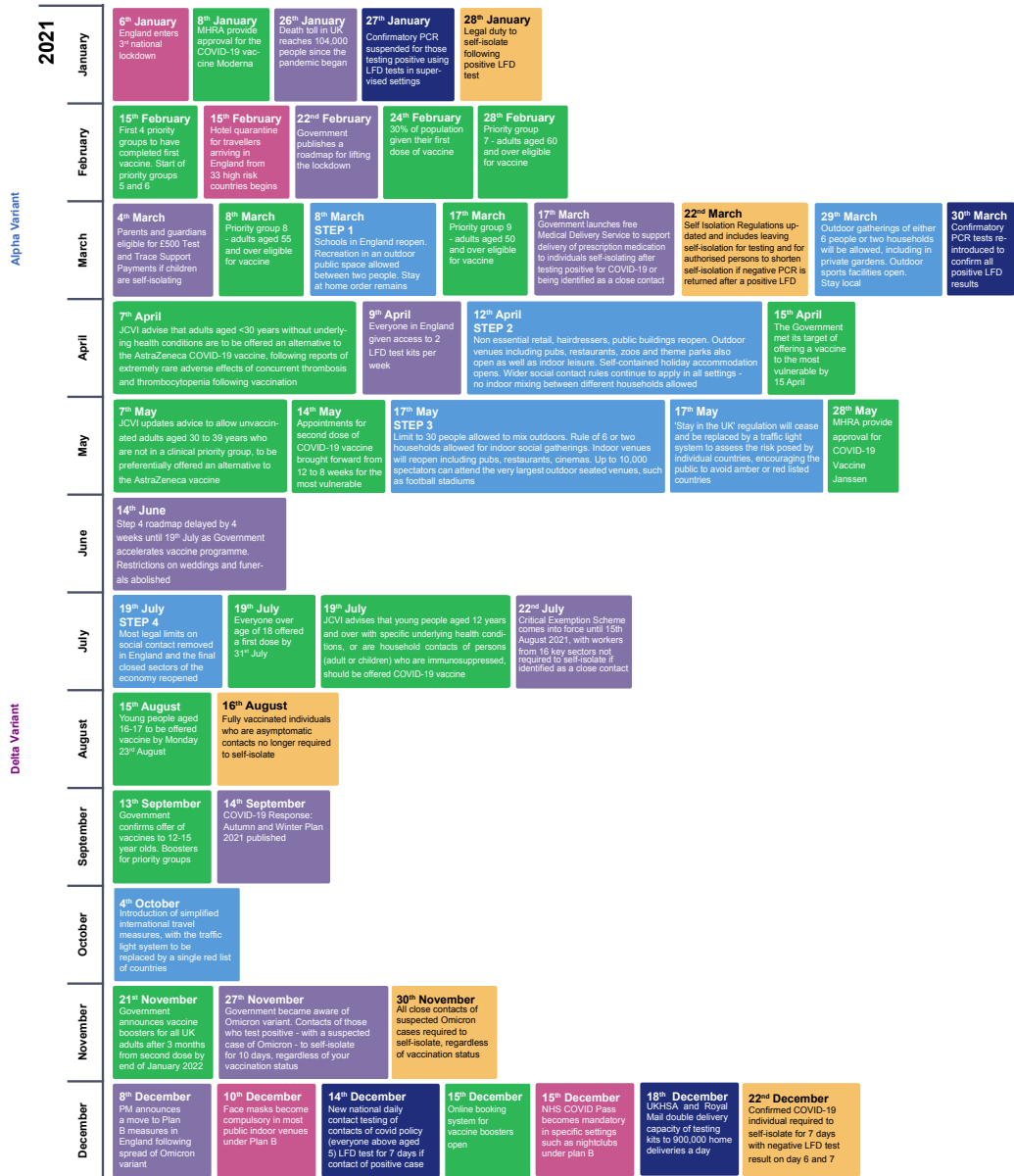
# Healthcare Timeline

- Isolation timeline
- Asymptomatic testing - Staff
- Vaccinations

2020	March	23 <sup>rd</sup> March See Generic Policy Timeline
		27 <sup>th</sup> March Government launches new drive on tests for front line NHS staff
	April	23 <sup>rd</sup> April DHSC announced that 'all essential workers in England and members of their households who are showing symptoms of coronavirus will now be able to get tested'
		28 <sup>th</sup> April Government announced that 'testing of all asymptomatic NHS and social care staff and care home residents also being rolled out'
	May	21 <sup>st</sup> May DHSC announced to 'offer antibody tests to health and social care staff and patients in England'. These tests were made available 'in a phased way' beginning with health and social care staff, patients, and residents
		30 <sup>th</sup> May Government reaches 200,000 testing capacity target a day
	June	30 <sup>th</sup> July See Generic Policy Timeline
		5 <sup>th</sup> November See Generic Policy Timeline
	November	16 <sup>th</sup> November Asymptomatic testing rolled out for patient-facing HCW in Trusts
		31 <sup>st</sup> December Letter from CMO outlining changes to change schedule recommending that first doses of the vaccine are prioritised for as many people as possible

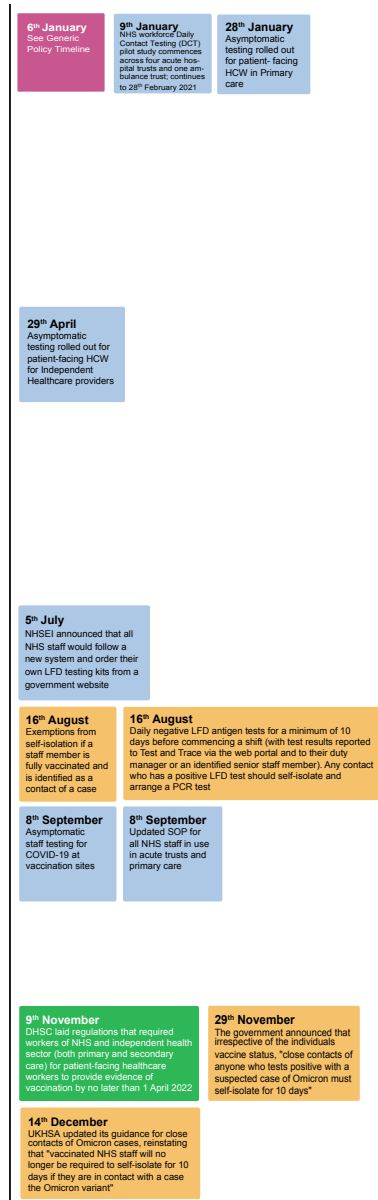
# Generic Policy Timeline

- Lockdown / restrictions introduced
- Isolation timeline
- PM / Government announcements
- Lockdown / restrictions eased
- Vaccinations
- Testing



# Healthcare Timeline

- Isolation timeline
- Asymptomatic testing - Staff
- Vaccinations





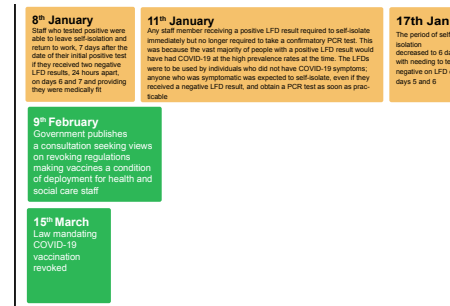
# Generic Policy Timeline

- Lockdown / restrictions introduced
- Isolation timeline
- PM / Government announcements
- Lockdown / restrictions eased
- Vaccinations
- Testing



# Healthcare Timeline

- Isolation timeline
- Vaccinations
- Asymptomatic testing - Staff



## Key policy changes

- ▶ On 9 November 2020, NHS confirmed that asymptomatic testing would be made available to all patient-facing NHS staff [2]; this was followed by an SOP [1].
- ▶ On 16 December 2020, NHSEI announced the rollout of LFDs for COVID-19 testing of asymptomatic, patient-facing staff delivering NHS services in primary care [14].
- ▶ On 28 January 2021, NHSEI published an SOP for the rollout of LFDs for asymptomatic staff testing for COVID-19 in primary care [4].
- ▶ In January and February 2021, an NHS workforce daily contact testing (DCT) pilot study was undertaken in four acute hospital trusts and one ambulance trust [13].
- ▶ On 29 April 2021, NHSEI published details of the rollout of LFDs for asymptomatic staff testing for COVID-19 in the independent sector [15].
- ▶ From 5 July 2021, NHSEI announced that all NHS staff would follow a new system and order their own LFD testing kits from a government website [16].
- ▶ From 16 August 2021, fully vaccinated staff identified as a contact of a positive COVID-19 case were no longer required to isolate and were expected to return to work (conditions applied) [17].
- ▶ On 8 September 2021, NHSEI published an SOP for the use of LFDs for asymptomatic staff testing at vaccination sites [18].
- ▶ On 8 September 2021, NHS published an updated SOP for all NHS staff in acute trusts and primary care [19].
- ▶ On 9 November 2021, DHSC set out regulations that required workers in the NHS and the independent health sector (both primary and secondary care), aged 18 years and over, who had direct, face to face contact with service users to provide evidence that they had received a complete course of an MHRA-approved COVID-19 vaccine, subject to limited exceptions, by no later than 1 April 2022 [5].
- ▶ On 29 November 2021, the government announced that irrespective of the individuals vaccine status 'lose contacts of anyone who tests positive with a suspected case of Omicron must self-isolate for ten days' [20].
- ▶ On 14 December 2021, UKHSA updated its guidance for close contacts of Omicron cases, reinstating that 'vaccinated NHS staff will no longer be required to self-isolate for 10 days if they are in contact with a case of the Omicron variant' [21].
- ▶ From 11 January 2022, any staff member receiving a positive LFD result for COVID-19 as a part of their repeat asymptomatic testing was required to self-isolate immediately but was no longer required to take a confirmatory PCR test, hence confirmatory PCR tests were temporarily suspended; they were never subsequently reinstated [22].
- ▶ On 15 March 2022, the requirement for mandatory vaccinations for health and social care staff was revoked [23].

### Pausing testing following a confirmed COVID-19 result:

- ▶ The November 2020 SOP [1] noted that staff would not need to self-test with an LFD for 90 days following a laboratory-confirmed positive PCR result.
- ▶ The September 2021 guidance for NHS Trusts [24] noted the same.
- ▶ This did not change until December 2021/January 2022, when the emergence of the Omicron variant led to the guidance evolving further, and staff members were required to resume the LFD testing regimen upon returning to work [21].

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## 4.2 Theory of Change

### 4.2.1 Methodology

As per the evaluation protocol [1], this evaluation used a 'Theory of Change (ToC) approach [2, 3]. A ToC framework is used to understand the causal pathways and intended and unintended outcomes of complex interventions (in this case, the asymptomatic testing service for healthcare workers), while exploring the effect of context on the service setting's intended outcomes.

Subsequently, these separate insights were used to define outcome and process indicators to determine if and how the combined aims of the testing service were achieved. The ToC was developed retrospectively by the evaluation consortium, presented to UKHSA stakeholders in a participatory manner and iteratively updated based on their feedback.

The key research questions that were used to support the design of the ToC are shown in Table 1.

**Table 1: Key research questions.**

1.	How did the delivery and uptake of the testing service compare with what was planned over time and what factors affected this?
2.	What were the barriers and facilitators to the access, use and delivery of the testing service?
3.	What measurable impacts were there from the testing service in terms of its intended purpose?
4.	What was the cost to the government and the cost-effectiveness of the testing service?
5.	Which aspects of the testing service might be beneficial to consider for future services?
6.	For the testing programme overall, how can the above learnings be used to inform future pandemic preparedness testing strategy for England?

The healthcare ToC was modelled and designed retrospectively, using publicly available information (testing policies and guidance) and insights received from UKHSA Secretariat, to evaluate the complex intervention of repeat asymptomatic COVID-19 testing with the use of LFDs and confirmatory PCR tests for healthcare staff in England between October 2020 and March 2022.

As described by Maini et al (2018) [4], the mapping was undertaken by identifying key activities/pre-conditions alongside assumptions and interventions that needed to be true in order for the outcome to be realised. For the purpose of the intended service, activities were defined as the elements required for setting up the testing, with conducting a test and appropriate actions following a test result listed under outputs.

### 4.2.2 Theory of Change diagrams

Based on feedback from UKHSA/evaluation consortium meetings, a high-level ToC was developed and is presented in Diagram 1.

**Diagram 1: Healthcare Theory of Change – high level view**

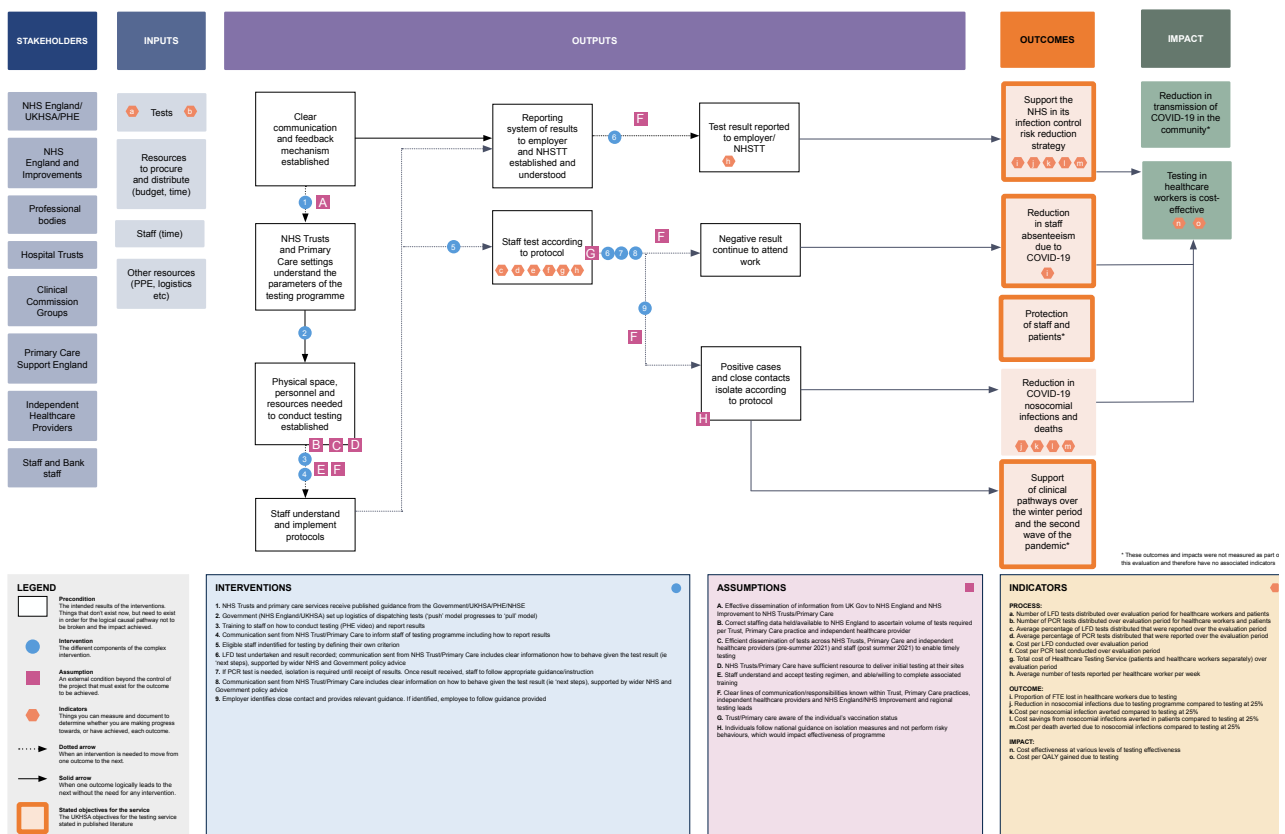
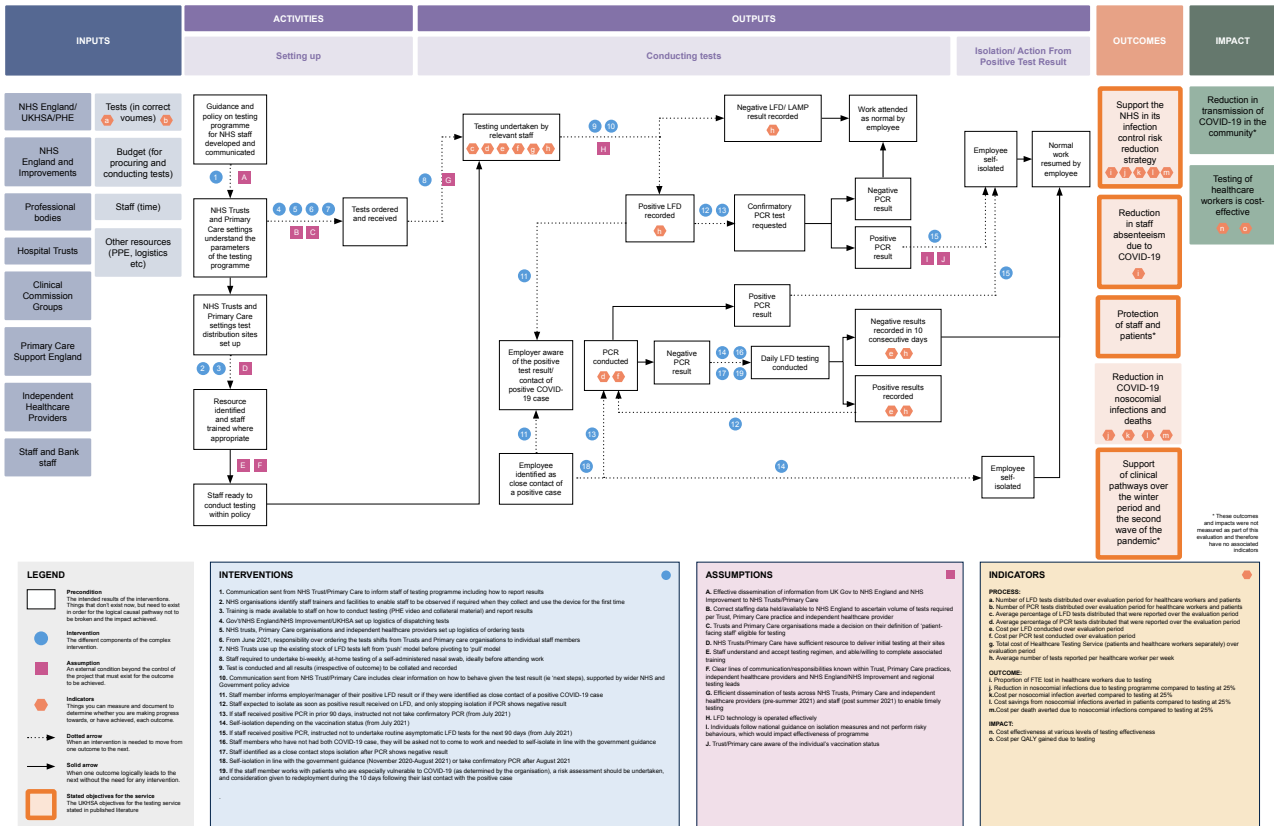


Diagram 2 provides additional detail, with clearer process mapping added into the overall process of the testing service in the healthcare sector.

It must be noted that the policy changes were happening amid the changing national picture in terms of prevalence, emergence of new variants of concern and vaccine rollout, among others. Therefore, the ToC model should be viewed with respect to the continuous changes that the service faced and that the representations presented may not have encompassed all the changes.

Diagram 2: Detailed Healthcare Theory of Change with process overlay



### 4.2.3 Appendix 4.2 references

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## 4.3 Qualitative methodology and findings

This appendix contains the following sections:

- Behavioural and operational research
  - Narrative review methodology (context and operational insights)
  - Scoping study methodology (behavioural insights)
  - Behavioural and operational insights
- Stakeholder engagement
  - Methodology
  - Stakeholder insights

### Behavioural and operational research

#### 4.3.1.1 Narrative review methodology

To support with an understanding of the policy timeline, the aims and context for each service and to identify information on how each of the services operated, a narrative review was conducted into publicly available data sources. Sources included academic literature and grey literature (e.g., information and guidance published on gov.uk). These sources were collated and analysed to provide context to the evaluation.

#### 4.3.1.2 Scoping study methodology

A scoping study was conducted to provide an overview of existing studies exploring barriers and facilitators to implementing and participating in COVID-19 testing in England. The key activities explored were COVID-19 testing, reporting of results and isolation following a positive result. This study aimed to provide: i) a summary of the research undertaken on this topic, ii) an overview of key barriers and facilitators for each setting, as well overall across all settings.

The findings were also triangulated with the statistical analysis, and then fed back into the developing Theories of Change to refine and explain the assumptions and to make recommendations.

### Methods

#### Study design

A rapid scoping study was conducted to evaluate the barriers and facilitators to engaging with COVID-19 testing, reporting of results and self-isolation in the United Kingdom during the COVID-19 pandemic. A scoping study was selected to synthesise knowledge as there is a large volume of heterogenous literature on this topic [1]. The proposed scoping study was conducted following the 2005 Arksey and O'Malley framework [2], with the adaptations proposed by Levac et al in 2010 [3], and using the 2015 Joanna Briggs Institute guidance on conducting scoping reviews [4].

#### Search strategy and selection of the evidence

A wide search strategy was developed with input from a health sciences librarian, using key phrases from relevant articles [2] (see Table 1 for categories and example terms). This was used to identify literature that described behaviour around COVID-19 testing, reporting and self-isolation in the UK during the COVID-19 pandemic. The search strategy was adapted for each database and information source that was searched and then refined according to key words in sources that the search identified.

**Table 1.** Search categories and examples of search terms.

Category	Search terms
<b>COVID-19</b>	COVID* OR corona OR coronavirus OR SARS-CoV-2 OR "SARS CoV 2" OR "SARS CoV-2" OR SARS-CoV2 OR SARSCoV2 OR "Severe Acute Respiratory Syndrome Coronavirus 2" OR "Severe Acute Respiratory Syndrome Corona Virus 2" OR 2019-nCoV
<b>AND</b>	
<b>Key activities</b>	test* OR screen* OR RT-PCR OR PCR OR "polymerase chain reaction" OR "lateral flow" OR "lateral flow device*" OR "lateral flow assay*" OR LFD OR self-test* OR "test and trace" OR "contact trac*" OR surveillance OR POCT OR report* OR self-report* OR selfreport* OR ""test positive"" OR "testing positive" OR result* OR "self-isolation" OR "self isolation" OR isolat* OR containment OR reopening OR re-opening OR mitigat* OR flatten*
<b>AND</b>	
<b>Behaviour, barriers and facilitators</b>	knowledge OR understand* OR attitude* OR perception* OR perceive OR belief* OR believ* OR expectation* OR trust OR willing* OR intention* OR behaviour* OR behavior* OR practice* OR enact* OR engag* OR adher* OR complian* OR comply OR experience* OR view* OR motivation* OR barrier* OR block* OR challeng* OR difficult* OR facilitat* OR enabl* OR access* OR feasib* OR accept* OR uptake
<b>AND</b>	
<b>Research methods</b>	qualitative* OR interview* OR FGD OR "focus group*" OR survey* OR questionnair* OR mixed-method* OR "mixed method*" OR ethnograph* OR theme OR thematic* OR "grounded theory" OR "content analysis" OR field-work OR "field work" OR selfreport* OR self-report* OR "self report*" OR view* OR experience* OR hermeneutic OR phenomenolog*
<b>AND</b>	
<b>Geographic setting</b>	"United Kingdom" OR UK OR England OR Ireland OR Irish OR Scot* OR Wales OR Britain OR British OR NHS OR "National Health Service*" OR UKHSA OR "United Kingdom Health Security Agency" OR "UK Health Security Agency" OR "Channel Island*" OR London OR Birmingham OR Liverpool OR Manchester OR Cardiff OR Belfast OR Edinburgh OR Glasgow

The databases searched included the following:

1. **PubMed:** covers Medline as well as other sources relevant for a scoping review on COVID-19 literature, including in process citations, out of scope citations, ahead of print citations and author manuscripts of NIH-funded research.
2. **Scopus:** covers biomedical and social science research.
3. **The World Health Organization COVID-19 Research Database:** the literature cited in the WHO COVID-19 Research Database is updated daily (Tuesday through Saturday) from searches of bibliographic databases, hand searching, and the addition of other expert-referred scientific articles. This database represents a comprehensive multilingual source of current literature on the topic. While it may not be exhaustive, new research is added regularly. Databases searched include MEDLINE, Scopus, EuropePMC, Web of Science, ProQuest Central, EMBASE, medRxiv, ICTRP, WHO COVID, and ScienceDirect, as well as the grey literature [5].
4. The search was supplemented after screening to identify key missing studies, by free-text searches on Google Scholar, review of the references of included articles and through stakeholder consultations [6]. UKHSA Secretariat provided documents formed part of the stakeholder identified sources for this study.

The search strategy aimed to identify both published and unpublished studies, as well as reports and guidance documentation. Qualitative or mixed methods studies published from 2020 in English were included. To be included in the review, papers needed to focus on any of the following three behaviours: undertaking a test; reporting a test; or isolating following a positive result, symptoms or a positive contact (see Table 2 for search limits and eligibility criteria).

**Table 2.** Summary of the search parameters and limits as well as the inclusion and exclusion criteria [2], categorised according to the ‘population, context, concept’ search framework [7].

	Inclusion	Exclusion
<b>SEARCH LIMITS</b>		
<b>Language</b>	Published in English	Published in languages other than English
<b>Dates</b>	Published between the start of 2020 and the search date (the database search was conducted on 07 November 2022 and the UKHSA documents were received throughout September – December 2022)	Published before 2020
<b>Methods</b>	Qualitative or mixed methods studies Quantitative surveys	Quantitative studies reporting only the association between demographic variables and behavioural outcomes
<b>ELIGIBILITY</b>		
<b>Literature</b>	Journal articles, peer-reviewed material, articles under review, published books and book chapters, other academic research, research commissioned by governments, unpublished reports	Opinion or statement pieces, magazine articles, blog posts
<b>Population</b>	England, Northern Ireland, Scotland, Wales, and the islands making up the British Isles. Multi-country studies were included if they included one of these settings	Countries outside the UK, including the Republic of Ireland
<b>Concept</b> (Key activities)	<p>Description of the behaviour, barriers and/ or facilitators of how people did behave regarding the key activities:</p> <ul style="list-style-type: none"> <li>▶ Antigen testing for COVID-19 (with a focus on LFDs but including LAMP and PCR testing).</li> <li>▶ Reporting the test results.</li> <li>▶ Isolating (with a focus on isolating due to a positive COVID-19 test result but including isolating after being identified as a close contact of COVID-19 positive case).</li> </ul> <p>The description of behaviours included associations of survey responses with behaviour or intention to test, report or isolate.</p>	<p>Describes testing, reporting or isolation but not the behaviour associated with them (e.g., describes the sensitivity of a specific test)</p> <p>Describes testing for antibodies</p> <p>Describes the barriers or facilitators to isolation in the context of social distancing, isolation if symptomatic or traveller isolation (hotel quarantine)</p> <p>Describes association of demographic factors with behaviour or intention to test, report or isolate</p> <p>Testing, reporting results or isolation after a positive result in the context of other diseases</p> <p>Describes facilitators or barriers to other COVID-19-related behaviours, such as vaccination or social distancing</p> <p>Describes the impact of testing/ reporting/ isolation on behaviour</p> <p>Knowledge, attitudes, or perceptions of COVID-19 itself</p>

As there was less evidence available on isolating after a positive test, the eligibility was widened to include studies that described perceptions or experiences of isolating as a response to a positive contact. This was done across all settings. The information related to testing in these studies was then also included in the analysis (but evidence about contact testing without discussion of isolation was not included, as more evidence was available about routine asymptomatic testing). Our assumption was that the perceptions and experiences of testing and isolating were similar across the reasons for testing (asymptomatic testing programme or in response to a positive contact) and that inferences on asymptomatic testing and reporting behaviours and isolation after a positive result, could be made from evidence about testing, reporting and isolating after a positive contact.

There was a paucity of evidence in relation the three priority service settings, therefore the eligibility was made more inclusive for healthcare, adult social care and schools. For the service-specific settings, evidence was available from before the evaluation period and before LFDs were available. Many of these studies were early, exploratory pilot studies. These sources provided insights into the behaviour around testing, reporting and isolation after a positive test, and inferences could be made regarding LFD testing behaviours. Therefore, evidence focused on LAMP or PCR testing, evidence on symptomatic testing and evidence from before October 2020 was also included for these three service settings (but not for the overall testing programme).

Following the database search, all identified citations were collated and uploaded into Rayyan [8], and duplicates were removed. Following an initial screening pilot, titles and abstracts were then screened by two reviewers for assessment against the inclusion criteria for the review. A sample of  $\geq 20\%$  were reviewed by a third reviewer to clarify eligibility criteria and ensure consistency of inclusion [3]. Once the final criteria were established, each reader applied the clarified criteria to all literature screened, and the inter-rater agreement was calculated for the final list using Gwet's first-order agreement coefficient (AC1) [9]. Potentially relevant sources were retrieved in full and then assessed in detail against the inclusion criteria. Any disagreements that arose between the reviewers at each stage of the selection process were resolved through discussion between them and with an additional reviewer if no consensus was reached.

### **Supplementary data**

UKHSA was identified as the major stakeholder in this study. UKHSA Secretariat identified a repository of data and documentation of potential relevance to the evaluation. Upon commencement of the evaluation, and where review of the documents highlighted further potentially relevant sources, additional documentation was requested by the Evaluation Consortium to support with understanding how the testing services were intended to work, how they were experienced and any prior measurement of their effectiveness. Supplementary documents provided by UKHSA Secretariat included:

- ▶ Testing guidance published by UKHSA
- ▶ Testing process documentation
- ▶ Business cases
- ▶ Primary qualitative or quantitative research (including behavioural studies) with anyone involved in the testing programme
- ▶ Documentation involving reporting, managing or measuring the testing programme
- ▶ Previous evaluations of testing services

Once the publicly available data had been screened, these stakeholder-identified sources were reviewed for inclusion. The documents were allocated to one of the service settings. The same pair of reviewers that screened the full texts from the database searches reviewed the documents sent by the UKHSA Secretariat for the healthcare, adult social care, and schools' settings. Six reviewers screened the general setting documents received by the UKHSA Secretariat due to a larger number of documents. The titles and abstracts of the documents were screened, then potentially relevant sources were retrieved in full, and assessed in detail against the inclusion criteria. Repeated discussions (and oversight by one reviewer of the other five for the general setting), helped to ensure consistency of the application of eligibility criteria.

## **Data extraction, charting and synthesis**

Two reviewers per priority service setting extracted the data, with a larger team (of six) extracting the universal testing and 'other' service setting data. The data extracted from each evidence source included study metadata (authors, title, year of publication/dissemination, publication stage, country, participant characteristics and methods), the setting (service setting and key activity), and information about the perceptions, experiences and the barriers and facilitators to each of the key activities (testing, reporting, and isolating). Data were extracted into an Excel template, which was piloted and refined using a handful of included sources. Each reviewer extracted data from two sources that overlapped with another reviewer, to check quality and support discussions to refine eligibility criteria.

Given the rapid timelines and the aim of the work, the articles were not assessed for quality. Once all the data had been extracted, we synthesised the data thematically by identifying key topics within the identified perceptions, experiences, barriers and facilitators. This was done for each service setting (healthcare, schools, adult social care and general, including universal testing and other non-priority settings). In addition, we compared the findings across all three service settings with the aim of identifying universal as well as service-specific barriers and facilitators.

## **Stakeholder input**

Stakeholder engagement is suggested to be useful for adding methodological rigour to scoping studies [3]. Therefore, stakeholders from UKHSA were consulted to identify additional sources of published and unpublished evidence, sense-check the findings and help frame the results. Additional sources identified through this route were included in the scoping review (PRISMA-ScR) flow diagram as 'stakeholder-identified studies' [6], and insights from these discussions were incorporated into the discussion of the results.

## **Healthcare literature review**

In total, 11 articles were identified after full text review and included in the healthcare setting synthesis (Table 3). Ten were from the database search and one was from the stakeholder identified sources. The 11 sources covered data collection from December 2019 to June 2021, with three from the evaluation period (October 2020 to March 2022). All included English participants, with three including participants from the UK overall and one including UK participants among other international participants. More than half (7/11) used interviews, 5/11 used surveys, 2/11 used focus groups and 1/11 used other methods (mass media analysis).

All included sources described testing behaviours, with 2/11 describing reporting behaviours and 3/11 describing isolation behaviours directly. The participants included healthcare staff members from different care settings, with three focusing specifically on primary care physicians, one on orthodontists, one on ethnic minority healthcare workers in particular, and one that included senior scientific advisors. Three of the articles from the database search overlapped with the adult social care (2/11) and the schools (1/11) service settings and therefore described testing and isolation behaviours across multiple settings.

Publication Reference	Methodology			Setting		Context
	Methods	Description of the sample	Data collection period	Country	Scope	
Heskin J, Pallett SJC, Mughal N, Jones R, Rayment M, Davies GW, et al. Healthcare worker perceptions of routine asymptomatic SARS-CoV-2 screening using lateral flow assays: A qualitative analysis across two London hospitals. <i>J Infect.</i> 2022;84(1):e26-e8	Surveys	2370 healthcare staff participating in this programme across two London hospitals	02 March 2021 to 02 May 2021	England	Testing & reporting	Evidence is from the evaluation period, when asymptomatic testing of healthcare workers was in place
Martindale, A. M., Pilbeam, C., Mableson, H., Tonkin-Crine, S., Atkinson, P., Borek, A., Lant, S., Gobat, N., Solomon, T. & Sheard, S. 2021. Perspectives On Covid-19 Testing Policies And Practices: A Qualitative Study With Scientific Advisors And NHS Health Care Workers In England. <i>BMC Public Health</i> , 21, 1216.	Interviews	24 interviews with 13 participants: five senior scientific advisors (all male Caucasian) and eight healthcare workers (five male, four female, all Caucasian) including nurses, physicians, general practitioners and allied healthcare workers	March 2020 to August 2020	England	Testing, reporting and isolation	Focus on perceptions of healthcare workers and scientific advisors, with data collected early in the pandemic before asymptomatic testing of healthcare workers was in place, and healthcare workers and patients were prioritised for symptomatic PCR testing
Moorthy, A., and T. K. Sankar. 2020. 'Emerging public health challenge in UK: perception and belief on increased COVID19 death among BAME healthcare workers', <i>J Public Health (Oxf)</i> , 42: 486-92.	Surveys	200 ethnic minority healthcare workers in Leicester	02 May to 17 May 2020	England	Testing	Focus on Black and minority ethnic (BAME) healthcare worker perceptions on PCR testing, with data collected early in the pandemic before asymptomatic testing was in place, and healthcare workers and patients were prioritised for symptomatic PCR testing
Sabbagh, Y., B. R. Lewis, S. M. Chadwick, and E. S. Abu Alhajja. 2022. 'The COVID-19 experience of orthodontists in the UK', <i>J Orthod</i> , 49: 259-72.	Surveys	560 members of the British Orthodontic Society	March 2021 to June 2021	UK overall	Testing	Data collected within the evaluation period, when asymptomatic testing of healthcare workers was in effect. Focus is on primary care orthodontists' perceptions
Vindrola-Padros, C., L. Andrews, A. Dowrick, N. Djellouli, H. Fillmore, E. Bautista Gonzalez, D. Javadi, S. Lewis-Jackson, L. Manby, L. Mitchinson, S. Mulcahy Symmons, S. Martin, N. Regenold, H. Robinson, K. Sumray, G. Singleton, A. Syversen, S. Vanderslott, and G. Johnson. 2020. 'Perceptions and experiences of healthcare workers during the COVID-19 pandemic in the UK', <i>BMJ Open</i> , 10: e040503.	Interviews and mass media analysis	30 interviews with healthcare staff members  101 newspaper articles and 146 000 social media posts to capture the direct or indirect perceptions and experiences of healthcare workers	December 2019 to the end of April 2020  Interviews took place in April 2020	UK overall	Testing	Focus on healthcare worker perceptions and experiences during the first wave, with data collected before asymptomatic testing was available but healthcare workers and patients were prioritised for PCR testing
Wanat, M., M. Hoste, N. Gobat, M. Anastasaki, F. Bohmer, S. Chlabicz, A. Colliers, K. Farrell, M. N. Karkana, J. Kinsman, C. Lionis, L. Marcinowicz, K. Reinhardt, I. Skoglund, P. D. Sundvall, A. Vellinga, H. Goossens, C. C. Butler, A. van der Velden, S. Anthierens, and S. Tonkin-Crine. 2021. 'Supporting Primary Care Professionals to Stay in Work During the COVID-19 Pandemic: Views on Personal Risk and Access to Testing During the First Wave of Pandemic in Europe', <i>Front Med (Lausanne)</i> , 8: 726319.	Interviews	11 primary care professionals in England (80 in total from England, Belgium, the Netherlands, Ireland, Germany, Poland, Greece and Sweden)	April 2020 to July 2020	International but includes UK	Testing	Focus on primary care workers, with data collected early in the pandemic before the asymptomatic testing of healthcare workers was in place, but healthcare workers and patients were prioritised for symptomatic PCR testing  International perspective that includes the UK



Publication Reference	Methodology			Setting		Context
	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Evidence overlapping between service settings</b>						
Graziadio, S., S. G. Urwin, P. Cocco, M. Micocci, A. Winter, Y. Yang, D. A. Price, M. Messenger, A. J. Allen, B. Shinkins, and Condor Steering group. 2020. 'Unmet clinical needs for COVID-19 tests in UK health and social care settings', <i>PLoS One</i> , 15: e0242125.	Survey and focus groups	447 health and social care professionals from hospitals (189), primary dental care (65) and general practice (55)	22 May 2020 to 15 June 2020	England	Testing	Focus on both healthcare and adult social care settings (with some findings difficult to differentiate between the two), and data collected early in the pandemic before asymptomatic testing of healthcare workers was in place, and healthcare workers and patients were prioritised for symptomatic PCR testing
Kierkegaard, P., T. Hicks, A. J. Allen, Y. Yang, G. Hayward, M. Glogowska, B. D. Nicholson, P. Buckle, and Condor Steering Committee. 2021. 'Strategies to implement SARS-CoV-2 point-of-care testing into primary care settings: a qualitative secondary analysis guided by the Behaviour Change Wheel', <i>Implement Sci Commun</i> , 2: 139.	Interviews	22 primary care physicians from 21 primary care practices across three regions (London, Thames Valley and South Midlands, North East and North Cumbria)	September 2020 to November 2020	England	Testing	Focus on perceptions of primary care physicians on LFD point of care testing of staff and patients, with data collected early in the pandemic before asymptomatic testing of healthcare workers was in place, and healthcare workers and patients were prioritised for symptomatic PCR testing  Covers both healthcare worker testing and delivery of asymptomatic testing to patients
Nyashanu, M., F. Pfende, and M. Ekpenyong. 2020. 'Exploring the challenges faced by frontline workers in health and social care amid the COVID-19 pandemic: experiences of frontline workers in the English Midlands region, UK', <i>J Interprof Care</i> , 34: 655-61.	Interviews	40 health and social care frontline workers, including 15 nurses, 10 managers and 15 support workers in the English Midlands	February 2020 to April 2020	England	Testing	Focus on both healthcare and adult social care settings (with some findings difficult to differentiate between the two), and data collected early in the pandemic before asymptomatic testing of healthcare workers was in place, and healthcare workers and patients were prioritised for symptomatic PCR testing
Watson, D., N. L. Baralle, J. Alagil, K. Anil, S. Ciccognani, R. Dewar-Haggart, S. Fearn, J. Groot, K. Knowles, C. Meagher, C. McGrath, S. Muir, J. Musgrove, K. Glyn-Owen, K. Woods-Townsend, A. Mortimore, P. Roderick, J. Baird, H. Inskip, K. Godfrey, and M. Barker. 2022. 'How do we engage people in testing for COVID-19? A rapid qualitative evaluation of a testing programme in schools, GP surgeries and a university', <i>BMC Public Health</i> , 22: 305.	Interviews and focus groups	8 general practitioners belonging to one Clinical Commissioning Group in the city of Southampton (223 participants in total)	04 June 2020 to 07 November 2020	England	Testing and isolation	The paper describes engagement with testing in schools, universities and in primary care service settings, so reflects broader perspectives than healthcare workers alone, with data collected before asymptomatic testing of healthcare workers was in place.  Specifically looking at a spit-sample LAMP testing programme pilot, which was only made available for asymptomatic testing to some who could not tolerate swabbing
<b>UKHSA Secretariat documents</b>						
Bow, S. M. A., Goddard, A., Cope, G., Sharp, N., Schick, J., Woods, C., Jeffery, K., Harrington, D., Williams, S., Rodger, A. J., Finer, S., Fowler, T., Hopkins, S. & Tunkel, S. A. 2022. An Evaluation Of A Pilot Of Daily Testing Of Sars-Cov-2 Contacts In Acute Hospital And Ambulance Trusts In England. <i>Public Health</i> , 209, 46-51.	Surveys and interviews	60 healthcare workers completed the survey (58 who did daily contact testing and 2 who did not).  28 interviews included trust daily contact testing leads, a union representative and two participants per trust. Healthcare workers were from four large, multisite acute hospital trusts in London, Oxford and Lancashire and a London ambulance trust	09 January 2021 to 28 February 2021	England	Testing	Data collected within the evaluation period, when asymptomatic testing of healthcare workers was in effect.  This paper focuses on daily contact testing rather than routine asymptomatic testing

## Full qualitative behavioural insights

### Barriers and facilitators to taking and reporting a test

#### Physical experience of the test

Nose and throat swab sample collection for testing was generally experienced as uncomfortable. However, it appears for healthcare workers that physical discomfort was not a barrier to engaging with testing. This seemed to be because this barrier was overcome by the value ascribed to testing.

Despite 60.1% (1187/1976) of respondents reporting the procedure 'fairly uncomfortable' or 'very uncomfortable', 94.5% (1829/1935) would continue the twice weekly LFA testing process during the pandemic. Respondents felt 'it is a negligible inconvenience if it helps save lives and livelihoods'. [10].

Saliva-based sampling for LAMP testing was perceived to be easier to carry out than nasopharyngeal swabs [11].

#### Individual capability to test and report

Most healthcare workers understood the requirements of when to test for COVID-19 [12, 13]. There were cases of healthcare workers using LFDs for symptomatic testing, in breach of the guidance to use PCR tests [10], but it was not clear whether this was a lack of understanding or a choice. Early experiences of testing (before the launch of repeat asymptomatic testing for healthcare workers) were characterised by a lack of knowledge of the point-of-care (POC) testing landscape [14] and reflected 'emerging knowledge on the nature of the virus, its symptoms and transmission routes' [15].

Not all healthcare workers understood the testing guidance. A lack of understanding of the requirement to test was described as negatively affecting healthcare worker attitudes to implementation of testing and 'negatively affected their willingness to adopt the tests'. This 'limited knowledge acted as a barrier as they were unable to identify the advantages or disadvantages of implementing POC tests into practice' [14]. Some healthcare workers were confused by the guidelines, which acted as a barrier to testing as per requirements:

Some [primary care physicians] also expressed uncertainty when one should be tested and found guidelines confusing and some sought clarification and advice from colleagues, which at times led to not getting tested. [15].

Furthermore, early in the pandemic, issues were raised regarding PCR results around who the test results should be given to and which clinical records they should go on:

“

... does it go to your GP? Does it go to occupational health or ... does it go purely to the individual?"  
Clinical director [16].

However, despite confusing guidelines [15], there appeared to be a better understanding of how to test than when to test. This is not unexpected as healthcare workers have experience with sample collection and POC testing through the management of other diseases, which may have contributed to their confidence in performing COVID-19 LFDs [14]. Additionally, the regular and routine performance of LFD testing meant staff reported being 'familiar with how to test and report LFD results' [13].

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All the people that work in the practice can take blood and do swabs, and quite a lot of us do respiratory stuff, spirometry and other breathing things. With simple training, we should be able to manage a point of care test that is simple, and it's making sure it can be done repeatedly and accurately. GP 16 [14].

Overall and in terms of technical ability, virtually no healthcare workers had any problem with LFDs [10], and most people felt that the 'testing instructions were clear' [11]. In one survey, all participants (n = 58) reported being at least 'fairly confident' that they conducted the test correctly [13]. This confidence was found across swabbing, mixing the sample with the buffer, cartridge inoculation and reading the test result [10, 13], with 98% (of 1937 healthcare workers surveyed) performing LFD testing unassisted, and preferring to do so [10].

#### Increasing knowledge and capability of testing and reporting

Understanding and confidence could be enhanced to facilitate testing through the communication of education materials and through training [14].

Whilst accepting that this extra work was in a good cause, some suggested a 'toolkit' of instructions and tips for those implementing the programme to help manage the expectations of both staff and participants. [11].

Individual support was reported to help staff 'adhere to the testing regime' [13]. It was also suggested that environmental changes be made to facilitate correct processes for LAMP testing, such as the suggestion that 'the tubes be marked with a clear indicator of the amount of saliva necessary' [11].

## Logistics of testing and reporting

### Eligibility

The NHS rolled out the asymptomatic COVID-19 testing service by publishing guidance in the form of an SOP that indicated that testing had been made available for patient-facing NHS staff. However, there was no definition of patient-facing staff and no list of professions covered. Our stakeholder feedback highlighted that trusts are best placed to take accountability for eligibility decisions, as nationally imposed definitions may have been too strict for one trust and too loose for another. While the first guidance for trusts included all patient-facing staff, once rolled out in primary care, the guidance was extended to any temporary patient-facing staff who provided NHS services through a contractor but were employed through an agency or other kind of temporary arrangements (e.g., locums).

### Convenience of testing and reporting

The testing service 'added responsibilities and added to their [staff's] workload', but this 'extra work was in a good cause' [11]. Some of this increased workload was due to time that some staff had to spend on the administration associated with the testing process.

“

But it's been a case of collating the packs for staff, you know, using our time to do that. Creating emails for internal staff to say actually we are going to summarise the booklet ... it's been a bit time heavy. GP [11].

However, LFDs themselves were seen as fairly convenient, with few reports of problems with test usability [17]. LFDs facilitate testing at home, which was described by healthcare workers as preferable to testing at work [13]. This convenience encouraged participation in the testing service [11].

“

You can do it at a time that is convenient. There is no way with our current caseload demand we could attend an appointment in work time ... I have a routine, and I incorporate it into my day's activities in the comfort of my home. [10].

There was 'ambivalence about the speed' of testing described early in the pandemic, when testing was mostly PCR-driven, before LFDs became available [18], with additional delays in the turnaround time of results reported to cause anxiety [19]. When testing was predominantly PCR testing, delayed results were identified as the most important problem across all settings [17]. LFDs have no delay in returning results, which are available within 30 minutes (depending on the manufacturer). In the early days of the pandemic, before the launch of repeat asymptomatic testing, challenges to accessing COVID-19 tests were described [16, 18], with issues raised around the availability of equipment [17]. Additionally, before LFDs were available, the testing process itself was seen as a potential driver of infection as individuals were 'worried that the test kit drop-off points were sites of potential infection' [11]. Thus, our interpretation is that LFDs could be seen as an enabler to overcome these barriers and that convenience and accessibility improved with the rollout of LFDs that could be stored and performed at home and which did not have delays in results.

### Financial resources required for testing

Healthcare workers early in the pandemic highlighted that additional funding would be required to accommodate the integration of testing and reporting into their activities, to avoid threatening the sustainability of the services [14]. Test kits were subsequently provided free of charge, and thus the price of testing was not considered a challenge, with 'too expensive' one of the least reported problems in one survey [17]. Our interpretation is that the provision of tests free of charge appears to be an enabler of testing behaviour.

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Physicians reported that they would be willing to integrate testing into practice if they received financial incentives to cover the costs of the devices and employee time to perform the tests. "If you provide the machines, and you provide the consumables, and you pay for our time, we will do it." GP [14].

## Consequences of testing and reporting

### Consequences of testing and reporting regardless of result

There was a substantial amount of anxiety around knowing whether an individual had COVID-19. Regardless of the result, the consequence of testing was a reduction in anxiety and 'peace of mind' [16]. Healthcare workers 'generally felt reassured by knowing their viral status' [11], which reduced their anxiety [15] and made them feel safer [10]. This safety was related to the role POC testing in particular plays in decreasing the risk of transmission [14].

Additionally, healthcare workers had negative perceptions of the test packaging, and were concerned about the environmental impact of 'the plastic waste generated from all the packaging' and 'creating more waste that will end up in the ocean'. [10]

Some were concerned about the amount of plastic in testing kits and the environmental impact of an expansion of the testing programme. [11].

Stakeholder feedback notes that substantial work was undertaken to reduce the environmental impact from packaging.

### Consequences of testing and reporting a positive result

While testing positive gave reassurance to some that they would have some immunity to COVID-19 going forward [16], the main consequence of testing positive was that individuals would be required to isolate. Isolation was viewed as a negative experience (see section 4.3.8.1 on acting on a positive result), which created anxiety around testing.

Participants reported feelings of anxiety whilst waiting for their test results, worrying about the personal consequences of having to self-isolate. [11].

Isolation interrupted 'normal life', and this could have had an impact on their work.

Fear of a positive test result was enough to make some decline to take part; they were concerned that if they had to isolate they would lose income, their employer would be unsympathetic. [11].

As described in section 4.3.8.2 (consequences of isolating), the loss of workforce due to isolating staff members put a particular strain on healthcare services [16, 18, 19]. The concern about testing positive and being required to isolate appears to have been a deterrent to engaging with the testing service, but it is unclear whether this was a deterrent to testing itself or to reporting a positive result after conducting a test.

This concern about isolation was more acute if there was doubt about the accuracy of the test, the biggest concern being about the personal consequences of a false-positive result [11]. Unnecessary isolation appeared to be a more substantial negative consequence than if it was warranted (isolation after a true-positive COVID-19 test result). This acted as a barrier to testing, particularly for those who had low levels of trust in the tests [11].

One reason some people declined to take part in the programme was a concern about the personal consequences of a false-positive result. [11].

Early in the pandemic there were also concerns that a positive test on record could have more far-reaching consequences, such as jeopardising future mortgage or life-insurance applications:

... that a history of infection with the virus might affect their ability to get a mortgage and life-insurance. These people preferred not to know their viral status. [11].

### Consequences of testing negative

Healthcare workers 'expressed a sense of relief and reduced feelings of anxiety when they tested negative' [11]. Much of this relief was due to the fact that testing negative meant that people could visit family and friends (particularly vulnerable people) [11] and that healthcare workers did not need to isolate and could continue working, particularly if they had symptoms and tested negative [15]. However, this does not appear to have been a driver of asymptomatic testing as much as of symptomatic testing or testing as a close contact of positive COVID-19 case. This was particularly pertinent at the start of the pandemic 'when staff reported having to stay home if they or someone in their household presented with symptoms indicative of COVID-19, putting extra pressure on the remaining staff' [18].

On the other hand, people were worried that negative tests would result in a change in behaviour for the worse.

Concern was expressed about the potential of those who received a negative test result to become less vigilant in applying social-distancing and hygiene measures. [11].

However, this concern was not universal, and other studies found that this was not necessarily an issue:

Site and IPC [infection prevention and control] leads reported that they observed no concomitant relaxation of IPC behaviours. Survey responses supported this: over 94% of DCT participants (n ¼ 50) reported that their behaviour, in terms of leaving home and social mixing, did not change or became more cautious following a negative result. [13].

Stakeholder feedback notes that all results that were returned flagged the need to continue to follow guidance and that testing may show a false result, with behavioural insight guidance on the wording of these messages. This may have influenced people to continue with IPC behaviours following a negative result.

### **Perceived value of COVID-19 testing**

Healthcare workers found value in COVID-19 testing, with most (95% in a large survey of healthcare workers in early 2021) saying that they 'would continue [to report twice weekly LFD testing] throughout the pandemic if given the opportunity' [10]. This value was found through the benefit it brought to keeping others safe [10, 11, 13] and improving the healthcare workers' health and work environment [15, 20]. Value was also perceived in testing for the organisation as a whole [11, 16]. The value testing represented overcame potential barriers to testing, such as the discomfort of sample collection [10, 11]. The perceived value varied between healthcare workers, with greater value ascribed by those who felt at higher risk of COVID-19, with multiple uses for the sample and increased by communication of the science behind testing [11, 15, 17].

### **Derivation of value**

#### **Benefit to others and sense of community**

A major driver of value was the perceived benefit that testing represented for keeping others safe [10, 11, 13]. The value of POC testing was associated with its ability to influence the 'risk of contagion' [14] and the 'motivation to protect their communities' [11], which outweighed any individual benefits of testing [10].

The perceived impact of the program was overwhelmingly focused on reducing transmission to others rather than personal gain; "I feel safe seeing my elderly/ vulnerable patients ", "I work with very vulnerable children, so it put my mind at rest I wasn't potentially spreading to them ", "Assures me I'm not a silent spreader, keeps my family safe and I know if I need further testing and/or to isolate." [10].

This concern for others was demonstrated by the worry people felt waiting for PCR test results before POC testing was available [11]. Healthcare workers described the security they felt that they would not be transmitting COVID-19 to either patients ('I feel safe seeing my elderly/vulnerable patients') or to their loved ones ('Assures me I'm not a silent spreader, keeps my family safe') [10]. Much of the reduction in anxiety that was a consequence of testing (see above) was related to the fact that people 'appreciated knowing that they were not spreading the virus' [11].

Study participants spoke of the pride they felt in 'knowing that they were contributing to a programme that was part of the national effort to manage the pandemic' [11]. The testing services were valued for (unexpectedly) helping participants find a common cause [11].

#### **Improvement of healthcare worker health and work environment**

Testing was perceived to be valuable in keeping the health workforce safe and healthy [18], particularly for ethnic minority healthcare workers who were at higher risk of dying, especially during the early days of the pandemic, when access to testing was limited [20]. They also reported that 46.5% said that a lack of testing contributed to the disproportionate death rates in the health work force comprising individuals from ethnic minority backgrounds [20].

Testing also improved the working environment for healthcare workers, for example reducing the impact on their workload (by reducing unnecessary absenteeism) and anxiety [15]; this was again particularly true for healthcare workers from ethnic minority backgrounds [20].

#### **Organisational value**

Value was found at different levels, both for individuals and for organisations as a whole. Organisational value was derived from the ability of testing to identify current infections in healthcare workers and 'thus avoid passing it to patients, other staff or those at home through isolation'.

From the perspective of the organisations, initial engagement was motivated by the cost-effectiveness of the programme and the value of having data on infection to manage outbreak hotspots by integrating programme data with data from symptomatic PCR testing, to keep the schools, the University and GP practices running. [11].

It was also seen as more valuable if conducted regularly as part of a service, rather than intermittently or as a 'one-off' [15].

### **The perceived value overcame potential barriers to testing and reporting**

The value that healthcare workers perceived testing to have reduced the weight ascribed to potential barriers such as the physical discomfort associated with the test [10] or the additional inconvenience testing created [11]. Therefore, healthcare workers would continue to engage with testing despite some challenges, as it was for a 'good cause' [11]. They described a 'negligible inconvenience if it helps save lives and livelihoods' [10].

### **Value was influenced by other factors**

Individual healthcare workers placed differing degrees of value on testing, with 41% reporting no change in their behaviour as a result of LFD testing [11]. The value healthcare workers placed on a test seemed to be related to their perception of individual COVID-19 risk [15]. Those who had a lower perception of risk were more accepting of limited access to testing, compared with those who had a higher perception of individual COVID-19 risk [15].

The perceived value, particularly of the benefit to the community, and motivation to test for COVID-19 was increased by communication of the science behind testing that 'address[ed] participants sense of community' [11].

### **Social influences on testing and reporting**

People 'feared the stigma of testing positive' [11]. However, as described in section 4.3.5 on the perceived value of testing, the benefit to the community was a driving force for individuals to test for COVID-19. People felt a duty to their community that was particularly strong among healthcare workers compared with other, less tightly knit groups [11]. This sense of duty was reflected in responses to reasons for testing being a 'desire to keep working out of a sense of personal, professional, or institutional obligation' [13].

Participants' decisions to take part [in LAMP testing pilot] and engage in the programme were, they felt, influenced by a pull on their sense of community. Participants from schools and GP surgeries felt this pull more strongly than participants from the University. The schools and GP surgeries were smaller, more cohesive organisations, where staff and pupils saw one another every day, spoke about the saliva testing frequently and encouraged one another to take part. This was less evident in the University. [11].

### **Communication around testing and reporting guidance**

Building trust was seen as 'necessary to improve engagement in the [testing] programme' [11], and interviews suggested that communication of targeted information from credible sources would be instrumental to building this trust [11]. However, communicating guidance and the implementation of the advice, rather than the guidance itself, was seen as a challenge by scientific advisors, who noted a 'gap between testing advice, policy and implementation' that threatened to undermine outbreak management efforts [16].

In addition to the formal channels of guideline communication, healthcare workers drew information from 'passive information seeking behaviour and incidental exposure', such as the exchange of information within professional networks. This included platforms such as WhatsApp and Facebook. The information obtained from these informal sources informed their knowledge of POC testing. The type of information shared also influenced healthcare workers attitudes to LFDs; this often was 'not scientific articles and in most cases were linked to news media reports' [14].

“

In terms of diagnostics, people have talked about it, but I've not really seen any kind of evidence-based information in those groups [social network platforms] yet about if there is one available for rapid testing. I mean, people have talked about that, posted articles which have been in the media. GP [14].

This information could undermine the official guidance from authoritative sources, even if healthcare workers generally trusted guidelines [14].



Participants discussed how information sharing across practices shaped their perception of POC tests, and some were wary of POC tests because of concerns expressed by colleagues. [14]

Good communication facilitated engagement with testing [11]. This helped to ensure that people understood when and how to test.

Participants emphasised the need for open and transparent communication from programme implementers of the reasons they should register for the programme, how to go about registering and why they should stay registered. [11].

It was considered that good communication should be transparent and clear to avoid the situation that was described of people not engaging in testing because of missed information. It should also be 'motivating in content', achieved by addressing the 'sense of community' and by highlighting the logistical convenience of the testing regime [11].

Aspects of culture, particularly language barriers, were viewed as a barrier to testing. Translation of communication materials into multiple languages was seen as a route to overcome this and facilitate engagement with testing [11].

### **Trust in the test, the reporting platform and the health system**

Trust played an important role in healthcare workers' engagement with testing and reporting. Trust facilitated engagement with testing, whereas a lack of trust acted as a barrier to testing for COVID-19 [11, 13]. This trust could be built and both those who tested or declined to test felt that 'building trust was necessary to improve engagement in the programme' [11].

### **Trust in the test and the healthcare system**

Trust facilitated COVID-19 testing [14]. Most healthcare workers (93% in one survey of 1954 healthcare staff in early 2021) trusted the accuracy and reliability of LFDs [10] with many (85% in one survey of 60 healthcare workers in early 2021) confident that they would not transmit the virus if they had a negative test result [13]. Healthcare workers also generally trusted the National Health Service and the health system: 'I trust the NHS' [10].

### **Lack of trust in the test and the health system**

Not all healthcare workers trusted the accuracy of the LFDs [10] with 'ambivalence about the ... effectiveness of tests' [18] that led to healthcare workers expressing 'doubts about whether testing was reliable, both for symptomatic and asymptomatic individuals' [15], which was especially true during the first wave of the pandemic.

There were perceived doubts pertaining to the quality of evidence available concerning the POC tests that [primary care physicians] were somewhat familiar with. [14].

This lack of trust was not solely directed at LFDs, extending to PCR testing as well, with doubts about whether results were meaningful and the implications for current infectiousness upon receiving a positive result [16]. This lack of trust in the accuracy of testing led to healthcare workers declining testing [13].

“

It seems that most of the devices seem to be on based on a lateral flow model and I am not aware of any that have sort of received proof that they are valid and can be used as a decision-making tool in clinical practice. But as I say, I've not sort of looked into detail about what there is more broadly out there. GP [14].

Stakeholders highlighted that LFD testing was not used for clinical decision-making, it was used for public health, at least until the introduction of anti-virals.

False-negative results were described as an issue [18], but healthcare workers appeared to be particularly concerned with false-positive results because of the potential for unnecessary isolation [11]. Our interpretation is that this negative consequence may have enhanced the negative effects of a lack of trust on testing behaviour.

One reason some people declined to take part in the programme was a concern about the personal consequences of a false-positive result. [11].

Lack of trust extended to the healthcare system, where individuals did not want to conduct a test, or report a test, as they did not trust the healthcare system with their information. This was an important barrier to testing and reporting.

A major reason some chose not to take part in the programme was that they did not trust the government with their data. Many of those who declined to take part in the Saliva Testing Programme were anxious about the possibility of losing control of their data when the programme passed them to NHS Test and Trace in the event of a positive test. [11].

The government was less trusted than the NHS itself or more local bodies. This seems to have been associated with perceptions of the government's competing political priorities.

“

But I think the general feeling I have, and I think most of my colleagues in the practice have is a lot of concern about that are they validated, and things like that, and our feeling, probably, broadly speaking, would be that it's widely talked about by the government, but that would seem to be a political exercise. GP [14].

This highlights the need for transparency of the evidence used in decision-making to support people in trusting the decisions.

### **Trust was influenced by other factors**

Confidence in the health system translated into confidence in the reliability of LFDs, as healthcare workers felt that 'our [NHS trust] trust wouldn't recommend a test that doesn't work' and 'the test is provided by a government program so it should be safe' [10]. Healthcare workers felt 'obligated' to follow guidance [13, 14].

“

If it was recommended by Public Health England or NICE, I think we would follow the guidelines. And the problem is that they are just changing so quickly, we have to rely on you know, the sources we've got available. So yeah, so if I think Public Health England said to us this test is a good test. You're all using it, and then we'd have to trust it. GP [14].

However, trust was stronger for local bodies than for national levels of the NHS. This affected the trust in the tests themselves and in the reporting (what would happen to their data), and some suggested that they would have been more likely to take part if the programme was run solely by local organisations [11].

[Despite not trusting NHS Test and Trace more broadly] The local NHS Foundation Trust and its partnership with the University and Southampton City Council, however, was trusted; scientific integrity, and as a local organisation, was felt to be answerable to the Southampton community in a way NHS Test and Trace was not. [11].

They [study participants] suggested that this [trust] would be helped by receiving more directed information from credible sources about the rationale for and design of the programme, about data protection and the accuracy of the tests, and about the progress of the programme. This information would increase transparency and help dispel myths, particularly about the accuracy of the saliva test. [11].

Some healthcare workers suggested that communication should cover 'the rationale for and design of the programme, about data protection and the accuracy of the tests, and about the progress of the programme' [11].

### **Experience**

Personal or collegial experiences of LFD result confirmation by PCR fuelled confidence in LFDs [10]. Conversely, prior experience of discordant results undermined a minority of healthcare workers' (7% in one survey of 1954 healthcare workers in early 2021) trust in the accuracy of LFDs [10].

“

I had COVID and the test came back as negative before I had a PCR test. [10].

### **Evidence**

Trust was influenced by the evidence available around test accuracy. Some healthcare workers were sceptical that the available evidence was sufficient [14].

Their lack of confidence in the accuracy of tests was linked to the mixed body of evidence pertaining to the clinical efficacy and utility of POC tests. [14].

This lack of understanding of the science behind LFDs appears to be related to the lack of trust in LFD results, which was especially the case before POC testing became routinely available for healthcare workers.

“

I think there is a huge gap in knowledge around what point-of-care, antigen tests look like, how they work, the level of confidence we can have in the results and we're hearing that even reading the results is variable. [14].

### **Other testing**

Antibody testing was suggested as a way to compensate for the lack of trust in the meaning of a positive result (i.e., whether it meant current or previous infection), which could also reduce anxiety and reduce the impact on staffing from unnecessary isolation due to false-positive results [16].

“

... you're a health care professional working with Covid patients, you've had an antibody test ... I think people would be reassured to know whether they had it or not, not just a swab at the time, because it means nothing, really, because I could be swabbed on a Tuesday and then I could actually have it that afternoon ... Respiratory nurse, ITU. [16].

This suggestion was, however, tempered by the lack of certainty that the presence of antibodies represented immunity [16].

### **Acting on a positive test**

#### **Experience of isolating**

Isolation was experienced negatively, as something that was difficult to do [13]. People described isolation as a burden on finances, daily activities such as grocery shopping and on their mental health. As described under testing behaviours (section 4.3.2.2), the anxiety and consequences of isolating were strong enough that healthcare workers described not testing to avoid isolation. This behaviour was exacerbated when there was a lack of trust in the test result, as 'unnecessarily' isolating was perceived as an unacceptable outcome [11].

The experience and attitudes to isolating may have influenced healthcare worker's willingness to test and report their results.

#### **Consequences of isolating**

Isolation was perceived as a negative experience because it interrupted 'normal life', such as grocery shopping and visiting friends and relatives [11]. Isolation was also a barrier to working, which had knock-on effects on work dynamics and potential income.

Fear of a positive test result was enough to make some decline to take part [in testing]; they were concerned that if they had to isolate they would lose income, their employer would be unsympathetic. [11].

Particularly in healthcare, where workloads were pressured by the demands of the pandemic, when 'staff would have to self-isolate [it would result in a] in shortage of staff' [19]. This loss of manpower had organisational implications for healthcare services [16], as it meant 'putting extra pressure on the remaining staff' [18] and threatened the ability of units to function.

“

One of the key vulnerabilities in this is the sustainability of the general practice service. You know, what we want to do is make sure that we don't lose people, we don't have to self-isolate ... So, we're losing manpower, and therefore productivity and sustainability. GP [14].

This loss of workforce was described as an 'ethical dilemma', because of the impact on health service provision [16]. It also resulted in feelings of guilt for those who were isolating and not contributing to the work of a team that was already running at reduced capacity, especially when they needed to contact these team members for information:

“

For 14 days I had to work from home without remote access. So I only had access to my emails, I couldn't get remote access to the electronic medical records system, so I had to do telephone reviews or do anything to help the team in the hospital ... I was feeling bad being at home, pestering my colleagues. Registered dietician [16].

#### **Logistics of isolating**

Healthcare workers noted difficulties in having to isolate following a positive result [16]. Isolation was described as logistically challenging, particularly with shopping for necessities like food and medication [11]. For healthcare workers who were required to work remotely while isolating, challenges included 'accessing work electronically, particularly patient files' [16].

People reported the need for additional social support 'in dealing with a positive test result' and suggested this additional support could act as an enabler of isolation [11].

Those who had experienced a positive test result asked for more efficient data management by the testing programme, NHS Test and Trace and their general practice, and more coordinated messaging. Participants requested more personalised support for those testing positive and having therefore to self-isolate. This included financial aid if unable to work, receiving food and medication supplies and mental health support. [11].

Conversely, too much support from the NHS was also described as a negative experience:

Some felt, however, that there were too many support calls from NHS Test and Trace for those testing positive [11].

### **Derivation of value from isolation**

Isolation was perceived as a way to protect others, even while waiting for test results before LFD testing was available.

Participants were particularly worried about the possibility of spreading the virus to others whilst they waited for a test result [11].

The intense workloads in healthcare also led to a unique value found in isolation, in that it offered an opportunity to take a break from work. One of the main reasons interviewees gave for staff declining daily contact testing was work fatigue, which led to a preference for 10 days of quarantine [13].

## **Stakeholder engagement**

### **Stakeholder engagement methodology**

In total, 7 semi-structured interviews were held with 10 representatives from within the healthcare sector, all of whom had experience working in England during the COVID-19 pandemic. The range of participants included representatives from UKHSA, NHS England, primary care settings, secondary care settings, and independent health providers. Following receipt of relevant ethics approval, contact details were obtained from internal UKHSA stakeholders. These representatives were sent an introductory email alongside a participant consent form.

The main objectives of these sessions were to test the key findings of this evaluation; test and validate the feasibility of emerging recommendations; identify dependencies and test whether the recommendations would help to meet the intended testing service objectives. The results of the discussions informed the recommendations chapter of this report (Chapter 4.8).

The sessions were conducted remotely with the use of Microsoft Teams and each lasted for 60 minutes. Discussion guides were developed to support the semi-structured interviews. The sessions were recorded following signed consent shared by stakeholders. The video content was used to generate transcripts. When the project ends, all of the recordings will be deleted. All of the input and quotes used in this report have been anonymised.

### **Stakeholder insights**

As part of the stakeholder sessions, we tested several key findings that came out of this evaluation. Please see below for the themes that were collated against each.

**Key Finding 1 – Healthcare workers are familiar with the process of testing and need less support on the 'how to test', but require clear, concise guidance on 'when to test' and when to self-isolate/how to act upon a positive test result. At-home and free testing acted as facilitators to testing.**

#### **Theme 1: Pace of change**

Stakeholders from trusts who took part in the testing programme pointed out the confusion that came from the national guidance, in particular around self-isolation and the clinical reasons behind changes related to self-isolation. They noted that at times the justification for the length of self-isolation was not clear and that changes were happening very rapidly. It was also noted that it became really difficult to follow the guidance when all of the policies were changing at the same time (number of days in self-isolation, number of people it was allowable to meet, frequency of testing) along with the tiering system. Those stakeholders who were implementing the testing for their NHS staff locally also mentioned the speed and complexity of changes that they had to implement as a barrier. However, they did acknowledge that it was a challenging role for NHS England to manage the health crisis given the novelty of the situation.

“

The rate at which the guidance changed and reviewed was at times really challenging, especially in early days, when changes sometimes happened several times a day. You just think you understand, get something to share with everybody and it's changed. And that was really challenging to implement. (Interviewee, stakeholder workshop).

Stakeholders representing policymaking bodies noted that from their side they had to deal with an unprecedented emergency, when there were many changing elements, such as the evolving scientific knowledge, the evolution of the virus and its impact on staff and patients, and the changing behaviours of people.

“

Science had to catch up with the reality and everything was happening so quickly. However, on the ground there were many changes for staff too in changes in clinical treatment of patients. I can see how it all could be very confusing. So we tried to do changes in a balanced manner and do the updated when we have a base of evidence for that. This was live real-world testing, it was a pilot at a scale of tens of millions of tests. To be upfront with changes could help. For clarity adding to the guidance that 'subject to change in relatively short notice. DHSC will review this in 4 weeks or 6 weeks.' (Interviewee, stakeholder workshop).

### **Theme: Lack of clarity in guidance**

Stakeholders from trusts who were implementing the testing locally noted that the guidance was set up for a single-site, acute hospital response and had limited consideration of variation (e.g., complex providers with care homes, community teams, inpatient mental health rehabilitation sites). Therefore, when different non-acute types of health providers were reaching out (via the email address given in the guidance) with specific questions for their setting, they received minimal support.

Stakeholders mentioned that the guidance had no limitation on the maximum number of days in which the tests could still be reported (after a test had been conducted). Stakeholders advised this is because it still informed prevalence data and was also recorded in their medical record, which may have been relevant in the future.

### **Theme: Trust and good practice in guidance**

Stakeholders mentioned some examples where local NHS organisations built on trust, they had from their staff by selecting local champions to educate their peers on the continuously changing guidance and narrative.

“

One good example was when one hospital took the NHSE educational materials and localised it by making videos with their own staff members. It worked for them because they are massive and have a large communications department, but most organisations don't have that luxury.

Another stakeholder, representing policymaking bodies, noted that a lot of confusion around testing came from mistrust of LFDs in general, with much criticism coming from the community of healthcare workers. This mistrust stemmed from the continually changing assessments of the efficacy of the tests coming from various bodies, including the manufacturers of the tests and the scientific community.

Having a robust policy at a time wasn't realistic as there was no clinical nor economic rationale. However, what could spell out this robustness is having public-facing local champions who could tell the story to users of testing: clinical champions for clinical users, vulnerable champions for vulnerable cohort. For each cohort to have someone who could explain the changing nature of the narrative in the language they understand.

All of these insights support the following recommendations:

**Recommendation:** Create a robust and clear policy, while providing clear justification, evidence and manage expectations for the future policy and guidance updates.

- ▶ Some stakeholders mentioned that it might be beneficial to support closer working of public health departments with local health organisations to ensure sustained testing of staff members. This could enable local NHS organisations and public health departments to rapidly identify pressure points and act on them in a timely manner.
- ▶ Facilitating continuous feedback on the experiences of local NHS organisations and participants in the testing service could enable real-time modifications of the service. The involvement could take the form of advisory meetings, workshops, focus groups or interviews.

**Recommendation:** Maintain testing for healthcare workers at-home and free of charge in the future to allow healthcare professionals to save time and focus on delivering care to patients.

- ▶ Stakeholders who were users of the testing programme recognised the fact that at-home and free testing acted as facilitators. Another stakeholder noted the connection between compliance and accessibility of tests:



If you require something around employment, it needs to be free. I'm sure that those who have to pay for tests should they want to, test less if it's not free. (Interviewee, stakeholder workshop).

### **Key Finding 2 - Every healthcare organisation was deciding for themselves who was eligible for regular asymptomatic testing**

All stakeholders who were the users or implementors of the testing programme locally mentioned the confusion around eligibility. Some said that it was not very clear who should be defined as patient-facing. In addition, stakeholders expressed challenges associated with the testing policies for contractors, non-clinical staff members or those who changed their roles throughout the pandemic (e.g., from managerial roles back to clinical) or worked across several sites.

Most of the stakeholders considered this flexible approach to eligibility to be reasonable, as organisations know their workforce best. However, it could also lead to some organisations having had a very restrictive definition for 'patient-facing', which could have led some groups of the workforce to be overlooked. This lack of equity of access can become an unintended consequence of such an approach.

A stakeholder noted that at the start, defining the eligible population among NHS staff was based on the number of LFDs available and guidance prioritised access to those available tests. As availability improved, it was agreed that it was not very valuable to ask about the share of staff eligible for testing, as the definition of the total workforce varied due to outsourcing some work to locums, contractors etc.

All of these insights supported the following recommendation:

**Recommendation:** Find the correct balance between giving agency/autonomy around defining the target population eligible for testing at local NHS level and defining it from the top-down.

- ▶ Stakeholders recognised the complexity of this balance of agency and the unintended consequences brought by a process prescribed from the top-down. Eligibility policy, however, should aim to decrease the likelihood of unintended consequences taking place while keeping the agency for local organisations to decide on eligibility. This could be achieved by setting broad parameters and some principles in professional codes of conduct to act as guardrails and leave the rest to be decided locally.

### **Key Finding 3 - discrepancy between LFD tests distributed and reported**

Stakeholders recognised that when the testing programme started, there was no single reporting solution available, which meant that every trust had to develop their own solution. Some organisations developed reporting apps, some other organisations found this more difficult and had to use emails and Excel spreadsheets to report results. Stakeholders mentioned that apps were mostly developed by large organisations, while smaller ones did not find this approach feasible.

Stakeholders suggested that a possible explanation for the discrepancy between the number of LFD tests distributed and reported could be that there was no rationale stated for reporting negative results, despite this being mandatory and required for the NHS to performance manage. In the stakeholder sessions, the link between recording a negative test result and the standard of health record keeping was not made. Therefore, stakeholders reported that staff saw a negative COVID-19 test result as a burden to report something that doesn't have an impact. It is worth noting that it was unclear from the literature review whether there were evaluated staff training materials detailing when and how to report which may also have impacted reporting rates.

Stakeholders who were setting up the testing service in their local NHS organisations mentioned several approaches to reporting when the system shifted to the gov.uk website. One stakeholder said that when the individual reporting became available and the distribution model changed to a pull model, they stopped reporting and shifted the entire responsibility to individuals. When regional management asked them to continue reporting as an organisation, they disagreed as they did not want to create more administrative work for their staff. However, another stakeholder said that their organisation decided to continue reporting as an organisation as well, as it helped them with staff and outbreak management.

One group of stakeholders suggested that a system of penalties and incentives could encourage staff compliance. However, it was recognised that this approach could only be feasible if NHS trusts had access to reporting data and understood the effectiveness of their communication and engagement



techniques. Another group of stakeholders mentioned that there should be a recognition and consideration of the amount of pressure that healthcare workers were facing and the reasons why people actually tested - to protect themselves, their loved ones and their patients. Stakeholders noted that while it was challenging to find a working approach to incentives or penalties to be applied at national level, there were some local initiatives in place, such as prize draws for full compliance with reporting.

Another approach discussed was to develop a sense of community and peer support by providing access to reporting data at the NHS trust level and sharing the contact details of infection control teams. This could act as a tool to connect with well-performing organisations to learn their best practices.

Some additional insights came out of the stakeholder conversations.

- ▶ Our stakeholder interviews showed that when the infrastructure was set up for health workers to request and report their test results via the government portal, this approach shifted the responsibility for reporting from the organisational level to the eligible healthcare staff. While this was positive for trusts from operational point of view, they lost access to the data at the granular level needed for more efficient staffing and surveillance of nosocomial spread. This meant that trusts did not know how compliant their staff were or how the testing service was performing. Trusts had to rely on their staff informing them of their test results after they had reported their test results via gov.uk. This was the only way for trusts to have that visibility and manage their staffing with the use of those data. This led to some trusts choosing not to make the shift to gov.uk and keep reporting internally. Some other trusts developed their own trust-based test and trace, which allowed them to collect test results, aggregate them and share them with UKHSA, while keeping the valuable granular level of data needed to manage outbreaks. On the other hand, confirmatory PCR tests were in place to provide a clearer picture, as it was a more trusted technology. However, trusts had no access to PCR test results, and our evaluation showed that PCR data were not differentiated by use case and that the PCR reporting system initially did not record the place of work. Therefore, trusts never had a clear picture of the epidemiological situation on their sites and always had to rely on their staff members to share their test results. Only when LFD reporting was put in place was the place of work recorded in the system.
- ▶ Officially, Test and Trace (T&T) also did not differentiate the definition of 'close contact' for healthcare workers and the rest of the population, even though the definitions differed due to the presence of correct PPE for healthcare workers. Therefore, many healthcare organisations asked their staff members to switch off their Bluetooth so they could not be traced by T&T, as it led to confusion and healthcare workers could be identified as a close contact of a COVID-19-positive case without consideration of the definition in a healthcare setting. This was another reason why some trusts developed their own test and trace approaches, which helped them to manage outbreaks and have a better understanding of their staffing challenges.
- ▶ Stakeholders representing policymaking bodies noted that instructions on how to use tests and educational materials produced based on them were produced with patient-facing staff in mind who did not have clinical roles (e.g., receptionists, porters, cleaners) and were not used to performing procedures such as testing.
- ▶ According to a stakeholder close to the design of the testing programme, when tests were distributed, people were not asked to sign for taking a box of tests. This meant that it was not possible to track the tests, which could have been a problem if someone received a batch of 'bad' tests. The alternative to this system was reporting of who had the test and when they had taken it.

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## 4.4 Statistical methods

### 4.4.1 Timeline

All analyses for the healthcare testing service were conducted within four time periods, corresponding to changing healthcare policies and vaccination status and availability of data:

**November-December 2020:** pre-vaccination; testing at home with LFD twice weekly with a follow-up confirmatory PCR in case of a positive LFD; testing was voluntary, reporting of all the results was a statutory duty, in case of a positive LFD+PCR result, staff were required to self-isolate in line with the government guidance at that time (10 days).

**January-July 2021:** vaccination rollout to healthcare workers was ongoing, but there were no available data on healthcare workers vaccination levels per trust; otherwise, the testing policy was as before.

**August-November 2021:** high coverage of vaccination; monthly data on vaccination coverage were available at the trust level for staff. Fully vaccinated members of staff who were identified as a contact of a positive COVID-19 case were no longer expected to isolate, while unvaccinated staff members had to self-isolate for the full 10-day period.

**December 2021-March 2022:** Confirmatory PCR was temporarily suspended for people with positive LFD results; individuals testing positive via LFDs were required to self-isolate for seven days; self-isolation in case of a positive LFD was reduced from seven to six days.

### 4.4.2 Reduction in healthcare workers' absentee days associated with testing

#### Methods

Only acute trusts were included in the analysis, as only these trusts had LFD testing data available at the trust level from both Pillar 1 and Pillar 2. Pillar 2 data were provided per lower-tier local authority (LTLA) rather than per trust, and a function from the covid19.nhs.data package [1] was used to

calculate the number of tests per trust based on the proportional contribution of the number of tests conducted in LTLA regions within trusts (we call this the 'mapping function'). This mapping only maps to acute trusts. Testing data were not available by staff groups, and as there were no specific recommendations throughout the evaluation period around which staff groups should be testing, the analysis was conducted with reference to the full-time equivalent (FTE) days available for all staff.

The outcome variable was defined as the proportion of total FTE days available that were lost due to COVID-19 per month per trust (obtained from NHS Digital [2]). Due to the skewed distribution, outcome was modelled following a log transformation. The primary exposure variable of interest was LFD test coverage, i.e., the number of tests reported per healthcare worker per trust per month (LFD test coverage = number of LFD tests reported/headcount for a given trust and month), which, for the analysis, was log-transformed due to having a skewed distribution and centred on the geometric mean within each trust.

Separate linear regression models, with random effects for trust and fixed effects for month of evaluation, were fitted for the four time periods described above, at the monthly level.

Models were adjusted for the following covariates at the trust level:

- ▶ Trust LFD positivity. Prevalence in healthcare workers in each trust for each month was estimated from LFD positivity and expressed per 1000 healthcare workers: number of LFD positive tests for a given trust and month/headcount for a given trust and month  $\times$  1000.
- ▶ Local COVID-19 prevalence. This was estimated at the LTLA- and week-level using the method described by Nicholson et al (2022) [3] and using both the REACT study data [4] and Pillar 2 PCR data provided to us by UKHSA and averaged per month.
- ▶ Average income deprivation score. This was the only deprivation score available at the LTLA level.
- ▶ Alpha/Delta/Omicron variant prevalence. This was defined as the proportions of Alpha, Delta and Omicron variants in circulation at the LTLA and week level, averaged per month.

Variables 2-4 were estimated at the acute trust level from LTLA estimates using the mapping function.

All of these variables are possible confounders of the causal relationship between testing/reporting coverage and FTE days lost due to COVID-19, as they could influence both testing and reporting behaviour and absences due to COVID-19.

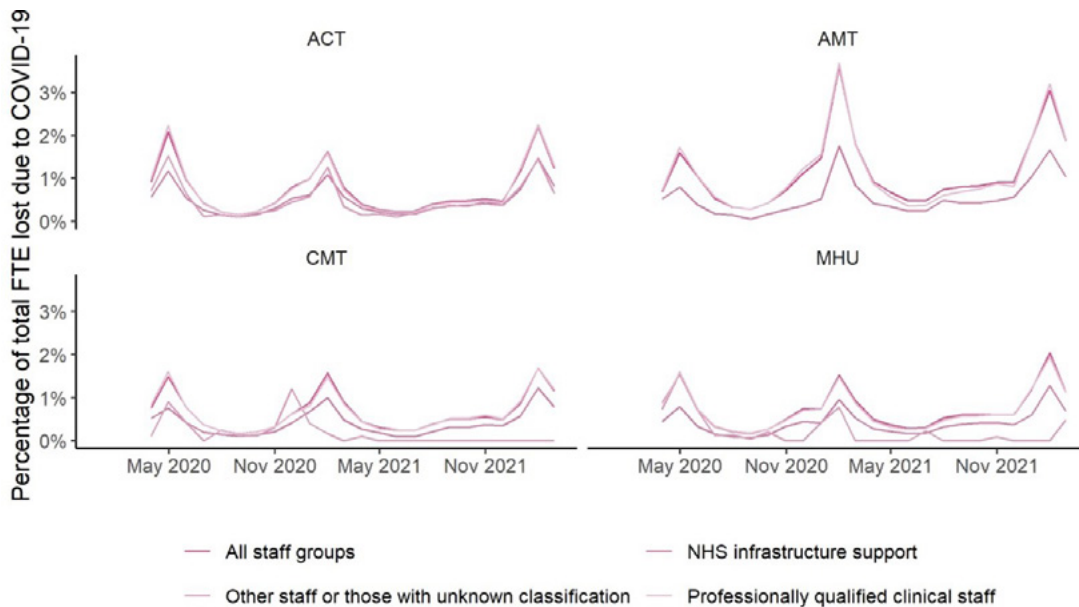
The selection of the models' structure was based on the Akaike information criterion (AIC) and residuals. Models without a time variable (month of evaluation), nonlinear form of covariates, and interaction term with transmission were evaluated.

Vaccination data for healthcare workers were only available from the end of August 2021, when high coverage for the first (85%) and second dose (75%) had already been achieved. Consequently, as no association between number of vaccination doses and FTE days lost was found (in the adjusted model) and there were gaps in the data for some trusts, vaccination data were not included in the final model.

## Results

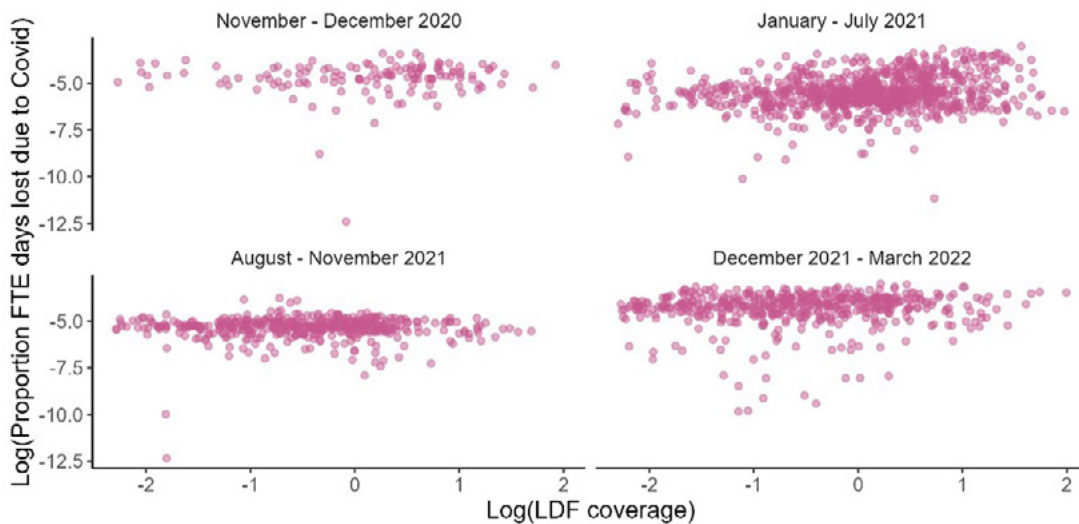
### Data summary

FTE days lost due to COVID-19 varied over time, by trust type and staff group (Figure 1) and ranged between 0% and 4% of the total corresponding FTE days available.

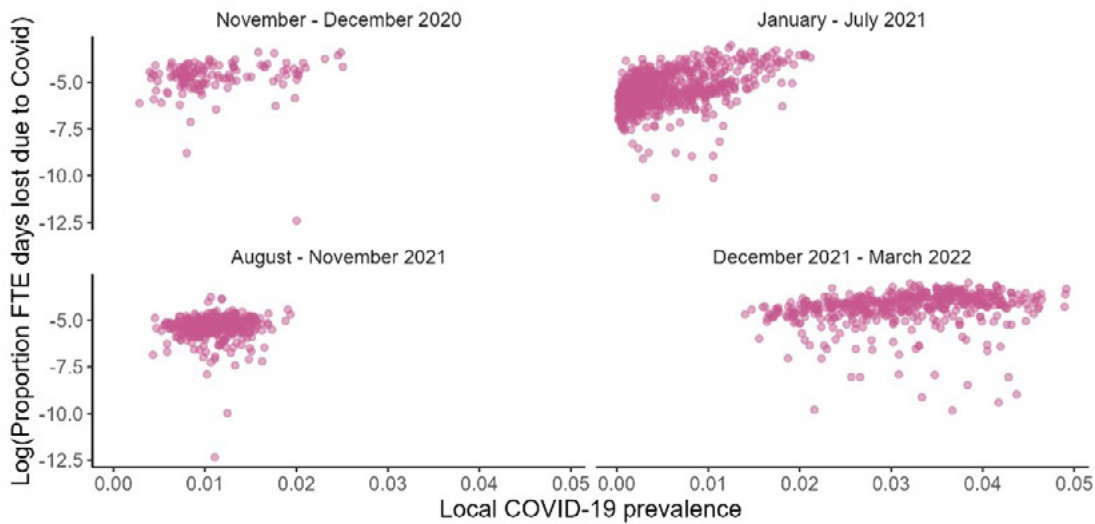


**Figure 1. Monthly absenteeism data over time, by trust type and staff group.** ACT = acute trust, AMT = ambulance trust, CMT = community provider trust, MHU = mental health trust.

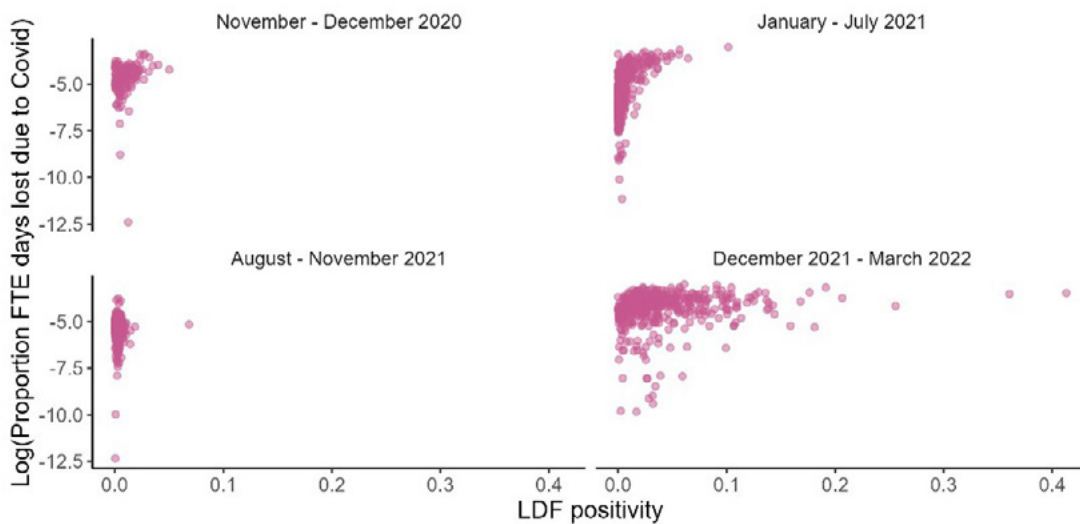
The associations between the proportion FTE days lost due to COVID-19 and testing coverage, and other covariates, are shown in Figures 2 to 6. No apparent associations between testing coverage and percentage FTE days lost due to COVID-19 were observed except for during the time period January to July 2021.



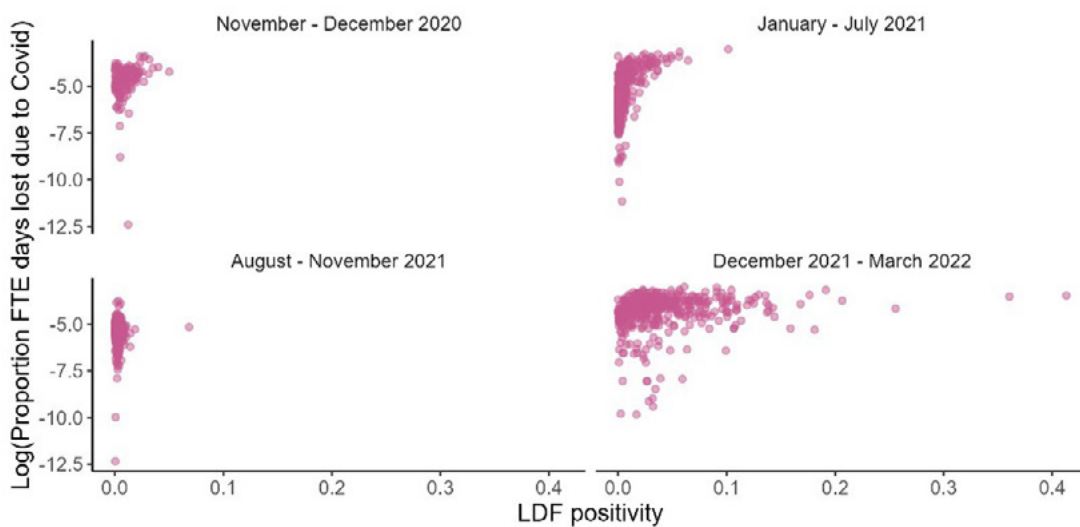
**Figure 2. Association between the proportion of FTE days lost due to COVID-19 and LFD testing coverage.**



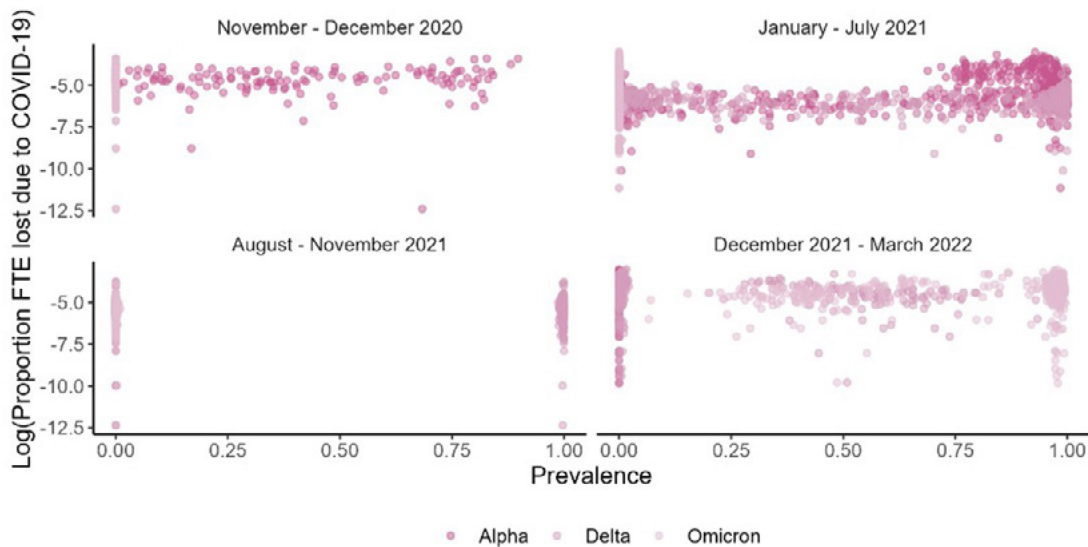
**Figure 3. Association between the proportion of FTE days lost due to COVID-19 and local COVID-19 prevalence.**



**Figure 4. Association between the proportion of FTE days lost due to COVID-19 and trust LFD positivity.**



**Figure 5. Association between the proportion of FTE days lost due to COVID-19 and trust average income deprivation score.**



**Figure 6. Association between the proportion of FTE days lost due to COVID-19 and prevalence of COVID-19 variants.**

### Regression model

The model with log-transformed trust LFD positivity and community COVID-19 prevalence was selected as the most appropriate, based on AIC values and residuals.

The increase in LFD test coverage was associated with decreases in FTE days lost due to COVID-19 during the first two time periods (models 1-2, Table 1). During the next two periods (Table 1, model 4: December-March 2022), LFD test coverage was not associated with a change in FTE days lost due to COVID-19. Higher community prevalence levels were associated with significant increases in FTE days lost due to COVID-19 in all periods except for the pre-vaccination period. Effect sizes ranged from 0.23% to 0.46% increases in FTE days lost for each 1% relative increase in community prevalence of COVID-19. Similarly, LFD positivity rate in healthcare workers was positively associated with FTE days lost due to COVID-19. Average income deprivation score was not associated with lost FTE days. Our model predicted that changes in testing levels (50%-150%) would have resulted in modest changes in FTE days lost due to COVID-19 for all time periods (Figure 7).

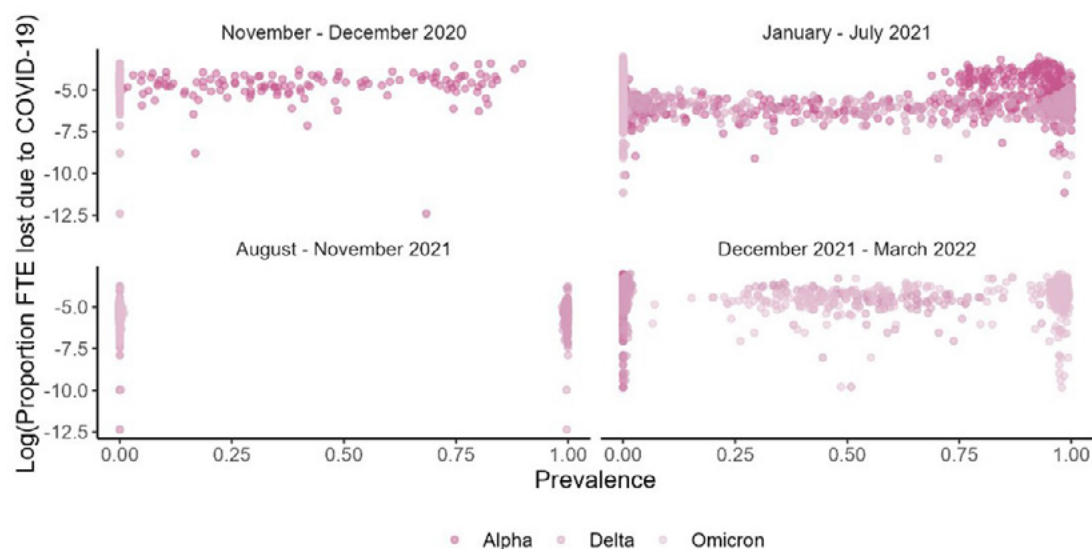
**Table 1. Estimated relative change (%) in the proportion of the total available FTE days lost due to COVID-19 in the four time periods.** These estimates are from linear regression models as described in the text.

	<b>November-December 2020</b> (pre-vaccination) (1)	<b>January-July 2021</b> (vaccine rollout) (2)	<b>August-November 2021</b> (Delta) (3)	<b>December 2021-March 2022</b> (Omicron) (4)
Number of observations <sup>1</sup>	134	832	432	490
LFD coverage (per 1% increase)	-0.29 (-0.50; -0.07)	-0.11 (-0.18; -0.04)	-0.03 (-0.13; 0.08)	-0.02 (-0.16; 0.12)
Trust LFD positivity (per 1% increase)	0.28 (0.06; 0.51)	0.19 (0.13; 0.25)	0.07 (-0.01; 0.15)	0.30 (0.21; 0.39)
Local COVID-19 prevalence (per 1% increase)	0.07 (-0.54; 0.68)	0.23 (0.12; 0.35)	0.29 (0.14; 0.44)	0.46 (0.24; 0.68)
Alpha variant prevalence (per 0.1 increase)	8.44 (-1.88; 19.84)	4.39 (-0.01; 8.99)	N/A	N/A
Delta variant prevalence (per 0.1 increase)	N/A	1.92 (-2.96; 7.04)	N/A	-0.30 (-11.71; 12.58)
Omicron variant prevalence (per 0.1 increase)	N/A	N/A	N/A	8.11 (-5.19; 23.28)



Average income deprivation score <sup>2</sup> per trust (per 0.01 unit increase)	1.51 (-3.72; 7.03)	-2.47 (-5.48; 0.64)	2.53 (-1.02; 6.21)	0.10 (-4.12; 4.51)
--	-----------------------	------------------------	-----------------------	-----------------------

<sup>1</sup>Number of trust/months observations included in the model. <sup>2</sup>Average income deprivation score: median (range) 0.123 (0.053-0.239) across trusts included in the analysis. A higher score means higher deprivation. 95% confidence intervals are shown in brackets.



**Figure 7. Predicted FTE days lost due to COVID-19 in all NHS acute trusts for a range of coverage of testing and reporting scenarios.** The data are shown as a percentage of total FTE days available (A) and as the number of additional FTE days lost compared with the actual testing (B).

### 4.4.3 The association between testing and nosocomial infections

#### Methods

Access to the ISARIC (International Severe Acute Respiratory and Emerging Infection Consortium) database [5] was requested through the Data Access Committee. The ISARIC COVID-19 Clinical Database is one of the world's largest and richest standardised collections of comprehensive COVID-19 individual patient clinical data for hospitalised patients. In our analysis, those patients who were tested and had confirmed COVID-19 infection and were treated in England in NHS acute trusts were included. Re-admissions, records with conflicting dates, admissions outside of study period (date of admission after 31 March 2022 or date of discharge before 1 October 2020) or COVID-19 cases outside of the study period (date of onset before 1 October 2020 or after 14 April 2022) were excluded.

For each week and for each acute trust in the ISARIC database (after exclusions), the total number of new COVID-19 infections, defined as new COVID-19 admissions or hospitalised patients with new COVID-19 symptoms, was calculated. Nosocomial infections were defined as patients who developed symptoms 7 days or more after their hospital admission. For a sensitivity analysis, we repeated analyses using a 14-day cut-off.

Publicly available data on daily new COVID-19 cases at acute trusts were extracted [6].

Weekly ISARIC data were merged with the corresponding trust/week data on new hospital cases, LFD testing levels in the previous week, LFD positivity (as a measure of trust-level prevalence) in the previous week, weekly REACT unbiased estimate of population-level prevalence, and the trust average income deprivation score.

The relationship between prevalence of nosocomial infections and lagged LFD testing coverage was modelled using logistic regression weighted by the number of COVID-19 cases per week/trust in the ISARIC dataset and was adjusted for all covariates listed below, week and trust as fixed effects (due to identifiability issues in fitting random effects) and number of COVID new cases reported per trust/week.

The models were adjusted for the following covariates at the trust level:

- ▶ Trust LFD positivity in the previous week. Prevalence in healthcare workers in each trust for the previous week estimated from LFD positivity and expressed per 1000 healthcare workers: number of LFD positive tests for a given trust and month/headcount for a given trust and month  $\times$  1000.

- ▶ Local COVID-19 prevalence in the previous week. This was estimated at the LTLA- and week-level using the method described by Nicholson et al (2022) [3] and using both the REACT study data [4] and Pillar 2 PCR data provided to us by UKHSA Secretariat.
- ▶ Average income deprivation score. This was the only deprivation score available at the LTLA level.
- ▶ Alpha/Delta/Omicron variant prevalence. This was defined as the proportions of Alpha, Delta and Omicron variants in circulation at the LTLA and week level.

The selection of the models' structure was based on the AIC and residuals. Models without a time variable (week of evaluation), nonlinear form of covariates, and interaction term with transmission were evaluated.

Our logistic regression estimates represent odds ratios (OR) for a hospitalised COVID-19 infection being nosocomial. However, as there was a low prevalence of nosocomial infections among hospitalised infections, the OR is a good estimate of the risk ratio (RR) [7], and the narrative of the effects is presented in term of the risks (not odds).

The results of the statistical models were used to project numbers of nosocomial infections under counterfactual testing scenarios. The prevalence of nosocomial infections among new hospital cases was estimated from fitted models for each of the counterfactual LFD testing scenarios, using the following relationship. In any of the counterfactual scenarios we consider, any changes to the number of nosocomial infections were assumed to result in an equivalent change in the total number of new infections, i.e., the number of new COVID-19 admissions remained the same. In the factual scenario,  $p$  is a proportion of nosocomial infections among  $N$  new hospital cases, so  $N_{\text{nosocomial}} = pN$  is the corresponding number of nosocomial infections. In a counterfactual scenario:  $p_{\text{new}}$  is the model-estimated proportion of nosocomial infections, so  $p_{\text{new}} = (N_{\text{nosocomial}} + x) / (N + x)$  where  $x$  is the change in the nosocomial infections. Substituting the first equation into the above, we obtain:

$$\frac{(pN + x)}{N + x} = p_{\text{new}}, \text{ so } x = (p_{\text{new}}N - pN) / (1 - p_{\text{new}})$$

Therefore, the number of nosocomial infections under the new scenario  $N_{\text{nosocomial}}^{\text{new}}$  is calculated as:

$$N_{\text{nosocomial}}^{\text{new}} = pN + x = p_{\text{new}}N(1 - p) / (1 - p_{\text{new}})$$

## Results

### Data summary

In the ISARIC database, 136 NHS acute trusts were represented with data available for a median of 53 (range 1-75) weeks. Overall, 3701 nosocomial infections were identified among 103,979 hospitalised COVID-19 patients. The median (range) of number of COVID-19 infections per week was 9 (1-513) with a median (range) 0 (0-40) nosocomial infections identified.

Table 2 shows the distribution of trust level parameters for hospitalised COVID-19 patients with/without nosocomial infections.

**Table 2. Summary statistics for measured covariates in hospitalised COVID-19 cases, by type of COVID-19 infection.**

Parameter	Nosocomial infections	Summary statistics				
		Minimum	P25*	Median	P75*	Maximum
November – December 2020						
LFD coverage (per 1000)	No	0	0	0.052	68.7	2121
	Yes	0	0	0	84.3	2121
Trust LFD positivity (per 1000)	No	0	0	0	1.37	64.4
	Yes	0	0	0	1.45	64.4
Local COVID-19 prevalence	No	0.001	0.008	0.011	0.016	0.031
	Yes	0.001	0.007	0.010	0.014	0.030
Alpha variant prevalence	No	0	0	0.008	0.215	1
	Yes	0	0	0.014	0.264	1

Parameter	Nosocomial infections	Summary statistics				
		Minimum	P25*	Median	P75*	Maximum
Average income deprivation score	No	0.053	0.115	0.141	0.167	0.240
	Yes	0.053	0.108	0.126	0.154	0.235
<b>January – July 2021</b>						
LFD coverage (per 1000)	No	0	176	352	523	1848
	Yes	0	221	417	618	1478
Trust LFD positivity (per 1000)	No	0	1.25	5.38	17.6	134
	Yes	0	2.00	7.43	22.9	134
Local COVID-19 prevalence	No	0.0001	0.007	0.010	0.015	0.034
	Yes	0.0001	0.006	0.010	0.015	0.029
Alpha variant prevalence	No	0	0.335	0.872	0.949	1
	Yes	0	0.699	0.898	0.956	1
Delta variant prevalence	No	0	0	0	0.323	1
	Yes	0	0	0	0	1
Omicron variant prevalence	No	0	0	0	0	0.012
	Yes	0	0	0	0	0.011
Average income deprivation score	No	0.053	0.110	0.137	0.167	0.239
	Yes	0.053	0.108	0.122	0.147	0.235
<b>August – November 2021</b>						
LFD coverage (per 1000)	No	0	58.8	127	225	1432
	Yes	0	75.3	126	220	1305
Trust LFD positivity (per 1000)	No	0	0.739	2.01	3.53	289
	Yes	0	0.858	2.22	3.58	14.6
Local COVID-19 prevalence	No	0.003	0.009	0.011	0.013	0.026
	Yes	0.003	0.010	0.011	0.013	0.021
Alpha variant prevalence	No	0	0	0	0	0.004
	Yes	0	0	0	0	0.0002
Delta variant prevalence	No	0.964	0.997	1	1	1
	Yes	0.975	0.998	1	1	1
Omicron variant prevalence	No	0	0	0	0	0.013
	Yes	0	0	0	0	0.008
Average income deprivation score	No	0.057	0.108	0.135	0.168	0.239
	Yes	0.057	0.108	0.141	0.184	0.235
<b>December 2021 – March 2022</b>						
LFD coverage (per 1000)	No	0	61.9	146	276	2437
	Yes	0	85.1	158	276	1240
Trust LFD positivity (per 1000)	No	0	2.49	14.9	33.3	479
	Yes	0	5.13	24.1	41.9	144
Local COVID-19 prevalence	No	0.006	0.023	0.033	0.041	0.057
	Yes	0.008	0.028	0.035	0.039	0.051
Delta variant prevalence	No	0	0.001	0.015	0.199	1
	Yes	0	0.0002	0.006	0.038	1
Omicron variant prevalence	No	0	0.768	0.962	0.981	1
	Yes	0	0.936	0.976	0.985	1
Average income deprivation score	No	0.057	0.116	0.141	0.170	0.235
	Yes	0.066	0.122	0.141	0.166	0.235

\*P25 = 25% centile; P75 = 75% centile.

LFD coverage, LFD positivity and prevalence data are per week.

## Regression model

The proportion of nosocomial infections among new weekly cases in hospitalised patients (which included new admissions and cases diagnosed in hospital) was negatively associated with reported LFD testing levels. However, the strength of the association varied over time and was estimated to be highest during the Omicron period, with a doubling of the testing coverage associated with a 22% (95% confidence interval (CI): 4%-47%) decrease in the risk of the COVID-19 infection being nosocomial (Table 3). Our model predicted that the observed healthcare worker testing/reporting was associated with a 16.8% (95% CI 8.2%-18.8%) reduction in nosocomial infections compared with a hypothetical testing scenario at 25% of actual levels (Table 4, Figures 8 and 9).

During this period, a 0.1% increase in the prevalence of the Omicron variant, compared with wild-type or Delta variant circulating, was associated with a 35% increase in the risk of nosocomial infections among hospitalised COVID-19 cases (OR = 1.35, 95%CI 1.07-1.70 from the model presented in Table 2 when changes in Omicron were compared with any other circulating variants, i.e., the Delta variant was not included in the model). No association was observed with LFD positivity rate in healthcare workers, or the population prevalence, for any of the time periods.

A negative association was observed with average income deprivation score, although this analysis was only conducted during the first two time periods, due to identifiability issues.

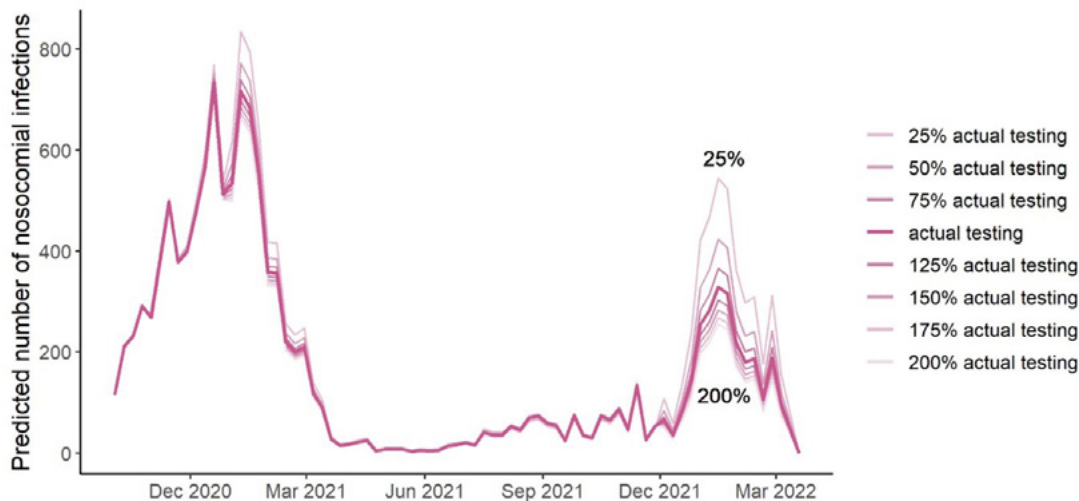
Similar results were obtained in the sensitivity analysis when a nosocomial infection was defined as a patient who developed COVID-19 symptoms after 14 days since their admission (Table 5).

Table 3: Logistic regression model for the prevalence of nosocomial COVID-19 infections among all COVID-19 infections in hospitalised patients. Odds ratios (95% CI) are shown.

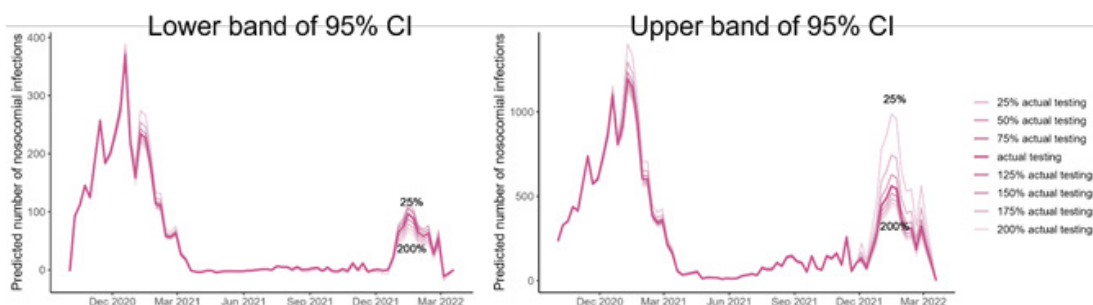
**Table 1. Estimated relative change (%) in the proportion of the total available FTE days lost due to COVID-19 in the four time periods.** These estimates are from linear regression models as described in the text.

	November – December 2020 (pre-vaccination) (1)	January – July 2021 (vaccine rollout) (2)	August – November 2021 (Delta) (3)	December 2021 – March 2022 (Omicron) (4)
Number of observations <sup>1</sup>	1314	2852	1489	829
LFD coverage (per 100% increase)	0.98 (0.96; 0.99)	0.92 (0.89; 0.95)	1.06 (0.89; 1.26)	0.78 (0.63; 0.96)
Trust LFD positivity (per 1/100 increase)	0.90 (0.82;1.00)	0.96 (0.89;1.04)	0.87 (0.53;1.42)	1.03 (0.97;1.09)
Local COVID-19 prevalence (per 1/100 increase)	0.90 (0.74; 1.09)	0.76 (0.53;1.11)	0.84 (0.45 - 1.53)	1.02 (0.82-1.27)
Alpha variant prevalence (per 0.1 increase)	1.02 (0.96; 1.08)	1.00 (0.92; 1.08)	N/A	N/A
Delta variant prevalence (per 0.1 increase)	N/A	1.00 (0.80,1.24)	Delta variant prevalent	1.33 (0.67;2.66)
Omicron variant prevalence (per 0.1 increase)	N/A	N/A	N/A	1.72 (0.90;3.27)
Average income deprivation score <sup>2</sup> per trust (per 0.01 unit increase)	0.16 (0.07;0.33)	0.53 (0.27;1.07)	N/E	N/E

<sup>1</sup>Number of trust/week observations included in the model. <sup>2</sup>Average income deprivation score, median (range) 0.130 (0.053-0.239) across trusts included in the analysis. A higher score means greater deprivation; 95% confidence intervals are shown in brackets. Adjusted for trust and calendar week (as fixed effects) and the number of new COVID-19 cases identified at the trust that week.



**Figure 8: Weekly number of nosocomial infections predicted for different testing scenarios, for 136 trusts included in the analysis.**



**Figure 9. Lower and upper limits of the 95% CI for the predicted weekly number of nosocomial infections predicted for different testing scenarios presented in Figure 8.**

**Table 4. Predicted total number of nosocomial infections in acute trusts studied.** These estimates do not include patients who were infected in the hospital but discharged before developing COVID-19 symptoms.

Testing/Reporting levels	Estimate	Lower 95% CI	Upper 95% CI
125% actual testing	11512	3740	19314
150% actual testing	11278	3646	18926
175% actual testing	11089	3564	18623
Actual testing	11816	3847	19838
200% actual testing	10931	3496	18377
25% actual testing	14207	4189	24437
50% actual testing	12891	4093	21895
75% actual testing	12236	3966	20605

**Table 4. Predicted total number of nosocomial infections in acute trusts studied.** These estimates do not include patients who were infected in the hospital but discharged before developing COVID-19 symptoms.

	November – December 2020 (pre-vaccination) (1)	January – July 2021 (vaccine rollout) (2)	August – November 2021 (Delta) (3)	December 2021 – March 2022 (Omicron) (4)
Number of observations <sup>1</sup>	1314	2852	1489	829
LFD coverage (per 100% increase)	0.99 (0.96;1.01)	0.92 (0.88;0.97)	1.00 (0.78;1.29)	0.74 (0.57;0.98)
Trust LFD positivity (per 1/1000 increase)	0.98 (0.97;1.00)	1.00 (0.99;1.01)	0.99 (0.96;1.03)	1.00 (0.99;1.01)
Local COVID-19 prevalence (per 1/1000 increase)	0.99 (0.96;1.02)	0.97 (0.92;1.02)	0.99 (0.92;1.07)	0.99 (0.97;1.02)

Alpha variant prevalence (per 0.1 increase)	1.02 (0.94;1.11)	0.98 (0.88;1.09)	N/A	N/A
Delta variant prevalence (per 0.1 increase)	N/A	1.10 (0.85;1.41)	Delta variant prevalent	1.23 (0.46;3.33)
Omicron variant prevalence (per 0.1 increase)	N/A	N/A	N/A	1.43 (0.56;3.67)
Average income deprivation score <sup>2</sup> per trust (per 0.01 unit increase)	0.11 (0.05;0.25)	0.39 (0.17;0.90)	N/E	N/E

Odds ratios (95% CI) are shown. <sup>1</sup>Number of trust/week observations included in the model. <sup>2</sup>Average income deprivation score, median (range) 0.130 (0.053–0.239) for trusts included in the analysis. A higher score means greater deprivation; 95% confidence intervals are shown in brackets. Adjusted for trust and calendar week (as fixed effects) and the number of new COVID-19 cases identified at the trust that week.

#### 4.4.4 Limitations

There are several important limitations of this work, which we briefly outline here.

Considering first the testing data, which were an input to both sets of analyses, only a limited number of tests was reported in many trusts, with an overall median (interquartile range (IQR); range) of 0.5 (0.05–1.19; 0–7.4) tests per person per month reported in trusts. There were no person-level identifiers in the dataset, therefore we could not distinguish between tests conducted in the same or different individuals. Reporting (and possibly testing) may depend on COVID-19 prevalence and these behavioural modifications are not accounted for in our models. There was no specific policy on which categories of staff should test, and in practice testing implementation varied across trusts and possibly over time within trusts (personal communication, Adam Shorrock). No staff categories were available in the testing data, and it is likely that LFD testing in different categories of staff (e.g., clinical vs non-clinical staff) may have had different effects on the risk of nosocomial infection. Only acute trusts were analysed, because no trust names were available in the Pillar 2 testing data. For acute trusts, we used the mapping function to assign LTLA-level tests to trusts. There was no information regarding whether testing was being conducted in symptomatic or asymptomatic individuals, so this distinction could not be taken into account. We therefore recommend caution in interpreting both sets of these results, due to the various issues with the testing data.

Our analysis to probe the impact of testing on FTE days lost due to COVID-19 was performed with respect to all FTE days available, which included staff with different exposure risks and likely different testing patterns. Because of this constraint, our results correspond to the association of FTE days lost and testing for an average member of staff, which may be unrepresentative for many members of staff. More broadly, our analysis was aggregate and ecological in nature, and future work should consider using individual-level case-control data (if such data can be located) to more adequately model the association between testing and absences.

We now discuss issues with the nosocomial infections analysis. A central assumption of this analysis was that the data in the ISARIC dataset were representative of overall hospitalised COVID-19 cases. If this is not true, the conclusions we draw could be arbitrarily biased estimates of the England population as a whole. Our analysis underestimates the number of nosocomial infections [8], as it does not include patients who were infected in the hospital but developed symptoms or were diagnosed after discharge. Therefore, our estimated effects of testing may understate the true impact of testing. Additionally, there were several computational limitations relating to underlying identifiability issues: models with fixed effects for trust had to be fitted, and multiple deprivation scores could not be included in two of the models.



#### 4.4.5 Appendix 4.4 references

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### 4.5 Economic model for the impact of testing on nosocomial infections

The statistical modelling exercise conducted as part of this evaluation (see appendix 4.4 for details) estimated that healthcare worker testing was associated with a 16.8% (95% CI 8.2%-18.8%) reduction in nosocomial infections compared to a hypothetical testing scenario at 25% of actual levels. This was in line with the findings from a modelling exercise carried out by UKHSA in 2022 [1], which estimated that the reduction in nosocomial infections due to weekly testing was 16% and the reduction due to daily testing was 25.4%. Therefore, using actual hospitalisation data deaths in England from ONS data during the evaluation period (October 2020 to March 2022) [2], a sensitivity analysis was developed assuming reductions of 4% to 26% due to weekly testing (8% to 20% presented in the main chapter, based on the 95% CI from the statistical analysis) and 15% to 30% due to daily testing. Nosocomial infections and deaths averted were modelled at these various potential reduction levels and cost savings from infections averted, including ICU admissions, were estimated. Combined with the total cost of the testing service, these were used to estimate the cost per nosocomial infection averted, cost per death averted and the cost per QALY gained. QALYs for symptomatic COVID-19 infections, hospitalisations and deaths due to COVID-19 from the literature [3, 4] were used to estimate the cost per QALY gained due to averted infections, hospitalisations and deaths. Table 1 summarises the input parameters and sources. A sensitivity analysis that tested the sensitivity of the outcome to the QALYs for death was conducted and presented (Figure 4-7, chapter 4) as the shaded area with a minimum and maximum weight of QALY for deaths (Table 1). Table 2 presents the results of the analysis, including an extended range of possible effect sizes.

See appendix 2.3 for details on methodology and details on cost and volumes.

**Table 1. Data inputs and assumptions for the testing service in healthcare**

Parameter	Value	Source
Reduction in nosocomial infections	16.8% (sensitivity analysis with range of 8-20)	Statistical analysis and [1]
Hospitalisation fatality ratio (HFR)	20.13	Calculated from ONS data (Deaths/Hospitalisations) [2]
QALYs for death	6.78 (4.98-8.8)	[3, 4]
QALYs for hospitalisations	0.201	[3, 4]
QALYs for ICU admission	0.15	[3, 4]
QALYs for symptomatic COVID-19 infections	0.008	[5]
Proportion of hospitalised patients with major manifestations	0.41 ( $\geq 19$ years) 0.2 ( $\leq 18$ years)	Statistical analysis (healthcare)

Parameter	Value	Source
Proportion of hospitalised patients with pneumonia	0.42 ( $\geq 19$ years)	Statistical analysis (healthcare)
	0.11 ( $\leq 18$ years)	
Proportion of hospitalised patients with major manifestations or pneumonia in ICU	0.11 ( $\geq 19$ years)	Statistical analysis (healthcare)
	0.9 ( $\leq 18$ years)	
Cost of hospitalisation (GBP)	2771	NHS Schedule of Costs [6]
	3138	
Cost of hospitalisation with major manifestations (GBP)	4507	NHS Schedule of Costs [6]
	8606	

**Table 2. Summary of the cost-effectiveness of weekly testing with respect to nosocomial infections averted.**

Reductions in new infections due to testing	4%	8%	12%	16%*	20%	24%	26%
Number of nosocomial infections averted	8,800	17,500	26,300	35,000	43,800	52,600	56,900
Number of deaths averted	2,800	5,500	8,300	11,000	13,800	16,500	17,900
Cost per nosocomial infection averted (GBP)	202,300	101,100	67,400	50,600	40,5500	33,700	31,100
Cost per death averted (GBP)	642,300	320,800	213,600	160,000	127,900	106,400	98,200
Number of QALYs gained	19,000	38,000	57,000	76,100	95,100	114,200	123,700
Cost per QALY gained (GBP)	93,000	46,400	30,900	23,200	18,500	15,400	14,200
Total financial savings (GBP billions)	1.14	2.29	3.43	4.58	5.72	6.86	7.43

\*The statistical analysis estimated that healthcare worker testing was associated with a 16.8% (95% CI 8.2%-18.8%) reduction in nosocomial infections compared with a hypothetical testing scenario at 25% of actual levels.

#### 4.5.1 Appendix 4.5 references

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# Appendix 5: Adult Social Care

# Adult social care

## 5.1 Appendices introduction, the adult social care sector, the initial government response and the policy timeline

### 5.1.1 Introduction to the appendices

This appendix has the following structure:

Appendix 5.1 provides details about the adult social care sector, including the initial government response for this sector; it also establishes the policy timeline of testing in care homes, with an adjacent timeline of key events and interventions for the general population during the pandemic.

Appendix 5.2 outlines a Theory of Change, developed to map out the intended design of testing in care home.

Appendix 5.3 draws on the results of qualitative research and covers operational findings that emerged from the review of data vaults shared by the UKHSA Secretariat and publicly available information; a rapid review of the behavioural literature, which relied on documents received from UKHSA Secretariat and those found as part of a rapid literature review; and stakeholder sessions, where the evaluation consortium tested the feasibility of emerging recommendations with the use of primary research methods.

Appendix 5.4 describes methods and findings of the statistical workstream that are not otherwise detailed in chapter 5.

Appendix 5.5 describes methods and findings of the economics workstream that are not otherwise detailed in chapter 5.

### 5.1.2 What is adult social care?

Adult social care is a complex sector, with the COVID-19 testing service covering seven settings/groups of personnel: care homes, homecare organisations, extra care and supported living services, adult day care centres, personal assistants, shared lives carers, and social workers. Adult social care in England is defined as:

... the care and support provided by local social services authorities pursuant to their responsibilities towards adults who need extra support. This includes older people, people with learning disabilities, physically disabled people, people with mental health problems, drug and alcohol misusers and carers. [1].

In England, local authorities provide long-term care services for adults. This provision includes care homes, i.e., services that provide both accommodation and personal care. The main types of care homes include [2]:

- ▶ Residential homes, which offer care and support (for 18-65-year-olds or people aged more than 65 years) [3], in a residential setting throughout the day and night, e.g., assisting with washing, dressing and eating. Some homes offer specialist care, such as dementia care, or specialise in care for individuals with learning disabilities. The size of residential care homes can vary immensely, from 1 to 2 beds to as many as 250 beds [3].
- ▶ Nursing homes, which offer the same type of care as residential homes, but specialised care is provided by qualified nurses who are available 24 hours a day. As with residential care homes, the size of nursing care homes varies.
- ▶ Supported accommodation, which includes long-term placements in adult placement schemes, hostels and unstaffed or partially staffed homes.

Care homes can be further classified as [4]:

- ▶ Older adult care homes: care homes serving any older people (aged 65 years or more), as identified from the latest Care Quality Commission (CQC) data on care homes in the 'older people service' user band. A small number of residents within care homes serving older people may be aged less than 65 years.
- ▶ Younger adult care homes (of which there are an estimated 6000 care homes for younger adults in the UK)[5]: care homes not serving any older people (aged 65 years or more), as identified from the latest CQC data on care homes in the 'older people service' user band.

As of August 2022, there were more than 14,500 care homes in England, of which 72% were listed as being residential care homes and 27% as nursing care homes [6].

Domiciliary care refers to services providing personal care for people living in their own homes.

### **5.1.3 Initial government response, policy changes and detailed timeline**

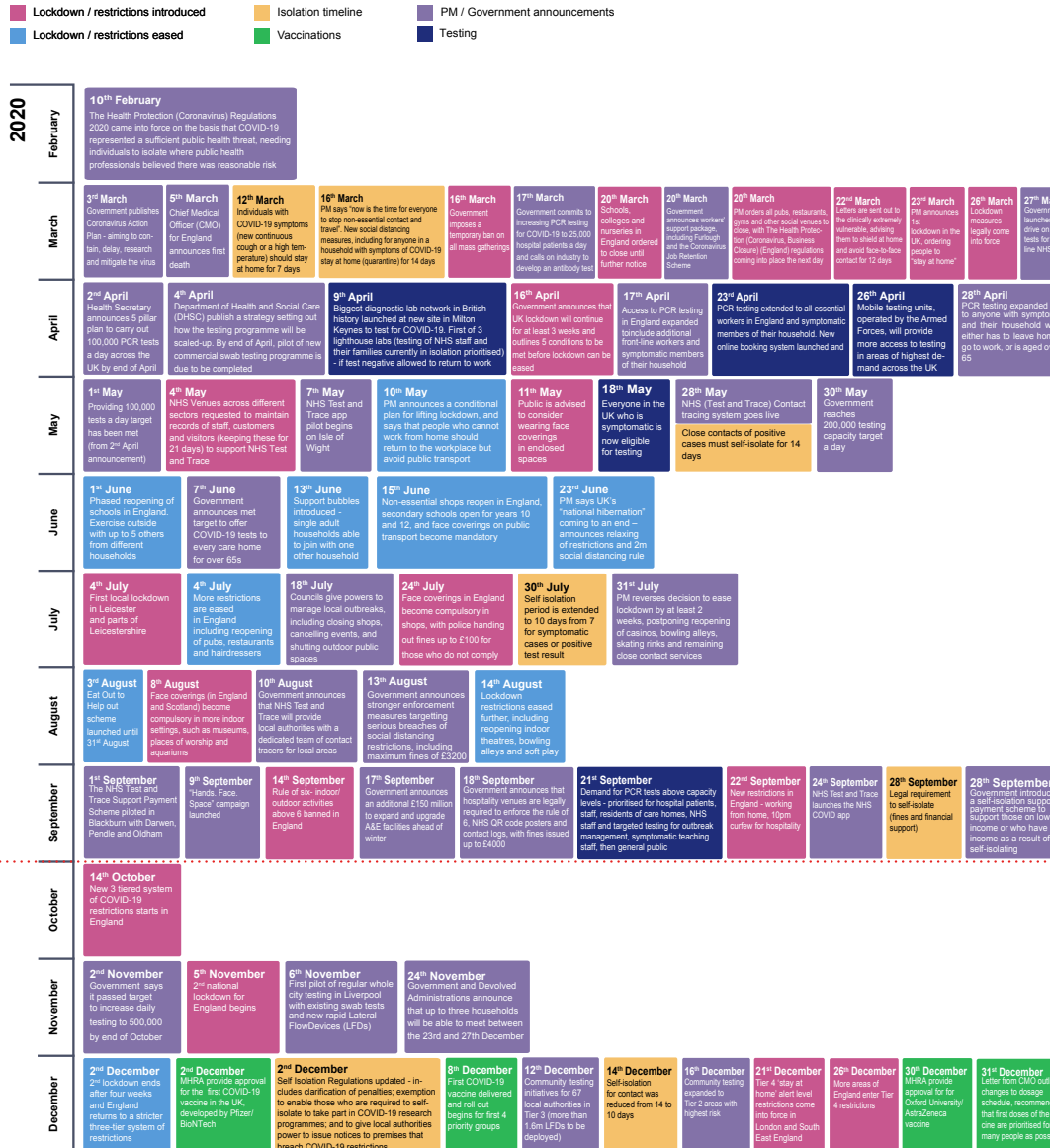
Government testing policies affecting adult social care in England evolved throughout the course of the pandemic. An early focus for the government was to free up 30,000 of the 98,000 hospital beds, equating to approximately one third of all beds [7]. The lack of availability of diagnostic tests for COVID-19 was a major issue for the adult social care sector at the beginning of the pandemic, with testing of individuals from hospital discharge to admission to care home not announced until April 2020 [8]. Initially, testing in care homes was used for symptomatic residents; as testing capacity increased over time this evolved into asymptomatic testing and culminated in the government expanding eligibility for testing to different types of care homes and population groups.

Summarised below are the key announcements and changes in policies – some of which occurred prior to our evaluation timeframe – that provide important context for the impact of the pandemic on a vulnerable sector.



### 5.1.3.1 Timeline

## Generic Policy Timeline

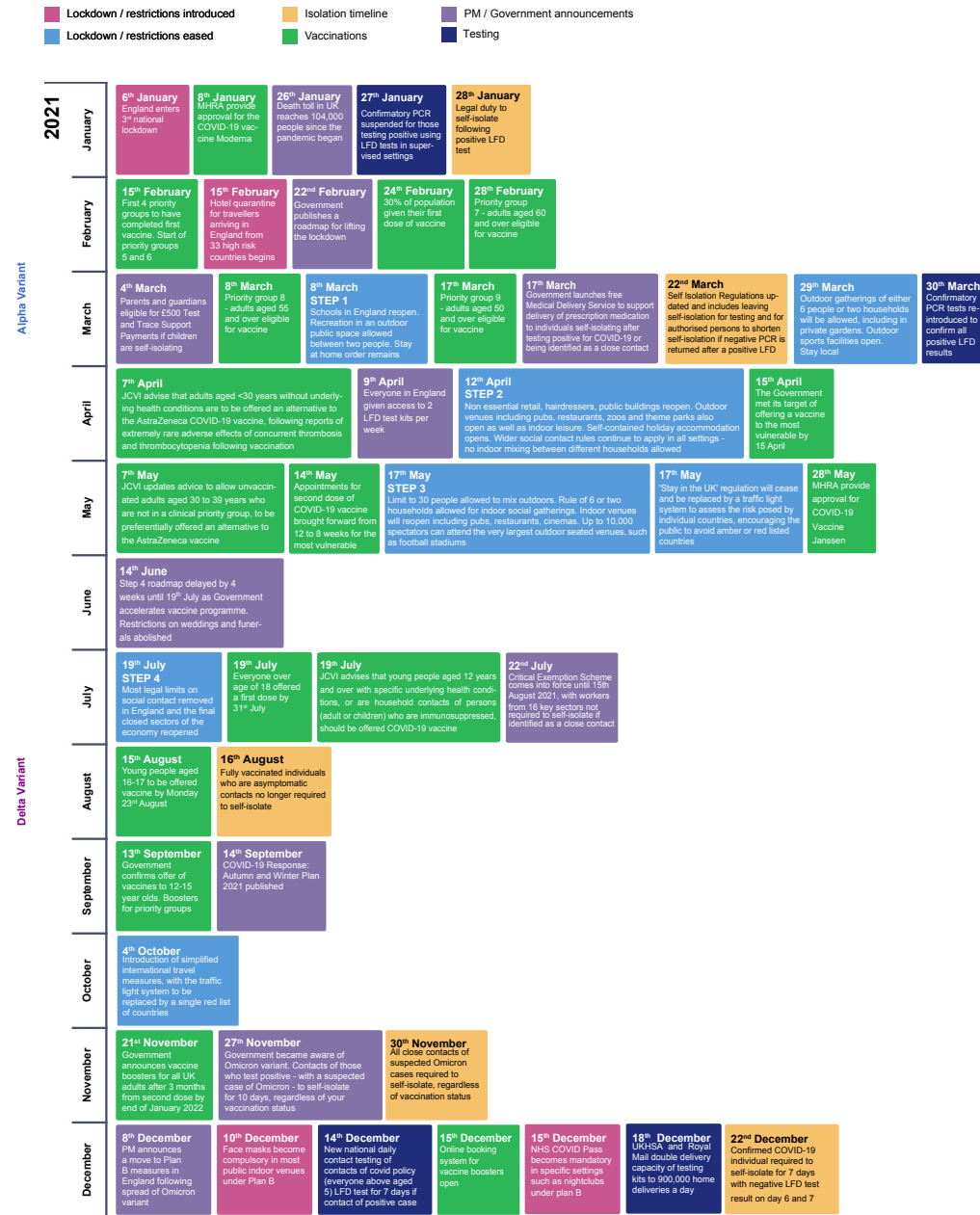


## Care Homes Timeline

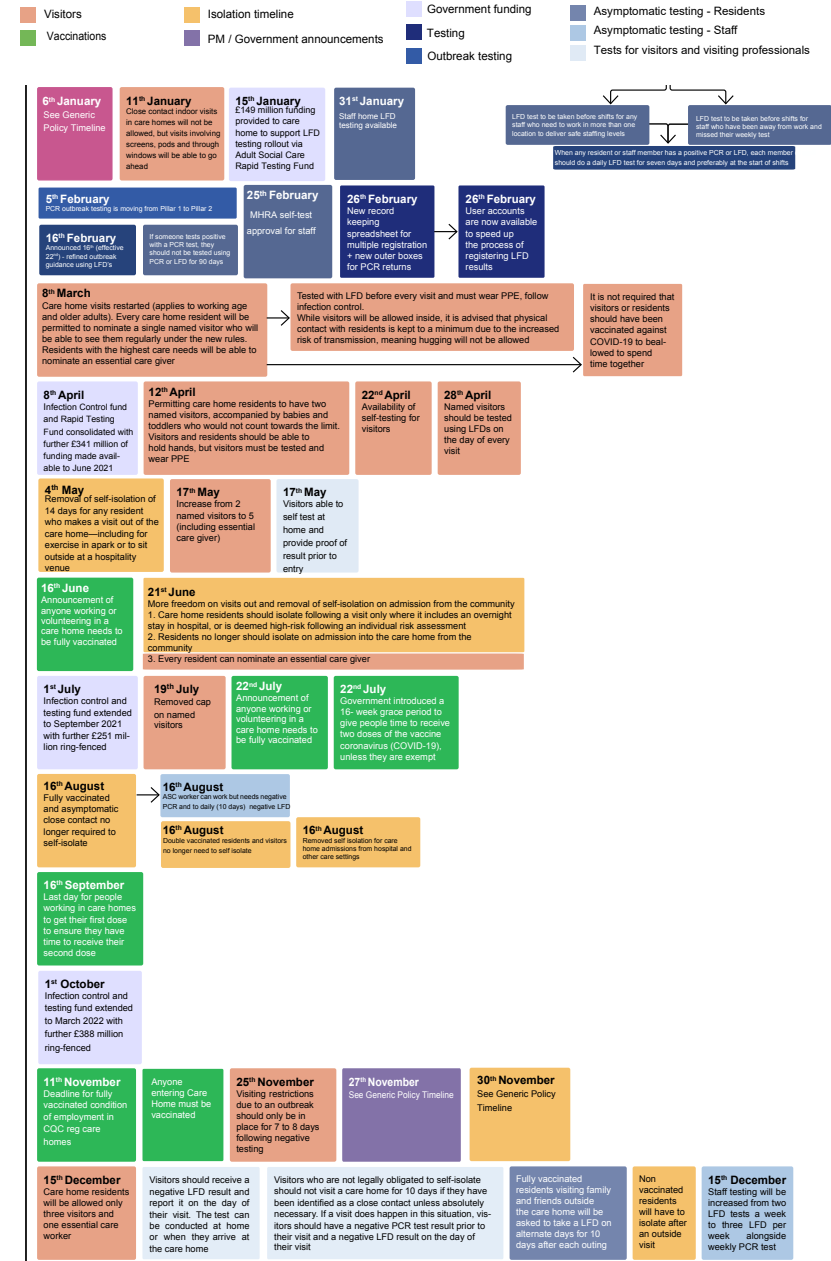


### 5.1.3.1 Timeline

## Generic Policy Timeline

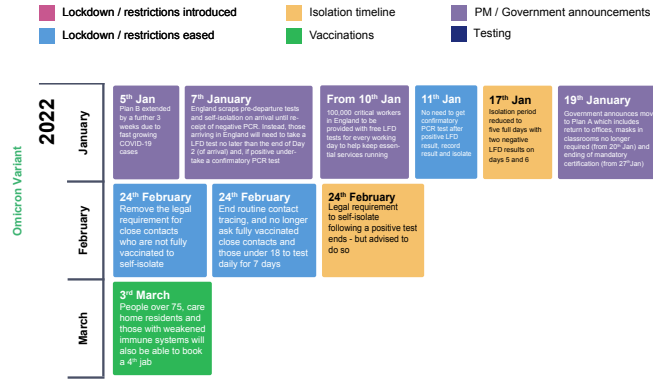


## Care Homes Timeline

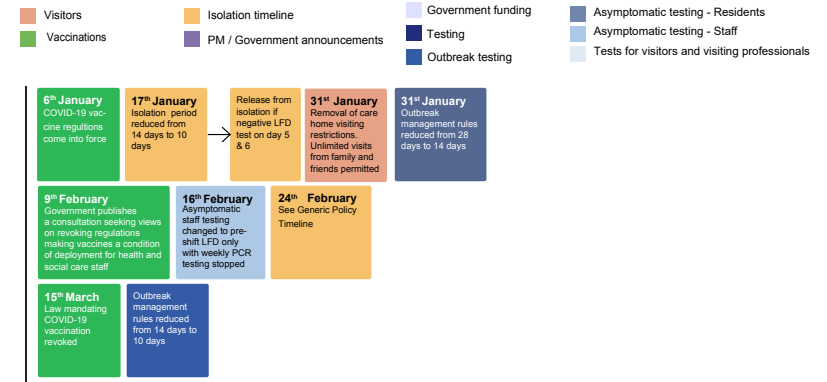


### 5.1.3.1 Timeline

#### Generic Policy Timeline



#### Care Homes Timeline



## 5.1.4 Early response in adult social care to the COVID-19 pandemic (pre-evaluation period)

- ▶ On 25 February 2020, PHE issued initial COVID-19 guidance for social care settings and advised that 'based on the data available at the time...it is very unlikely that anyone receiving care in a care home or the community will become infected', and 'there is no need to do anything differently in any care setting at present' [9].
- ▶ On 19 March 2020, NHS England published a letter detailing the 'COVID-19 Hospital Discharge Service Requirements', to request immediate action on discharging patients who were medically fit to leave hospital, to free up capacity for COVID-19 cases [10]. There was no national policy requirement to test patients before being discharged was outlined [11].
- ▶ On 2 April 2020, DHSC, CQC and NHS England jointly published new guidance for care homes, including that negative tests for COVID-19 were not required prior to admission into care homes and that testing was offered for up to five initial possible cases to confirm outbreaks where there was more than one symptomatic resident. It advised against visitors except in exceptional situations and 'care as normal' for individuals without symptoms [12].

### 5.1.4.1 Symptomatic testing

- ▶ On 15 April 2020, DHSC announced a new plan to test (with PCR) every social care worker who needed one; it also included a plan to test, as a matter of course, all symptomatic care home residents and all patients discharged from hospital prior to being sent to a care home [8, 13]. On 16 April 2020, the NHS published new guidance stating that all patients discharged from a hospital to a care home must be tested for COVID-19, regardless of whether they were residents of the care home previously [14].
- ▶ On 23 April 2020, DHSC announced that PCR testing would be made available to all essential workers in England and members of their households who were showing symptoms of COVID-19 [15]. However, personal care assistants and unpaid carers were not added to the list of essential workers until the beginning of May 2020 [16].
- ▶ On 28 April 2020, DHSC announced that any individuals in England with COVID-19 symptoms who had to leave home to go to work or were aged 65 years or more were able to get tested via PCR [17]. Alongside this, it was announced that testing was being rolled out for all asymptomatic NHS and social care staff and care home residents [17].
- ▶ On 11 May 2020, the DHSC launched a new portal via which care homes could arrange PCR testing for COVID-19; while all symptomatic and asymptomatic care home staff and residents in England were eligible for testing, it was prioritised for care homes that looked after the over-65s or those with dementia [18, 19]. This was reiterated in the government's COVID-19 recovery strategy, published on the same day, which stated that all care homes for those aged 65 years or more would be offered PCR testing by 6 June 2020 [20].
- ▶ On 18 May 2020, DHSC announced that anyone in the UK who had COVID-19 symptoms was now eligible for a COVID-19 PCR test, with the government aiming to expand total testing capacity to 200,000 tests per day [21].
- ▶ On 21 May 2020, DHSC announced the offer of antibody tests to patients and health and social care staff in England. These tests were made available in a phased manner, but little detail was provided about how the testing service would work in social care, stating that the government would 'agree with local leaders the best place in the country to start' and would 'work with them to decide how this is implemented' [22].

### 5.1.5 Initiation of asymptomatic testing in care homes

- ▶ On 7 June 2020, DHSC announced that whole care home testing (using PCR tests as LFD tests were yet to be commonly available) for all residents and asymptomatic staff was to be expanded to cover all remaining adult care homes, including care homes catering for adults with learning disabilities or mental health issues, physical disabilities, acquired brain injuries, and other categories for adults aged less than 65 years [23]. The government also announced that COVID-19 tests had been offered to every care home for the elderly or those with dementia [24]. At that time, since the launch of whole care home testing, the government stated it had provided 1,071,103 test kits to 8984 care homes and that they were able to dispatch more than 50,000 test kits per day [24]. In a further announcement on 8 June 2020, it was stated that a new social care sector COVID-19 support taskforce was to be established, to continue supporting the care sector and prevent further transmission [25].
- ▶ On 3 July 2020, staff and residents in care homes for the over-65s and those with dementia were to receive regular, repeat PCR testing for COVID-19 from the following week, as part of a new social care testing strategy [26]. Repeat rapid testing for NHS staff was introduced nationwide in mid-November 2020 [27].

- ▶ On the same day, DHSC confirmed that whole home PCR testing had been rolled out to all care homes registered on the portal [28]. It was also announced that regular testing in care homes – weekly PCR testing of staff and monthly PCR testing of residents – would be introduced on 6 July 2020, starting with homes caring for those aged 65 years or more and those with dementia.
- ▶ From 13 July 2020, enhanced outbreak testing (involving PCR and LFD tests) for care homes was due to be rolled out by the end of the month to all homes that had registered [28]. However, the regular retesting of whole care homes was unable to proceed as quickly as had been anticipated, due to a variety of factors, including increased demand for testing and unexpected delays; revised timelines were therefore published [29]. This resulted in individuals in care homes for those aged 65 years or more or for people with dementia having the first of their regular PCR retests by 7 September 2020, with the remaining care homes (for people younger than 65 years) able to register for PCR retesting from 31 August 2020. [29].
- ▶ From 23 December 2020, additional twice weekly rapid LFD testing was introduced for care home staff (or daily testing in the event of identifying a positive case) supported by funding announced by DHSC on 23 December 2020 [30].
- ▶ From February 2021 to December 2021, individuals were no longer required to undertake a PCR test for a period of 90 days, had they received a prior positive PCR test [31].
- ▶ In December 2021, staff testing with LFDs increased further, to three times a week, in response to the emergence of the Omicron variant [32, 33].
- ▶ On August 2021, care home staff who were double vaccinated but noted to be a close contact of a positive case were able to continue attending work (with relevant risk assessment in place), having obtained a confirmatory negative PCR test and undertaking daily LFD tests for 10 days that were all negative [34].
- ▶ In January 2022, confirmatory PCR tests following a positive LFD were temporarily suspended due to the confidence that a positive LFD result was indicative of an individual having COVID-19 [35].
- ▶ A further change to the testing regime came into effect on 16 February 2022, when staff testing moved to a pre-shift LFD for all staff on days that they were working, with the removal of weekly PCR testing [36].

## 5.1.6 Site set-up, communications, training etc.

### 5.1.6.1 Communications

The general policies related to testing and isolation were developed by various teams within UKHSA and DHSC. These policies were made available via the gov.uk website, along with emails and other forms of communication. Each care home organisation was then responsible for the clear communication of these policies to their staff members; care home managers had overarching responsibility for the correct adherence to the policy by their care home.

### 5.1.6.2 Site set-up

To implement onsite testing, care homes needed sufficient space and resources. To support this, funding was made available via local authorities. In May 2020, the government introduced the Adult Social Care Infection Control Fund, which was worth GBP 600 million at the time [37]. The main purpose of the fund was 'to support adult social care providers, including those with whom the local authority does not have a contract, to reduce the rate of COVID-19 transmission in and between care homes and support wider workforce resilience' [37]. This fund later became the Adult Social Care Infection Control and Testing Fund [38]. An extension to the funds continued until the end of March 2021, with an additional GBP 546 million of funding made available [39]. The fund was further extended through to the end of March 2022, by which time the total funding ring-fenced to support infection prevention and control amounted to almost GBP 1.75 billion, with supporting funds for testing amounting to almost GBP 523 million in adult social care settings [40].

### 5.1.6.3 Staff training

Care home staff were required to complete an online training programme and pass an online exam prior to supporting their site with the specific requirements of conducting the tests, processing the tests and analysing the results (of LFD) [41]. Care home managers were required to assure themselves that staff had passed the online exam, with a certificate of completion stored locally as evidence of this [42].

The guidance allowed care homes to make local decisions about staff roles based on the care home's requirements, e.g., clinical staff would assist the individual testing if they could not self-test, or they would oversee the transfer of the swab and reagent; administrative staff would provide support in recording and reporting test results. The training was critical with respect to reading and interpreting the result of an LFD.



The initial LFD kits were Innova brand, packaged in boxes of 25. These were not self-contained kits; they could only be used for self-testing by staff who had completed their training or by visitors or residents under the supervision of a trained staff member [43].

By the summer of 2021, additional LFD kits were available and were largely self-contained, so although staff could still support testing of individuals in care homes, the necessity for this had reduced. However, as the LFD brand differed from the original Innova boxes of 25, it was critical that care homes were using the kits as per required directives. A one-page poster was available on the government website, outlining the different rapid LFD tests and their respective high-level instructions [44].

#### **5.1.6.4 Test distribution**

The initial stages of testing in care home utilised a 'push' model: care homes were provided with the required quantity of tests and these tests were dispatched to them automatically. Over time, this transitioned to a 'pull' model, in which care homes could order the tests via an online portal, launched the week commencing 1 February 2021 [45, 46].

At a local level, care homes were required to ensure that they had sufficient tests to meet their testing needs, including additional tests for periods of rapid response and outbreak testing. Care homes were able to obtain additional/emergency kits by calling the 119 phonenumber [43].

On receipt of tests, care homes were required to store the tests and distribute them to staff and visitors as required [42, 47]. Care home managers were required to keep a record of the batch numbers of the test kits distributed. In addition to having the test kits, care homes were required to have appropriate personal protective equipment (PPE) [48] to support testing while maintaining safe infection prevention and control (IPC) measures.

#### **5.1.6.5 Test collection and registration**

Courier collection of PCR tests was available when sending more than eight tests to a laboratory [32]; eight or fewer PCR tests had to be dispatched via the nearest Royal Mail priority post-box. For some priority post-boxes, collection was made available seven days a week [49].

PCR waiting times were increasing from 48 hours to 72 hours [50]. The government's own targets for PCR results, as published in January 2021, noted a target of 90% return of results for care homes within 72 hours, communicating 87.5% of results within 72 hours and 58.1% within 48 hours [51].

PCR tests were analysed by laboratories, with results automatically transferred into relevant databases (assuming that the correct registration had been completed), whereas LFD test results were required to be inputted/reported by an individual themselves or by a care home on their behalf. The variation in distributed versus reported LFD results is highlighted in chapter 5.3, with qualitative insights detailed in Appendix 5.3.

#### **5.1.6.6 Rapid and outbreak testing**

In addition to asymptomatic testing, additional rapid response testing was needed when there was one or more positive LFD or PCR result from either a resident or staff member.

In these circumstances (up until mid-February 2021), staff (only) were required to undertake an LFD test for seven days until no new positive cases were found for five consecutive days [31].

From February 2021, rapid testing with an LFD was extended beyond seven days if positive tests were still identified [31].

In the case of outbreak testing, additional whole home (staff and resident) testing was required. An outbreak was defined as two or more positive (or clinically suspected), linked cases that occurred in the same setting within a 14-day period; this included PCR or LFD results [52].

Recovery testing was undertaken following an outbreak; the timings for this evolved throughout the evaluation period.

If there was a suspected or actual outbreak, care homes were required to contact their local health protection team, who provided guidance and support.

##### **5.1.6.6.1 Isolating following a positive result or if identified as a close contact**

For long periods of the pandemic, staff and residents were required to self-isolate if they had received a positive test result or were identified as a close contact.



The guidance evolved in August 2021, and staff who had been double vaccinated (14 days post their second vaccine) and had been identified as a close contact were still allowed to attend work on the proviso of having received a confirmatory negative PCR result and a negative daily LFD result for 10 days. The staff member also had to be asymptomatic. If the staff member worked with vulnerable individuals, a risk assessment was performed to determine whether they were able to attend work [53].

In late November 2021, and with the emergence of the Omicron variant, staff members, even if double vaccinated, were still required to self-isolate for a period of time [54]. This guidance was only in place for a short period of time, as on 14 December 2021, UKHSA updated its guidance for close contacts of Omicron cases, reinstating that 'vaccinated staff (health and social care) will no longer be required to self-isolate for 10 days if they are in contact with a case of the Omicron variant' [55].

From 11 January 2022, any staff member receiving a positive LFD result for COVID-19 as a part of their repeat asymptomatic testing was required to self-isolate immediately but was no longer required to take a confirmatory PCR test, hence confirmatory PCR tests were temporarily suspended; they were never subsequently reinstated [56].

### **5.1.7 Visitors and visiting professionals testing**

The opening of care homes to visitors varied in response to national lockdowns, regional tier lockdowns and the emergence of new variants of concern. At the point that care homes reopened to visitors in the summer of 2020 [57], LFD testing was not yet available and was not enabled until December 2020 [58]. Where required, testing was facilitated by a care home (including PCR testing if required).

The purpose of testing visitors was two-fold; i) to enable safe visiting while reducing the risk of introducing the virus into a care home from the community and ii) to support the health and wellbeing of residents through their relationships with family and friends [51]. Testing of visitors was in conjunction with other infection prevention and control measures, such as good hand hygiene, wearing of PPE and social distancing [75].

In principle, visitors were required to have received a negative LFD test result before entering a care home, with this testing initially facilitated by care homes, prior to testing being made available to individuals through the wider universal testing service in April 2021.

Irrespective of the location a test was conducted, the LFD test result was required to be registered against a care home's unique organisation number (UON) [47]; however, the guidance did note that it was at care homes' discretion 'whether they wish to accept visitors who self-tested at home.' [47]

Essential caregivers were able to be nominated by residents from June 2021 and attend care homes, providing residents with additional support during their visits [59] and were testing in line with staff testing requirements – including rapid and outbreak testing [60].

Additionally, visits during palliative care or during a resident's end of life was permissible under the guidance [61], with testing facilitated by the care home when it became available.

Visiting professionals, such as healthcare workers or CQC inspectors, were required to partake in their sector's testing service [62]. Care homes could request to see evidence of a test result or request that the individual took a test prior to entry, but as noted in our stakeholder discussions, this evidence was not always provided by visiting professionals.

By law, a CQC inspector cannot be blocked from entering a care facility if undertaking an inspection [62], but the policy of requesting such individuals to provide proof of a result was not always enacted.

#### **5.1.7.1 Positive tests for non-staff or residents**

In the event that, prior to entry, a visitor or visiting professional produced a positive LFD result, the care home conducted a PCR test, registering it against their UON and advising the individual of the isolation requirements in line with the latest government guidance. In instances when a PCR test could not be facilitated, the individual was advised to book a test online or via 119, while also following the government guidance.

#### **5.1.7.2 Testing expansion across the sector (beyond care homes)**

The following describes the expansion of asymptomatic testing across the sector from November 2020 onwards, to include:

- ▶ Home care workers in domiciliary care organisations registered with the CQC, with care workers looking after people in their own homes offered weekly tests from 23 November 2020 [63].
- ▶ Eligible extra care and supported living settings, initially announced by DHSC on 7 December 2020 and further expanded in February 2021 [64].
- ▶ Testing that allowed care home residents to be reunited with their families by Christmas 2020 [65].
- ▶ Daily COVID-19 testing for anyone working in adult social care and who did not receive regular testing at work was announced on 16 February 2021 [66].
- ▶ On 18 February 2021, daily COVID-19 testing was announced for adult day-care centre workers and service users [67].
- ▶ On 22 March 2021, guidance on testing was issued for essential caregivers for care home residents with the highest needs and nominated visitors for all adult care home residents [68].

### 5.1.8 Deployment of the COVID-19 vaccine

In addition to asymptomatic testing, the rollout of the vaccine programme was notable for care home staff due to the following announcements:

- ▶ On June 16 2021, the government announced that COVID-19 vaccination would be a condition of deployment for everyone working in a care home [69].
- ▶ On 9 September 2021, the government announced a six-week consultation regarding whether COVID-19 vaccination should be made as a condition of deployment across the wider social care and health sector [70].
- ▶ 16 September 2021 was the deadline for frontline social care staff to have received their first COVID-19 vaccine as a condition of deployment (unless medically exempt).
- ▶ 11 November 2021 was the deadline for staff and volunteers to have received their second vaccine as a condition of deployment in the service [71].
- ▶ On 6 January 2022, the COVID-19 vaccine regulations came into force [72].
- ▶ On 9 February 2022, the government announced that it would undertake a consultation and seek views over the government's intention to revoke the vaccine mandate as a condition of deployment [73].
- ▶ On 15 March 2022, the law mandating vaccines as a condition of deployment in health and social care was revoked [74].

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## 5.2 Theory of Change

### 5.2.1 Methodology

As per the evaluation protocol [1], this evaluation consortium used a Theory of Change (ToC) approach [2, 3]. Such an approach lends itself to understanding complex interventions with multiple causal pathways [4]. A ToC framework was therefore used to understand the causal pathways and intended and unintended outcomes of the adult social care homes testing service, while exploring the effect of context on the service setting's intended outcomes.

Subsequently, these separate insights were used to define outcome and process indicators to determine if and how the combined aims of the testing service were achieved. The ToC was developed retrospectively by the evaluation consortium, presented to UKHSA stakeholders in a participatory manner and iteratively updated based on their feedback.

The key research questions that were used to support the design of the ToC are shown in Table 1

**Table 1:** Key research questions.

1.	How did the delivery and uptake of the testing service compare with what was planned over time and what factors affected this?
2.	What were the barriers and facilitators to the access, use and delivery of the testing service?
3.	What measurable impacts were there from the testing service in terms of its intended purpose?
4.	What was the cost to the government and the cost-effectiveness of the testing service?
5.	Which aspects of the testing service might be beneficial to consider for future services?

For the testing programme overall: how can the above learnings be used to inform future pandemic preparedness testing strategy for England?

The care homes ToC was modelled and designed retrospectively using publicly available information (testing policies and guidance) and insights received from UKHSA Secretariat, to evaluate the complex intervention of asymptomatic COVID-19 testing by LFD and PCR tests across various personnel – staff, residents, visitors and visiting professionals – in care homes in England between October 2020 and March 2022.

As described by Maini et al (2018) [5], the mapping was undertaken by identifying key activities/ pre-conditions alongside assumptions and interventions that needed to be true for the outcome to be realised. For the purposes of the intended service, activities were defined as the elements required for setting up the testing, with conducting a test and appropriate actions following a test result listed under outputs.

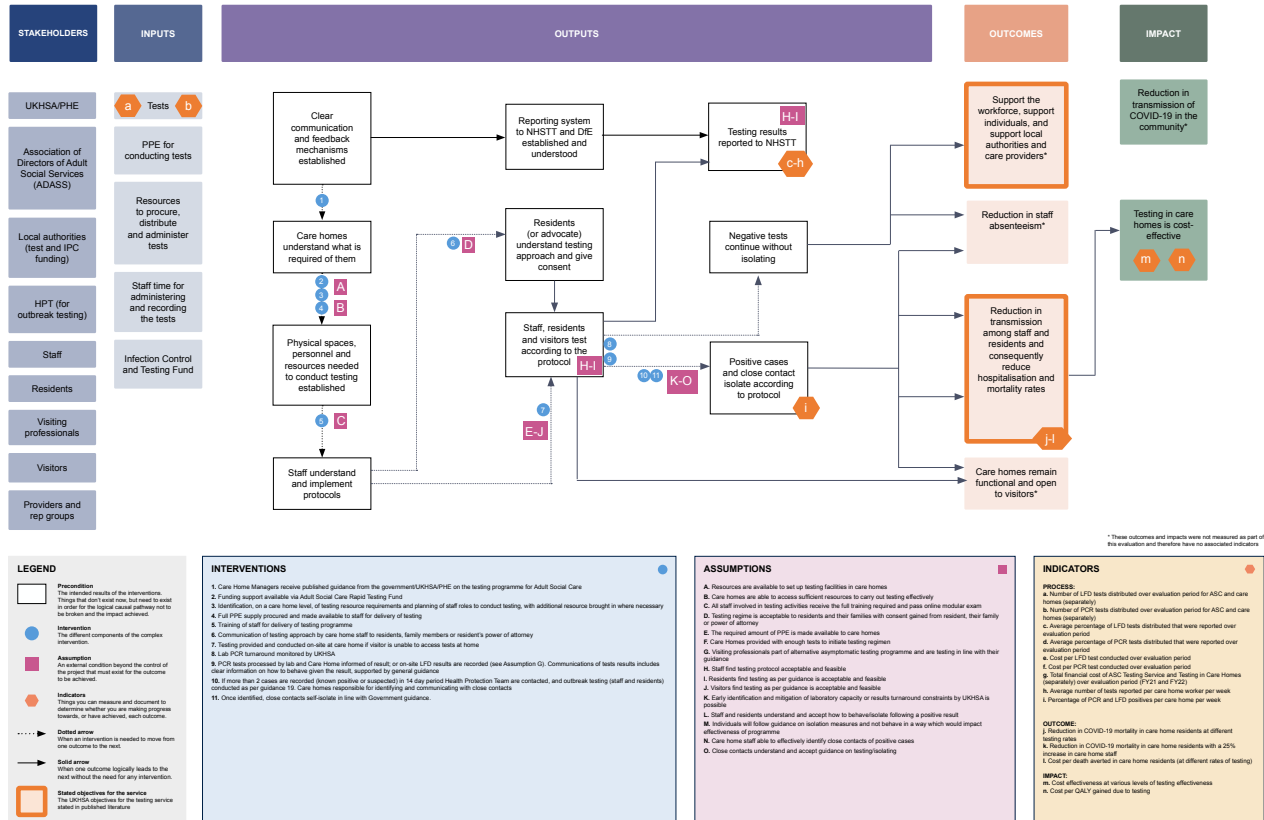
## 5.2.2 Theory of Change diagrams

### 5.2.2.1 Theory of Change – high level view

It was not possible to encompass each iteration specific to care homes testing throughout the evaluation period, due to the volume of policy changes and the changing pandemic context, so the ToC has been developed as a snapshot of the intended service design.

Based on feedback from UKHSA and evaluation consortium meetings, a high-level ToC was developed and is presented in Diagram 1.

Diagram 1: Care Homes Theory of Change - high level view

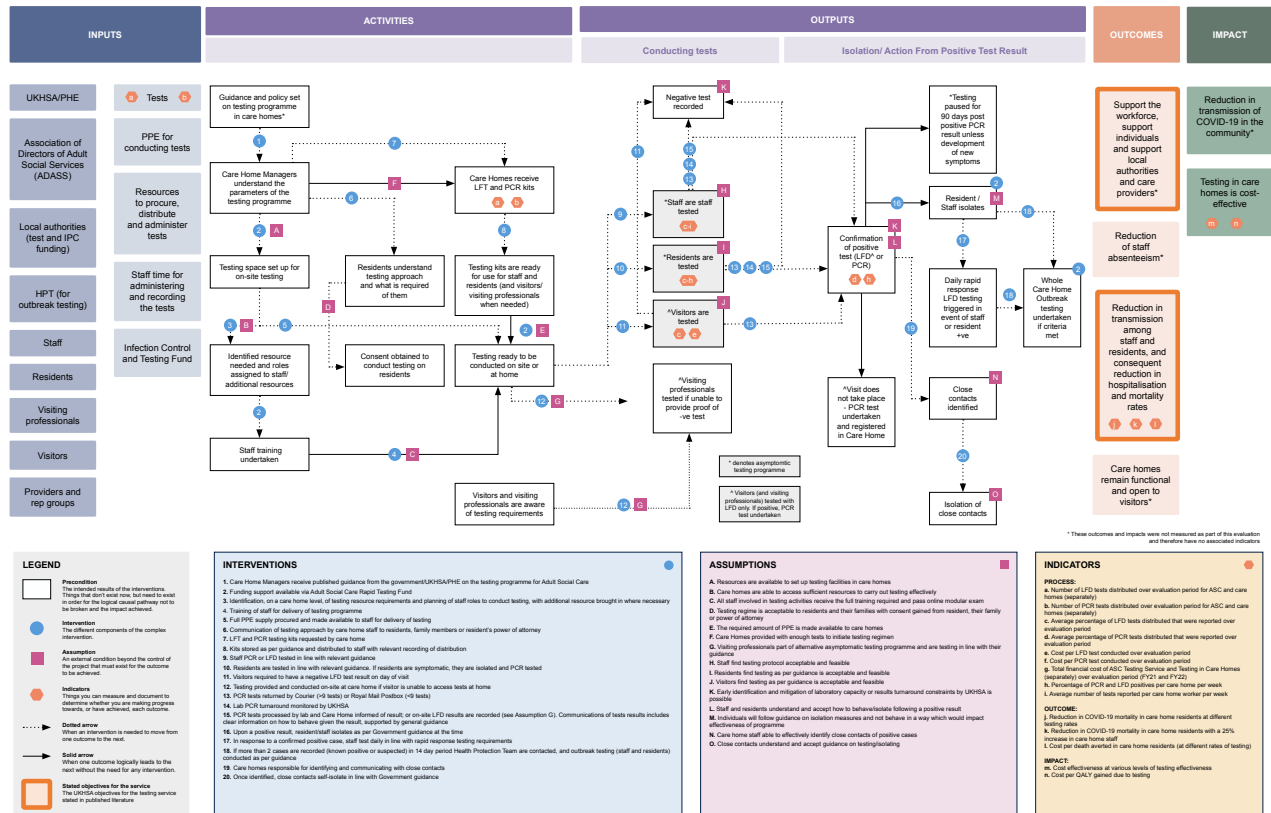


### 5.2.2.2 Theory of Change – detailed view

Diagram 2 of the care homes ToC provides additional detail, with clearer process mapping added into the overall process of the testing service in adult social care homes. Appendix 5.1 provides some narrative around the associated key activities required for the implementation of the testing service.

The narrative around the description of the testing service and operational findings can be found in appendix 5.1.

Diagram 2: Detailed Care Homes Theory of Change with process overlay



\* These outcomes and impacts were not measured as part of this evaluation and therefore have no associated indicators

### 5.2.3 Appendix 5.2 references

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## 5.3 Qualitative methodology and findings

This appendix contains the following sections:

- Behavioural and operational research
  - Narrative review methodology (context and operational insights)
  - Scoping study methodology (behavioural insights)
  - Operational insights
  - Behavioural insights
- Stakeholder engagement
  - Methodology
  - Stakeholder insights

### 5.3.1 Behavioural and operational research

#### 5.3.1.1 Narrative review methodology

To support with an understanding of the policy timeline, the aims and context for each service and to identify information on how each of the services operated, a narrative review was conducted into publicly available data sources. Sources included academic literature and grey literature (e.g., information and guidance published on gov.uk). These sources were collated and analysed to provide context to the evaluation consortium.

#### 5.3.1.2 Scoping study methodology

A scoping study was conducted to provide an overview of existing studies exploring barriers and facilitators to implementing and participating in COVID-19 testing in England. The key activities explored were COVID-19 testing, reporting of results and isolation following a positive result. This study aimed to provide: i) a summary of the research undertaken on this topic, ii) an overview of key barriers and facilitators for each service setting, as well overall across all service settings.

The findings were also triangulated with the statistical analysis, and then fed back into the developing Theories of Change to refine and explain the assumptions and to make recommendations.

## Methods

### Study design

A rapid scoping study was conducted to evaluate the barriers and facilitators to engaging with COVID-19 testing, reporting of results and self-isolation in the United Kingdom during the COVID-19 pandemic. A scoping study was selected to synthesise knowledge as there is a large volume of heterogeneous literature on this topic [1]. The proposed scoping study was conducted following the 2005 Arksey and O'Malley framework [2], with the adaptations proposed by Levac et al in 2010 [3] and using the 2015 Joanna Briggs Institute guidance on conducting scoping reviews [4].

### Search strategy and selection of the evidence

A wide search strategy was developed with input from a health sciences librarian, using key phrases from relevant articles [2] (see Table 1 for categories and example terms). This was used to identify literature that described behaviour around COVID-19 testing, reporting and self-isolation in the UK during the COVID-19 pandemic. The search strategy was adapted for each database and information source that was searched and was refined according to key words in sources that the search identified.

**Table 1: Search categories and examples of search terms.**

Category	Search terms
<b>COVID-19</b>	COVID* OR corona OR coronavirus OR SARS-CoV-2 OR "SARS CoV 2" OR "SARS CoV-2" OR SARS-CoV2 OR SARSCoV2 OR "Severe Acute Respiratory Syndrome Coronavirus 2" OR "Severe Acute Respiratory Syndrome Corona Virus 2" OR 2019-nCoV
<b>AND</b>	
<b>Key activities</b>	test* OR screen* OR RT-PCR OR PCR OR "polymerase chain reaction" OR "lateral flow" OR "lateral flow device*" OR "lateral flow assay*" OR LFD OR self-test* OR "test and trace" OR "contact trac*" OR surveillance OR POCT OR report* OR self-report* OR selfreport* OR ""test positive"" OR "testing positive" OR result* OR "self-isolation" OR "self isolation" OR isolat* OR containment OR reopening OR re-opening OR mitigat* OR flatten*
<b>AND</b>	
<b>Behaviour, barriers and facilitators</b>	knowledge OR understand* OR attitude* OR perception* OR perceive OR belief* OR believ* OR expectation* OR trust OR willing* OR intention* OR behaviour* OR behavior* OR practice* OR enact* OR engag* OR adher* OR complian* OR comply OR experience* OR view* OR motivation* OR barrier* OR block* OR challeng* OR difficult* OR facilitat* OR enabl* OR access* OR feasib* OR accept* OR uptake
<b>AND</b>	
<b>Research methods</b>	qualitative* OR interview* OR FGD OR "focus group*" OR survey* OR questionnair* OR mixed-method* OR "mixed method*" OR ethnograph* OR theme OR thematic* OR "grounded theory" OR "content analysis" OR field-work OR "field work" OR selfreport* OR self-report* OR "self report*" OR view* OR experience* OR hermeneutic OR phenomenolog*
<b>AND</b>	
<b>Geographic setting</b>	"United Kingdom" OR UK OR England OR Ireland OR Irish OR Scot* OR Wales OR Britain OR British OR NHS OR "National Health Service*" OR UKHSA OR "United Kingdom Health Security Agency" OR "UK Health Security Agency" OR "Channel Island*" OR London OR Birmingham OR Liverpool OR Manchester OR Cardiff OR Belfast OR Edinburgh OR Glasgow

The databases searched included the following:

1. **PubMed:** covers Medline as well as other sources relevant for a scoping review on COVID-19 literature, including in process citations, out of scope citations, ahead of print citations and author manuscripts of NIH-funded research.
2. **Scopus:** covers biomedical and social science research.
3. **The World Health Organization COVID-19 Research Database:** the literature cited in the WHO COVID-19 Research Database is updated daily (Tuesday through Saturday) from searches of bibliographic databases, hand searching, and the addition of other expert-referred scientific articles. This database represents a comprehensive multilingual source of current literature on the topic. While it may not be exhaustive, new research is added regularly. Databases searched include MEDLINE, Scopus, EuropePMC, Web of Science, ProQuest Central, EMBASE, medRxiv, ICTRP, WHO COVID, ScienceDirect, and the grey literature [5].
4. The search was supplemented after screening to identify key missing studies, by free-text searches on Google Scholar, review of the references of included articles, and through stakeholder consultations [6]. UKHSA Secretariat provided documents formed part of the stakeholder-identified sources for this study.

The search strategy aimed to identify both published and unpublished studies, as well as reports and guidance documentation. Qualitative or mixed methods studies published from 2020 in English were included. To be included in the review, papers needed to focus on any of the following three behaviours: undertaking a test; reporting a test; or isolating following a positive result, symptoms or a positive contact (see Table 2 for search limits and eligibility criteria).

**Table 2: Summary of the search parameters and limits as well as the inclusion and exclusion criteria [2], categorised according to the ‘population, context, concept’ search framework [7].**

	Inclusion	Exclusion
<b>SEARCH LIMITS</b>		
<b>Language</b>	Published in English	Published in languages other than English
<b>Dates</b>	Published between the start of 2020 and the search date (the database search was conducted on 07 November 2022 and the UKHSA documents were received throughout September – December 2022)	Published before 2020
<b>Methods</b>	Qualitative or mixed methods studies Quantitative surveys	Quantitative studies reporting only the association between demographic variables and behavioural outcomes
<b>ELIGIBILITY</b>		
<b>Literature</b>	Journal articles, peer-reviewed material, articles under review, published books and book chapters, other academic research, research commissioned by governments, unpublished reports	Opinion or statement pieces, magazine articles, blog posts
<b>Population</b>	England, Northern Ireland, Scotland, Wales, and the islands making up the British Isles. Multi-country studies were included if they included one of these settings	Countries outside the UK, including the Republic of Ireland
<b>Concept</b> (Key activities)	<p>Description of the behaviour, barriers and/ or facilitators of how people did behave regarding the key activities:</p> <ul style="list-style-type: none"> <li>▶ Antigen testing for COVID-19 (with a focus on LFDs but including LAMP and PCR testing).</li> <li>▶ Reporting the test results.</li> <li>▶ Isolating (with a focus on isolating due to a positive COVID-19 test result but including isolating after being identified as a close contact of COVID-19 positive case).</li> </ul> <p>The description of behaviours included associations of survey responses with behaviour or intention to test, report or isolate.</p>	<p>Describes testing, reporting or isolation but not the behaviour associated with them (e.g., describes the sensitivity of a specific test)</p> <p>Describes testing for antibodies</p> <p>Describes the barriers or facilitators to isolation in the context of social distancing, isolation if symptomatic or traveller isolation (hotel quarantine)</p> <p>Describes association of demographic factors with behaviour or intention to test, report or isolate</p> <p>Testing, reporting results or isolation after a positive result in the context of other diseases</p> <p>Describes facilitators or barriers to other COVID-19-related behaviours, such as vaccination or social distancing</p> <p>Describes the impact of testing/ reporting/ isolation on behaviour</p> <p>Knowledge, attitudes, or perceptions of COVID-19 itself</p>

As there was less evidence available on isolating after a positive test, the eligibility was widened to include studies that described perceptions or experiences of isolating as a response to a positive contact. This was done across all settings. The information related to testing in these studies was then also included in the analysis (but evidence about contact testing without discussion of isolation was not included, as more evidence was available about routine asymptomatic testing). Our assumption was that the perceptions and experiences of testing and isolating were similar across the reasons for testing (asymptomatic programme or in response to a positive contact) and that inferences on asymptomatic testing and reporting behaviours and isolation after a positive result could be made from evidence about testing, reporting and isolating after a positive contact.

There was a paucity of evidence in relation to the three priority service settings, therefore the eligibility was more inclusive for healthcare, adult social care and schools. For the service-specific settings, evidence was available from before the evaluation period and before LFDs were available. Many of these studies were early, exploratory pilots. These sources provided insights into the behaviour around testing, reporting and isolation after a positive test, and inferences can be made regarding LFD testing behaviours. Therefore, evidence focused on LAMP or PCR testing, evidence on symptomatic testing and evidence from before October 2020 was also included for these three service settings (but not for the overall testing programme).



Following the database search, all identified citations were collated and uploaded into Rayyan [8], and duplicates were removed. Following an initial screening pilot, titles and abstracts were then screened by two reviewers for assessment against the inclusion criteria for the review. A sample of  $\geq 20\%$  were reviewed by a third reviewer to clarify eligibility criteria and ensure consistency of inclusion [3]. Once the final criteria were established, each reader applied the clarified criteria to all literature screened, and the inter-rater agreement was calculated for the final list using Gwet's first-order agreement coefficient (AC1) [9]. Potentially relevant sources were retrieved in full and then assessed in detail against the inclusion criteria. Any disagreements that arose between the reviewers at each stage of the selection process were resolved through discussion them and with an additional reviewer if no consensus was reached.

### **Supplementary data**

UKHSA was identified as the major stakeholder in this study. UKHSA Secretariat identified a repository of data and documentation of potential relevance to the evaluation consortium. Upon commencement of the evaluation, and where review of the documents highlighted further potentially relevant sources, additional documentation was requested by the evaluation consortium to support with understanding how the testing services were intended to work, how they were experienced and any prior measurement of their effectiveness. Supplementary documents provided by UKHSA Secretariat included:

- ▶ Testing guidance published by UKHSA, DHSC or the NHS
- ▶ Testing process documentation
- ▶ Business cases
- ▶ Primary qualitative or quantitative research (including behavioural studies) with anyone involved in the testing programme
- ▶ Documentation involving reporting, managing or measuring the testing programme
- ▶ Previous evaluations of testing services

Once the publicly available data had been screened, these stakeholder-identified sources were reviewed for inclusion. The documents were allocated to one of the service settings. The same pair of reviewers that screened the full texts from the database searches reviewed the documents sent by the UKHSA Secretariat for the healthcare, adult social care and schools' settings. Six reviewers screened the general setting documents received from the UKHSA Secretariat due to a larger number of documents. The titles and abstracts of the documents were screened, then potentially relevant sources were retrieved in full, and assessed in detail against the inclusion criteria. Repeated discussions (and oversight by one reviewer of the other five for the general setting), helped to ensure consistency of the application of eligibility criteria.

### **Data extraction, charting and synthesis**

Two reviewers per priority service setting extracted the data, with a larger team (of six) extracting the universal testing and 'other' service setting data. The data extracted from each evidence source includes study metadata (authors, title, year of publication/dissemination, publication stage, country, participant characteristics and methods), the setting (service setting and key activity), and information about the perceptions, experiences and the barriers and facilitators to each of the key activities (testing, reporting and isolating). Data were extracted into an Excel template, which was piloted and refined using a handful of included sources. Each reviewer extracted data from two sources that overlapped with another reviewer, to check quality and support discussions to refine eligibility criteria.

Given the rapid timelines and the aim of the work, the articles were not assessed for quality. Once all the data had been extracted, we synthesised the data thematically by identifying key topics within the identified perceptions, experiences, barriers and facilitators. This was done for each setting (healthcare, schools, adult social care and general, including universal testing and other non-priority settings). In addition, we compared the findings across all three service settings with the aim of identifying universal as well as service-specific barriers and facilitators.

### **Stakeholder input**

Stakeholder engagement is suggested to be useful for adding methodological rigour to scoping studies [3]. Therefore, stakeholders from UKHSA were consulted to identify additional sources of published and unpublished evidence, sense-check the findings and help frame the results. Additional sources identified through this route were included in the scoping review (PRISMA-ScR) flow diagram as 'stakeholder-identified studies' [6], and insights from these discussions are incorporated into the discussion of the results.

### Care homes rapid literature review

In total, 14 articles were identified after full text review and included in the care homes service setting evidence synthesis (Table 3). Six were from the database search and eight were from documents received from UKHSA Secretariat. The 14 sources covered data collection from May 2020 to May 2022, with nine covering a range from the evaluation period (October 2020 to March 2022). All included English participants, with one including participants from the UK overall and one including UK participants among other international participants. Half (7/14) used interviews, 4/14 used surveys, 2/14 used retrospective analysis, 1/14 used systemic review and 2/14 used other methods.

All included sources described testing behaviours, with 8/14 describing reporting behaviours and 1/14 describing isolation behaviours directly. The participants included adult social care staff (predominantly those working in care homes) and ranged from frontline workers to care home managers. There were limited differentials made on ethnicity, age or other protected characteristics. members from different care settings, with three focusing specifically on primary care physicians, one on orthodontists, one on BAME healthcare workers, in particular, and one including senior scientific advisors. One of the articles from the database search overlapped with the healthcare (1/14) and was included across both analyses.

Publication	Methodology			Setting		Context
	Methods	Description of the sample	Data collection period	Country	Scope	
<p>JSP, Tulloch and M, Micocci and P, Buckle and K, Lawrenson and P, Kierkegaard and A, McLister and AL, Gordon and M, Garc�a-Fi�ana and S, Peddie and M, Ashton and I, Buchan and P, Parvulescu</p> <p>2021, Age and Ageing</p> <p><b>Enhanced lateral flow testing strategies in care homes are associated with poor adherence and were insufficient to prevent COVID-19 outbreaks: results from a mixed methods implementation study</b></p>	Interviews	15 care home staff members (from 9 care homes)	December 2020 - January 2021	England	Testing	<p>Pilot that largely mirrored protocols adopted in the UK at that time</p> <p>Sample focused on nursing homes</p> <p>Same time as initial vaccine rollout</p>
<p>K, Hanna and C, Giebel and J, Cannon and J, Shenton and S, Mason and H, Tetlow and P, Marlow and M, Rajagopal and M, Gabbay</p> <p>2022, BMC Geriatrics</p> <p><b>Working in a care home during the COVID-19 pandemic: How has the pandemic changed working practices? A qualitative study</b></p>	Interviews	One member of staff from 16 care homes Care home staff, aged ≥ 18, who worked in a care home or worked solely with care homes as part of their clinical roles, were eligible to take part.	October - November 2020	UK (no country specified)	Testing	<p>Asymptomatic PCR testing</p> <p>Visits limited according to tier levels in October</p> <p>In November national lockdown, visits only outside of with screens</p>
<p>KL, Gray and H, Birtles and K, Reichelt and IA, James</p> <p>2022, Aging and Mental Health</p> <p><b>The experiences of care home staff during the COVID-19 pandemic: A systematic review</b></p>	Systematic review	14 papers included in review and 1 intervention study. Of these, five were of quantitative methodology, two were mixed methods and eight were qualitative studies.	March 2020 - March 2021	International but includes UK	Testing	A review of the experiences of care home staff during the pandemic and how better to support them during the continuation of the pandemic and in the future
<p>M, Micocci and AL, Gordon and AJ, Allen and T, Hicks and P, Kierkegaard and A, McLister and S, Walne and G, Hayward and P, Buckle</p> <p>2021, Age and Ageing</p> <p><b>COVID-19 testing in English care homes and implications for staff and residents</b></p>	Interviews	10 staff members from eight care homes in England –with more than 5 years' experience in the sector	July - August 2020	England	Testing and reporting	The paper describes PCR testing and the feasibility of point of care testing to support the complexity of testing and detection of COVID-19
<p>P, Kierkegaard and M, Micocci and A, McLister and JSP, Tulloch and P, Parvulescu and AL, Gordon and P, Buckle</p> <p>2021, BMC health services research</p> <p><b>Implementing lateral flow devices in long-term care facilities: experiences from the Liverpool COVID-19 community testing pilot in care homes- a qualitative study</b></p>	Interviews	<p>15 staff from 9 care homes</p> <p>~ Broad representation of staff working in a range of care homes (residential and nursing homes)</p> <p>~ Staff who had received training on how to use the LFDs, were directly involved in working with the LFDs to administer visitor and staff testing, and had been working at the care homes prior to the first national lockdown in March 2020, with the rationale that such staff would have a longitudinal perspective</p> <p>from working before and during the pandemic, on how different testing regimes had influenced care home work, and vice versa.</p>	December 2020 - January 2021	England	Testing	<p>Pilot that largely mirrors protocols adopted in the UK at that time</p> <p>Sample focused on nursing homes</p> <p>Same time as initial vaccine rollout</p>

Publication	Methodology			Setting		Context
Reference (Includes authors, title, publication year, journal)	Methods	Description of the sample	Data collection period	Country	Scope	
<b>Evidence overlapping between service settings</b>						
S, Graziadio and SG, Urwin and P, Cocco and M, Micocci and A, Winter and Y, Yang and DA, Price and M, Messenger and AJ, Allen and B, Shinkins 2020, PloS one <b>Unmet clinical needs for COVID-19 tests in UK health and social care settings</b>	Surveys	447 Health and social care professionals (HCPC); policymakers	22 May 2020 – 15 June 2020	England	Testing	Focus on both healthcare and adult social care settings (with some findings difficult to differentiate between the two), and data collected early in the pandemic before asymptomatic testing of care home workers was in place. Adult social care workers and patients were prioritised for symptomatic PCR testing
<b>UKHSA Secretariat documents</b>						
Care Home Insights Playback User Research Insights and Recommendations UKHSA report C. Hornsby-Waide (Deloitte); D. So (Deloitte)	Interviews and surveys	Programme feedback survey (1.5k care homes); LFT self-report tool survey (~500); webinar feedback session (+100 attendees); in depth interviews (14 care home managers and staff) and outbound calling (~200)	Not stated PDF dated 29 March 2021	England	Testing and reporting	3 months into routine twice- weekly LFD for staff Approximately 1-2 months post introduction of home LFD testing
Care home Staff LFD Testing Research Insights Playback UKHSA report C. Hornsby-Waide (Deloitte); D. So (Deloitte)	Interviews and surveys	8 in depth interviews (7 x care home managers; 1 x cleaning staff); Care home testing programme feedback survey: c.1.5K respondents and LFT self-report tool survey: 514 respondents (85% non-management staff e.g., admin, catering, housekeeping, activities coordinators); 196 outbound calls	Week commencing 15 February 2021	England	Testing and reporting	2 months into routine twice-weekly LFD Approximately 1 month post introduction of home LFD testing and 10 days post LFD individual account registration
Risk Analysis Report: Sensitivity of LFDs in Adult Social Care	Retrospective analysis	The following was be taken into account when assessing the risk of reduced sensitivity in adult social care testing and the benefits of continuing to use LFDs in this setting: <ul style="list-style-type: none"> <li>▸ The results of the root cause analysis conducted to explore the potential causes of the observed reduction in sensitivity in this setting</li> <li>▸ The views of key stakeholders in adult social care ▸ Risk reduction and control measures already in place 3</li> <li>▸ The impact on residual risk associated with removing PCR tests from the adult social care testing regime</li> </ul>	Not stated Report signed off March 2022	England	Testing and reporting	Review of LFD sensitivity in adult social care covering period where policy changed for staff to increase 2 weekly to 3 weekly LFD
RWDO02 Report: Root cause analysis of observed sensitivity of LFDs below that of pre-deployment expected baseline performance when used by Adult Social Care staff	Retrospective analysis	Dual tests data collected between December 2020 and December 2021 Reconciled and analysed to explore differences (if any) device sensitivity within the population user group Reviewed Innova and Biotime LFD devices	24 December 2020 to 23 December 2021	England	Testing and reporting	Generally, when staff followed testing regimen, LFD sensitivity matched baseline expectation. Recognition that funding was available to support self-isolation, with acknowledgement that decisions made at LA level are not reviewed

Publication	Methodology			Setting		Context
Reference (Includes authors, title, publication year, journal)	Methods	Description of the sample	Data collection period	Country	Scope	
Care Home Visitors Discovery Research Insights and Recommendations Row 37 Master evidence	Interviews	3 x family visitors 8 x care home managers	November 2020	England	Testing	Pilot in November 2020 of visitor testing in Care Homes prior to rollout across all other care homes
Baselining the asymptomatic testing journey in adult social care (ASC)	Evaluation of all the touchpoints between end-user and UKHSA	Spoke to stakeholders (# undefined) to create high-level and detailed end-to-end service maps Reviewed existing research to identify user needs and mapped user pain points Created a content inventory of adult social care testing guidance and plotted key documents onto the service map Conducted a SWOT analysis (strengths, weaknesses, opportunities and threats) to identify gaps and opportunities	Undefined	England	Testing and reporting	Non-specific as timeline not known. Expected that due to detail, this is after introduction of twice weekly LFD + PCR testing
Adult Social Care Vaccination & COVID-19 Testing Report	Surveys	651 adult social care workers including those in care homes, domiciliary and supported living	27 April 2022 to 16 May 2022	England	Testing, reporting and isolating	Survey conducted following removal of vaccinations as requirement for deployment in adult social care. Further testing changes in April 2022 (outside of evaluation period)
ASC user research interventions output review	Undefined	Undefined	Undefined Published ~May 2021	Undefined	Testing and reporting	High-level insight findings of testing journey in care homes (including UON and bulk uploads), testing requirements for visiting professionals, visitors, and those in extra care/supported living settings

## 5.3.2 Operational insights

The intended design of testing in care homes sits within appendix 5.1; however, below we describe findings relating to the experiences of those setting up and rolling out the testing in the care homes sector.

### 5.3.2.1 Key activities needed in care homes for testing to succeed

#### 5.3.2.1.1 Establishing the testing regimen

Some care home organisations and care associations were involved in the testing pilots of the were able to relay their experiences to support the development of the testing regimen. Stakeholders involved (see appendix 5.3.4) noted that this was beneficial to them in being able to plan and operationalise when formal testing was subsequently implemented.

As noted in the results in chapter 5, care home residents who were aged 65 and over or had dementia were at higher risk of mortality from COVID-19 when compared to those younger than 65 or without dementia. The initial testing in care homes therefore focused on these resident groups.

#### 5.3.2.1.2 Communications

As noted in appendix 5.1, the policies related to testing and isolating were developed by various teams within UKHSA and the Department for Health and Social Care (DHSC). Some stakeholders from large care home organisations advised that they were involved in testing pilot and were consulted on the design of the policy.

Communications and guidance changed frequently, causing a lack of understanding, and was flagged as a barrier to testing adherence (see appendix 5.3.3).

The DHSC communications were described by care homes as having 'the right level of detail', with the use of bullet-point headers enabling them to find relevant information [10]. A minority of care homes highlighted that the training/guidance was not always applicable to their atypical care home setting, for example with drug and alcohol rehabilitation units [11]. Care home staff expressed a need for a 'single source of the truth for guidance' and for extensive resources to be 'written in plain English' [10].

#### 5.3.2.1.3 Site set-up

In relation to setting up care homes to support testing, some care homes reported having multiple rooms with outside access; others reported 'a single entrance and limited free space', which limited the ability to socially distance visitors prior to their being tested [12] or meant that there was no space to conduct visitor testing onsite [10].



The only extra rooms we have are upstairs, which means those who come in need to travel through the home and use the corridors. (Manager; independent, nursing) [12].

#### 5.3.2.1.4 Staff training

The training required of staff was noted to be in English only (video and transcripts). When raised with stakeholders, they did not note this to be an issue within their organisation.

From discussions with UKHSA stakeholders, it was confirmed that care home staff needed to undertake online training to ensure that the testing was undertaken correctly; specifically, using the correct volume of buffer solution, dropping the correct number of drops onto the device, waiting for the correct amount of time and how to read the result - this was noted in particular for the Innova branded boxes of 25 in which the kits were not self-contained. Care home staff were required to complete an online training programme and pass an online exam prior to supporting their site with the specific requirements of testing, processing and analysing the results[13]. Although transcripts of the videos were available, the videos and the transcripts were only available in English. Care home managers were required to assure themselves that staff had passed the online exam, with a certificate of completion stored locally as evidence of this [14].

There was some inconsistency between training materials and the testing kits delivered, with some care homes reporting that the training videos they had seen used bar codes for the LFD kits, but that the kits arrived with QR codes [11]. However, most figured out how to scan the QR codes [11].

Many care homes reported that the online training and PDF guidance for the use of LFDs was 'relatively straightforward', with a preference expressed for the video training [11].

Video is great, very clear, very basic, laymen's terms. [11].

Many care home managers also reported feeling the need to walk frontline carers through the testing and reporting processes in person [11].



### 5.3.2.1.5 Test distribution

The use of the 'push' or 'pull' model for ordering of tests was discussed with external stakeholders, with no preference noted for the model used for obtaining the testing kits.

Care homes did, however, report challenges with ordering and receiving tests. Some care homes noted receiving an email advising that their kit would be arriving, but without specification as to which type of kit, thereby causing some confusion [11]:

We got an email saying you placed an order, but it doesn't say for which type of test. [11]

We'll get LFT and PCR tests arriving randomly. [11].

Care home research insights from February 2021 noted that in the period between September and November 2020 there were delays in the delivery of test kits to most care homes in England [15].

On receipt of tests, care homes were required to store the tests and distribute them to staff and visitors as required. Care home managers were required to keep a record of the batch numbers of the test kits distributed, and external stakeholders confirmed that recording of the batch numbers of distributed test kits was required ([14, 16]) so the number could be provided if a batch was faulty. The sourcing of the correct PPE to conduct testing was reported as a challenge by some care homes [17]. UKHSA stakeholders advised that PPE was centrally managed, initially by DHSC.

### 5.3.2.1.6 Test collection and registration

The collection of tests by the courier option was a challenge highlighted by several care homes [10] and external stakeholders. An example from insights noted that not being able to track couriers or test kits was reported to create anxiety for some managers [17].

In discussions with external stakeholders, they also raised that there were issues with test collections often arising from the courier attending a location with an address and postal code originating from the CQC database that was incorrect or out of date.

Some stakeholders also stated that the delay in receipt of PCR results was challenging and they sought work-arounds, such as sending their tests on different days of the week to avoid periods of bottlenecks in testing laboratories.

Turnaround times for PCR results were noted to have periods of increasing waits (which was noted more during period of high prevalence) - insights in February 2021 noted that times to receive PCR results increased from 48 hours to 72 hours [15]. The government's own targets for turnaround of results was 90% of PCR results to be communicated within 72 hours and figures at end of January 2021 showed that 87.5% of results were being communicated within 72 hours and 58.1% within 48 hours [18]. This implies that generally, the targets were close to being met, but care homes may have found the increase from 48 to 72 hours or beyond challenging [18]. UKHSA stakeholders noted that SAGE (the Scientific Advisory Group for Emergencies) factored PCR turnaround times into their modelling of testing regimens.

As noted in chapter 5 and appendix 5.1, PCR tests were analysed by laboratories, with results automatically transferred to the relevant databases (assuming that registration had been completed correctly), whereas LFD test results were required to be inputted/registered by an individual themselves or by a care home on their behalf. The variation in LFDs distributed versus reported LFD results is highlighted in chapter 5.3, with qualitative insights detailed in appendix 5.3.2 to 5.3.4.

For the purpose of this evaluation, the evaluation consortium has noted that PCR registered tests indicates the volume of tests registered in order for a result to be linked following laboratory analysis. Reported results for PCR indicates the number of tests analysed by the laboratory with the subsequent result available and linked to the individual. For care homes, PCR tests were required to be registered against a care home's UON.

### 5.3.2.1.7 Rapid and outbreak testing

At the point of a suspected or actual outbreak, care homes were required to contact their local health protection team, who provided guidance and support. In discussion with stakeholders, this was noted to be varied and inconsistent.

### 5.3.2.1.8 Isolating following a positive result or if identified as a close contact

Findings in relation to isolating if testing positive or being identified as a close contact can be found in the behavioural findings of this appendix.

Full details about the changes to isolation and testing requirements during this evaluation period can be found in appendix 5.1.

### 5.3.2.1.9 Testing of visitors and visiting professionals

As noted in appendix 5.1, visitors and visiting professionals were required to have a negative LFD test prior to entry to a care home. Discussions with stakeholders revealed there were particular difficulties with health professionals, who were unwilling to comply with the care home requirements. It was further noted that, at times, CQC inspectors also would not provide proof of a negative LFD result, creating difficulties for care homes as, by law, they cannot refuse entry for an inspection. Further details about the provision of proof of test results by visiting professionals can be found in the stakeholder engagement section of this appendix.

## 5.3.3 Behavioural insights

### 5.3.3.1 Barriers and facilitators to taking and reporting a test

#### 5.3.3.1.1 Knowledge and understanding of the testing and reporting guidance

As noted previously, the frequently changing guidance was challenging for providers and staff.

The testing policy alone changed 19 times across the time period evaluated. A report commissioned by The Health Foundation noted that:

Government guidance and measures appear to have been rushed, heavily focused on care homes and their workers, and impossible to find in one place on the internet. [19].

Care home staff highlighted the importance of communications from managers, government and other organisations to enable staff to effectively perform their roles [20].

While some staff felt there was sufficient and timely communication on guidance and procedures from their managers [20], there was evidence of challenges with the communication of changes from care home managers to frontline workers [21]. In a survey of adult social care staff members in April and May 2021, the majority (91%) of managers reported knowledge of the change in testing guidance to twice weekly LFDs; however, there were much lower reported levels of knowledge (74%) among frontline carers [21]. This may have been linked to reports by care home staff in early 2021 that they had been provided with limited information to share with their teams [17]. There was also reported to be limited engagement with testing communications among some care home managers and staff, which may have led to gaps in compliance knowledge, such as the need to report LFD results [10].

Care home staff reported challenges with the guidance on testing requirements and protocols. In a survey of care home staff, nearly half (44% of approximately 1500 staff) reported feeling that it was challenging to stay up to date with testing communications, in part due to the frequency of updates [12]. With the testing communications provided, the testing information was sometimes perceived to be unclear [17] or to be missing key guidance, such as testing requirements for agency workers or visiting professionals [10].

Care homes suggested a number of improvements relating to the content, timing and format of communications [12], including:

- ▶ Do not repeat the same information across communications  
When lengthy pieces of guidance change perhaps a bullet point summary of what has changed rather than having to read through copious pages. ([12])
- ▶ Provide more concise updates and provide more notice for changes  
More relevant updates rather than reams of information which we have already received several times e.g., how to LFT test, we have been doing this for months. ([12])
- ▶ Provide information that is easier to understand  
They need to be clearer, sometimes it is hard to decipher the messages being given. Perhaps ask a care home manager to review before sending out? [12]
- ▶ More use of FAQs as well as answering more questions in the webinars that were held
- ▶ Have a regular day of the week for sending updates
- ▶ Preference for communications to be sent earlier in the day  
There seems to be a regular occurrence where the emails are received late on a Friday night when you are either at home or about to leave, weekends/days off are virtually non-existent so this seems a tad unfair when you are trying to spend time with your families. [12]
- ▶ More variety in the format and aesthetic of the communications would help to drive engagement
- ▶ Send emails that are printable

In a survey conducted in April and May 2022, nearly all (97%) care home staff working in care homes for older adults reported encouragement from their workplace to regularly test, mainly from line managers (61%) and senior leadership (53%) [21].

Self-reported adherence to reporting requirements showed that the majority of care home staff reported all tests [12]. In an LFD self-report survey in early 2021, most respondents (77% of 514 care home staff) stated that they reported results every time they tested; a minority did not report results at all (11%) or only reported positive results (5%) [12].

Most care homes reported finding the process of reporting LFD results 'simpler and more straightforward' than registering PCR results, as the process requested less information [11]; most staff reported their LFD results every time they tested [12]. Care homes reported no issues with staff ability to self-report LFD results, although some staff members did require individual training to understand the reporting process [11]. Some care home managers allowed self-swabbing, but then took control over the processing, reading and reporting of results to ensure accuracy [11]. The reporting process was seen as particularly quick and simple by care home managers who reported having created an account, which meant that they did not have to enter their details for each registration [11].

Once you've done the account once, the process of registering a test isn't too bad.

It's much faster with the account...I wish we had that for PCR tests as well.

It's worth spending the 5 min to create the account rather than putting in the information new every time. [11].

Non-compliance with reporting appeared to be influenced by a lack of awareness of the need to report all LFD results or a lack of understanding of the rationale for why reporting was required [11, 12]. In a 2021 LFD self-report survey, among those who stated that they did not report results at all, some (36%) said that they did not realise that they were required to, whereas a minority (8%) realised that they needed to but did not see the point in registering the results [12]. These findings are consistent with those of other UKHSA research [21].

Overall, these findings imply that where there was variation in understanding and implementing the testing regimens between care homes, this may have been due to either a lack of awareness of changes in protocols or an unwillingness from the care home to follow them.

#### **5.3.3.1.2 Physical experience of the test**

By September 2020, asymptomatic testing had been rolled out to all care homes [22]. The slow increase in testing volumes may have been compounded by the fact that, early in the pandemic, care home staff reported difficulty in swabbing residents due to residents' physical discomfort [23, 24]. Furthermore, residents were reported to find the testing daunting [23, 24], with particular difficulties faced by those with dementia and those without the capacity to understand the reasons for testing [17, 24]. A minority (15%) of adult social care workers surveyed in 2022 also reported that they did not like the experience of taking a COVID-19 test, with this sentiment particularly high among younger staff [21]. It took time to convince residents and staff to accept testing [17]. More time and flexibility were also required from staff to identify an appropriate time to test residents [24].

#### **5.3.3.1.3 The care home layout and physical environment**

Kierkegaard and colleagues (2021) noted the need to investigate testing 'in relation to finding the balance between infection control and architectural design', including how to accommodate testing within older buildings [25].

#### **5.3.3.1.4 Trust in the test, its results and the reporting process**

Care home staff members reported viewing regular LFD testing as a useful safety measure [11]. However, questions were raised by some staff members over the accuracy of LFD results, with care home staff citing concerns over the reliability and accuracy of tests [12] and the effectiveness of LFDs for detecting COVID-19 [21]. One stakeholder noted 'There wasn't any consistency sometimes where somebody would do a test twice ... and they'd come out positive on the 2nd test, but they were actually negative on the 1st test ...'

UKHSA stakeholders have noted that the dual testing regime was in place in part due to the effectiveness of LFD tests.

However, providers did come to recognise that the speed in obtaining LFD results aided them in acting quickly to contain infections and reduce the risk of COVID-19 entering the care home in the first instance [26]. There was also concern expressed by care home staff over the risk of false-positive LFD results, which would cause staff members to isolate unnecessarily and reduce staffing levels [25].

Concerns around the accuracy and reliability of LFDs were reported to have been influenced by news and media stories [11, 12] and anecdotal evidence received through peer networks [10]. In some instances, mistrust of LFD results was compounded by differences observed between LFD and PCR test results, where both types of test were used concurrently in asymptomatic testing protocols [12]. In early 2021, when the guidance was for care home staff to test themselves with twice-weekly LFDs, concerns about their reduced sensitivity led some providers to consider the use of LFDs unsafe, with a minority requesting care homes not to use them [11].

The issue of trust (as noted by staff concerns) was mainly focused on whether LFDs were an effective and accurate way to identify COVID-19 cases. This was exacerbated by the requirement to self-isolate upon receiving a false-positive result, which would have resulted in reduced income for the individual concerned and additional staffing pressures at the care home.

PCR testing was generally considered the 'gold standard' [27] and thought to be effective at detecting COVID-19 [21]. PCR tests were considered more accurate than LFDs [12, 28], which may have been emphasised through the use of confirmatory PCR tests upon receiving a positive LFD result [28, 29]. However, there is evidence of care home staff raising issues over the reliability of test results [29]. Furthermore, concerns around the accuracy and reliability of LFDs were reported to have been influenced by news and media stories [11, 12] and anecdotal evidence received through peer networks [10]. In some instances, mistrust of LFD results was compounded by differences observed between LFD and PCR test results, where both types of test were used concurrently in asymptomatic testing protocols [12].

“

Sometimes we have contradictory results and we don't know which test to consider ... sometimes the PCR is positive and they have to isolate without symptoms even though the LFT says they are negative. [12]

“

LFT test came back negative when PCR same day came back positive. Feels like a futile exercise. [12]

It is possible that attitudes to the utility of LFDs changed over time, as summarised by one stakeholder 'the confidence in the lateral flow test was fairly low to begin with. I think people now rely on the lateral flow test.'

### 5.3.3.1.5 Perceived resources to conducting, registering and reporting of tests

A consistent finding from both academic and internal literature sent from UKHSA Secretariat was that the reporting (LFD results) and registering of tests (PCR) took considerable time. Each individual test and its result had to be registered for auditing purposes [30]. From the onset, it was a requirement that all test results be reported via the relevant portal, irrespective of whether they were positive, negative or inconclusive.

Prior to the self-reporting portal being made available for LFD results, for care homes this largely meant completing an NHSTT spreadsheet [31]. This allowed multiple individuals' PCR and LFD results to be entered, with separate spreadsheets for staff and residents. The rationale was that this would be quicker than individual registration for each result, particularly the entry of personal details which could be reused in future uploads of the spreadsheet. The spreadsheet could be uploaded to the government portal, with further instructions to cross-check that the data matched the information entered in the spreadsheet [32]. Internal UKHSA findings suggested that lower literacy levels among care home staff may have presented a challenge for staff to use the spreadsheets for the bulk upload of results from care homes [17].

In a DHSC/NHS T&T survey, most care homes surveyed (70% of approximately 1500 care home respondents) advocated a faster registration process [12]. Challenges with the effort required for registration was an issue for both PCR and LFD tests. Although most care homes (85% of approximately 1500 care home respondents) reported satisfaction with the PCR testing experience in February 2021, registration was reported as being 'the single most time-consuming part of the PCR testing experience for care homes, taking an average 5 hours each week', with particular issues around bulk registration [12].

Care home staff perceived testing protocols to place a high burden on staff, as the perceived 'effort involved in organising, managing and conducting tests is very high' [12]. The requirement to regularly test using a combination of LFD and PCR tests for asymptomatic and symptomatic residents, in addition to visitor testing, was felt to contribute to 'an already saturated workflow' [30]. This became a particular issue as the incidence of COVID-19 increased [24].

In February 2021, most care home staff (82% of approximately 500) responding to the LFD self-reporting tool survey reported that all or most of the staff at their care home were being tested onsite [11].

“

We know that the tests are done and done properly if at the home. [11].

“

It's not because I don't trust them, but if they do it at work then they're present and I'm here so I can give them clear instructions. [11].

Care home staff felt they had a vastly increased workload due to the pandemic. This was in part due to the need to conduct tasks remotely; an example from one care home was that pre-pandemic, a social work review and associated documentation could be performed independently of the care home staff [25]. However, the change in workflow due to the pandemic required care home staff to make time for 'scanning emails and doing all of the documentation work of social workers' and to sit in on all video call assessments, which could take 2 to 3 hours [25]. Care home staff also reported struggling with additional tasks, such as remote death verification, and feeling 'mentally fatigued' and 'exhausted' [25]. This increased workload may have been a barrier to participating in testing, with time identified as being an important factor to convince residents and staff to accept testing [17, 24].

Care home managers reported that the move to enable staff to self-test at home was beneficial both for care homes [11] and for staff, in the case of the latter avoiding the need for them to attend the care home early to test before their shift [28].

“

It's been so much simpler since staff moved to testing at home ... It's reduced the chaos, taken it away from the home. [11].

Together, these findings imply that where there was variation in applying the guidance between care homes, this may have been due to either a lack of awareness of changes in protocols or an unwillingness on the part of the care home to follow them.

#### 5.3.3.1.6 Individual capability of taking and reporting a result

The ability to self-report via the government portal was introduced in the spring of 2021, enabling staff members to report their own LFD result, thereby reducing the workload of care home teams. In discussions with UKHSA stakeholders, it was suggested that entering results remained complex, still requiring the navigation of multiple screens just to enter a result.

A lack of understanding about how to register and report test results may have impacted registration rates. During February and March 2021, the NHSTT outbound calling team contacted care homes that had ordered LFDs but not reported any results (n = 1901); it was found that some care homes did not know how to register tests (24%), had difficulties with the registration process (12%), or had been told they did not have to register them (5%) [12]. The registering of results through government portals was considered a cumbersome, time-consuming process [24, 30], 'with many deciding either not to register or not to test as a result' [10]. National guidance also suggested that two staff members were required to take swabs and then register the tests, with implications for staff resources and rostering [24].

“

To be frank, I don't have time to be testing people – no chance. Manager (Provider group; manages two care homes, one residential, one for people with dementia) [28]

A further burden identified by care home managers was the need to keep an additional local record of LFD results for local reporting and for reporting to their head office, CQC or for local authority inspections [11].

The introduction of LFD testing as part of the asymptomatic testing service further impacted the available resources. For example, smaller care homes may have struggled to report high volumes of LFD results compared with larger sized care homes [11]. The manual element of data entry was one issue:

“

When you have to do 24 members of staff and typing barcodes twice and double-checking it can take ages. [11].

A further insight from an individual who participated in the study suggested that if the UON (unique organisation number) came up automatically with more information, the time taken to log the tests would be reduced [12]. Among adult social care staff surveyed in April and May 2022, a common reason cited (by 24% of 651 respondents) for rarely/never reporting LFD results online was that too many tests were being taken to report them all [21].

Prior to the availability of self-testing at home, care home staff reportedly had to attend care homes for testing on their days off or stay at work outside of their shift times without additional pay [25, 30]. Some care home staff were reported to find this 'impractical and inequitable' and that being 'tested multiple times a week was not compatible with the contextual realities of the working schedule of care home employees' [25].

“

They are not willing to come back and do the LFD test on a fourth day or a fifth day that we've been told to do it within. So not many staff been able to do it because of travel and the cost and then their time and obviously this time of the year everyone is busy. You know, they don't want to spend all these hours to come in for the lateral flow test. (Participant 12) [25].

“

We can't all test before we start shift, it's just not practically possible...asking people to come in early for no money all the time. It's not acceptable. It's not fair on people who are already on minimum wage to expect more and more from them. (Participant 14) [25].

### 5.3.3.1.7 Individual perceptions, values and responsibilities in relation to testing and reporting

Care home staff reported that the pandemic had a negative impact on their health. A Queens Nursing Institute survey reported that '56% of its membership of nurses and managers working in care homes felt "worse" or "much worse" in terms of their physical and mental well-being compared to usual' [20, 33]. Greene et al (2020, referenced in [20]) found that '57.9% of the UK health and social care workers sampled (including staff working in care homes) met criteria for clinically significant levels of distress (PTSD, depression or anxiety)' [20]. Other factors associated with the psychological impact of the pandemic on care workers included working conditions, workload and redeployment, and the availability of PPE [20].

Testing fatigue may have impacted participation in testing and reporting. Although outside the timeframe of the scope of this evaluation, during April and May 2022 some adult social care staff members (18% of 651 surveyed) reported feeling tired [21] of the frequency of testing, which at the time of the survey was pre-shift LFD [34]. The rates of testing fatigue were highest in groups not fully vaccinated and those who identified as struggling financially [21]. Vaccinations may also have impacted staff perceptions of the need for testing, with many staff reported to doubt the need for testing following vaccination [10]. In April and May 2021, care home staff who were not fully vaccinated did not perceive COVID-19 to be as much of a risk as it had been earlier in the pandemic [21].

“

I don't think there is much of a risk. [21].

“

It's not a big thing at the moment. [21].

The value of LFD testing was perceived to be in increasing vital social interactions of residents, enabling physical interactions and controlling infections:

Feedback from care providers is that LFDs have been a really important tool that has helped them to act quickly to contain infections. They appreciate the speed of results compared to PCR tests since a positive LFD result enables them to rapidly act to isolate those individuals and stop further transmission much sooner than waiting for the PCR result to come back from the lab. Key care home representatives reported that LFDs have been particularly important this winter because PCR results were taking much longer than usual (due to increased demand from the general population due to the Omicron variant). [26].

Care home staff and visitors reported a perceived responsibility to protect residents and staff members from infection [12]. The majority of adult social care workers surveyed in April and May 2022 (92%) reported feeling a duty to protect those they care for from infection [21]. In the same survey, nearly all (97%) care home staff working in care homes for older adults reported encouragement from their workplace to regularly test, mainly from line managers (61%) and senior leadership (53%).



### 5.3.3.1.8 Value of visitors versus the impact of testing

The key perceived value of testing was widely reported to be to enable visits, which was thought to have several benefits, including the ability to 'restore a sense of normality for residents', for residents and families to re-establish bonds, and to 'reduce the risks of social disconnect from the world outside care homes' [25].

“

It really benefits the residents and family members. You know, it opens up those doors again. Yeah, I think that's an important message to bring through the emotional aspect for it. (Participant 04, care home staff member) [25].

“

I think that that moving forward is sort of some normalcy if you like, they can sit together in clumps again, they can hold hands, they can hold them without feeling guilty. (Participant 10) [25].

There was also the perception that testing with LFDs enabled physical interactions, such as hugging and holding hands, between residents and family [25], which could improve the mental health of both residents and visitors [12]. The use of testing to support visits was also perceived by care home staff to help reduce staff members' workload, as during periods when visitors were restricted staff faced additional pressures to meet residents' emotional needs [25]. It also meant that care staff were no longer needed to supervise remote visits; furthermore, the use of LFDs enabled care homes to feel more comfortable about opening up to visitors [12].

“

Testing would make us feel more at ease with allowing someone into the home. Manager (Independent, adult specialist care) [12].

LFDs were perceived by care home staff to be safer than PCR tests for visitor testing 'as you know the result at the time of entry to the care home' [12].

The protocol for asymptomatic visitor testing primarily required LFD testing onsite prior to a visit [18]. PCR tests were used as confirmatory testing upon a positive LFD result being received onsite (for both visitors and visiting professionals). In a pilot study (November 2020) to enable care homes to reopen to visitors, there appeared to be some mistrust in the visitors undertaking tests, with some care home managers expressing concern that some visitors may lie about their test result or use someone else to take the test for them so that their visit could go ahead [28]. The staff surveyed as part of this pilot study were more confident if the LFD tests were being undertaken at the care home, where they could monitor the process and assure themselves that a visitor was negative for COVID-19, thereby reducing the risk of bringing infection into the care home [28].

“

I suspect if people tested positive and would still want to see their loved ones, they might lie about it or use someone else's negative test result. Manager (Provider group, residential) [28].

Visitor testing requirements negatively impacted staff. Care home staff felt that visitor testing added to the burden on staff [30]. The time taken to conduct testing for visits was reportedly underestimated when combined with the wait for the result and any related infection prevention and control measures, where 'a test that appears to take 30-min to generate a result could potentially take up to 3 h of a staff member's time', in contrast with the 10 to 30 minute average time to clean rooms pre-pandemic [25].

Care home managers felt that staff and visitors experienced confusion due to the frequent changes to visiting policy, leading to 'frequent calls and requests from visitors around changing guidance' [12]. Managers also felt that frequent changes in guidance did not allow homes sufficient time to prepare and obtain the correct equipment to support visits [12].

### 5.3.3.2 Barriers and facilitators to isolating

#### 5.3.3.2.1 Financial consequences of isolating

The financial implications when required to self-isolate were highlighted as potentially being a particular challenge for care assistants, who are on a low wage and may be financially vulnerable [25]. This may have impacted staff willingness to undertake a test, with a minority (8% of 651) of adult social care workers surveyed in April and May 2022 reporting that they 'could not' test positive as they could not afford to self-isolate/not work [21]. Financial support provided by local authorities could potentially support workers if they were required to self-isolate, however allocation differed across local authorities [27]. Care home staff were concerned about testing positive due to the financial consequences of having to isolate:

“

They expressed that fear, “I don’t want to be tested and I’ve got to go home and you’ll, you’ll make me stay off work and I’ll lose money”. And you know that they were really worried about that. (Participant 10) [25].

#### 5.3.3.2.2 Trust in the system

There was concern expressed by care home staff over the risk of false-positive results from LFDs causing staff members to self-isolate unnecessarily and resulting in reduced income [25].

“

I was quite reluctant because there was a 50/50 chance of a false positive. And so, I was a little bit concerned about that, if we’re going to have this test, and we got positive results, they’re going to have to isolate. I’m going to lose a lot of my staff ... I’m sending staff home and having to pull my hair out and bring down for agency staff or get to staff to cover them. (Participant 06) [25].

#### 5.3.3.2.3 Isolation of residents

The isolation of residents who had varying cognitive capacities or other impairments was identified as a challenge, such as residents with differing degrees of dementia [35] or mobility [36]; it was also highlighted that some residents often wished to isolate with their door open but other residents would sometimes wander into their rooms [37]. This was similarly noted in a systematic review of COVID-19 management in social care, which also pointed out that isolation can be distressing and have a negative impact on residents’ health and well-being [25].

Staff reported variation in testing and isolation protocols across care homes [29]. This was perceived to be caused by the diverse range of facilities and rooms available for testing and isolation between homes, where this variance was perceived to have ‘hindered the standardization and potentially affected adherence to the recommended protocol’ [30].

### 5.3.4 Stakeholder engagement

#### 5.3.4.1 Methodology

The key objectives of engaging with external stakeholders (who were quite close to the on-ground operations or policy/quality perspectives during the COVID-19 pandemic) were to discuss the initial findings of this evaluation and to test some of the emerging recommendations via semi-structured interviews. A further objective was to identify dependencies and test whether the proposed recommendations would help meet the intended testing objectives. Discussion guides were developed to support the semi-structured interviews.

Following receipt of relevant ethics approval, contact details were obtained from internal UKHSA stakeholders; an introductory email was sent to these contacts, along with a participant consent form. Similar interviews to discuss the recommendations were also undertaken with UKHSA stakeholders, who were our point of contact for the adult social care testing service. The results of these discussions informed the considerations and recommendations section in the adult social care chapter (chapter 5.6).

In total, we interviewed 10 individuals, across six sessions, from care home organisations, national care associations and UKHSA. All participants were actively involved in the sector during the pandemic. The sessions were conducted remotely (via Microsoft Teams), lasted approximately 60 minutes and, for transcribing purposes, were recorded. Each participant had provided a signed consent form and had verbally agreed to the recording. At the culmination of this evaluation, all recordings and transcripts will be deleted; any quotes used in this report have been anonymised.

These discussion sessions are summarised below. A finding is presented, followed by relevant insights from the stakeholders on how this manifested in their organisation. The recommendations arising from the evaluation were also tested with stakeholders, who were asked how feasible the recommendations would be to implement in their respective organisations. Where appropriate, relevant quotes have been included. While some of this information is already embedded within chapter 5, for the richness of this report, it has also been included in this appendix. Additional insights that arose from these discussions have also been included where relevant.

### 5.3.4.2 Key finding one: Repeated changes to the guidance were challenging, particularly those released at short notice

Stakeholders concurred that the guidance changed frequently and were critical of the timing of the release of such changes, which was often late in the evening or required implementation at short notice. This element had already been highlighted in discussions with internal UKHSA stakeholders as being an area that could have been handled better.

The external stakeholders made reference to the December 2021 guidance update as being particularly challenging to implement at short notice, given the proximity to Christmas.

Some providers advised that they updated their internal guidance and policies following government announcements, while other providers supported care home managers or association members by undertaking remote meetings to advise them of the changes; stakeholders noted that on some occasions it was challenging to see what had changed.

“

... they [care homes] were supposed to implement it immediately. How do you do that over Christmas?

“

That didn't allow providers time to digest the information and also to the practical implication implementation.

“

It would arrive at 7:00 o'clock, eight o'clock, sometimes 9:00 o'clock on a Friday night with the expectation that it would be in place by Monday morning and that was a real challenge.

“

... we would amend our own policies in line with the constant changing of government guidance.

These findings imply, as noted in our recommendations, that any changes to guidance should be minimal, to allow all providers and organisations the opportunity to implement them.

#### 5.3.4.2.1 Sub-theme finding 1: Stakeholders who were part of the pilot studies for testing felt that they had a voice in relation to policy changes

Some of the stakeholders we spoke to were part of the cohort that supported the pilot studies for testing. They largely found this to be beneficial, as they felt that they had a voice that was more listened to during the calmer periods of the pandemic. The stakeholders involved in the pilot studies were at the very least aware of upcoming changes to the guidance. The stakeholders highlighted that they were able to present policy- and decision-makers with direct, frontline experience:

“

Signposted what was likely to be coming down the line....

“

... we did have a voice. We were part of the conversation. We did get an opportunity to influence and at times comment on policy changes coming down the track.

“

... whenever there was a crisis...that collaborative approach went out the window and things tended to be changed overnight without any proper consultation.

“

... it doesn't mean they always got it right...but they got better at doing it.

“

... you actually felt more involved, and you were able to influence some policy and some guidance updates.

Nevertheless, they were mindful that other providers, who were not involved, may have found the changes more challenging to deal with:

“

I do wonder how that would have failed for small providers that weren't part of that process, that were then just picking up the press release...the news story and then the guidance coming and trying to make sense of that.

#### 5.3.4.2.2 Sub-theme finding 2: Guidance changes that vary across devolved nations can be difficult for providers to manage

Although this evaluation was specifically related to the testing programme in England, some stakeholders highlighted the challenges that they had when testing programmes, isolation requirements or guidance for the wearing of PPE differed across the nations:

“

... there's got to be a much better correlation across the whole country ... that was the biggest pain for us across the board ... we had homes in Scotland, Wales, England and Jersey – not one set of guidance ever, ever, ever matched ... and if you didn't keep up with it, suddenly we have stuff going on in Scotland, we stopped wearing masks and stopped testing in Scotland and Wales far quicker than we did in England ... I think there's got to be a whole country, a whole nation approach to this ... we actually had four sets of policy about absolutely everything ... we need one policy across the whole of the UK, in my view.

“

... we've had to write three lots of different guidance every time it changes. So we've got one Scotland, one for England, one for Wales.

“

... have to continually remind ourselves to remember whether this does or doesn't apply to our Scottish or Welsh colleagues and if not, what do we need to do in relation to that to make sure that they didn't feel forgotten or not valued ...

“

Scotland was much further ahead of England on pretty much for most of the pandemic ... the risk assessed approach about masks in Scotland came about six months earlier than it did in England.

The variation in guidance and support across the nations appears to have been more acutely felt with respect to isolation payments and other financial incentives:

“

... it really impacted were things like the financial incentives ... I think it was £1000 for all of the social care staff in Welsh care homes and there was a similar retention incentive in Scotland and that's quite galling as an organisation ... essentially, it feels as if different colleagues are in the same job, are being valued in different ways, so that can be challenging.

“

Where we got funding in all three countries, then obviously we gave that funding to colleagues, but when it stopped, we did, we couldn't possibly afford to keep paying people full pay and they are still paying it in Scotland interestingly nowhere else.

“

... in terms of bonus payments to frontline workers to allow them to self-isolate, Scotland was a lot more generous.

#### 5.3.4.2.3 Sub-theme finding 3: Testing was not rolled out simultaneously across the sector

Although the evaluation consortium initially sought to review the testing service across all of adult social care, as noted in chapter 5.3, the testing in care homes became the focus of this evaluation consortium.

In the semi-structured interviews, the stakeholders did highlight that the sector caters for other individuals who are as vulnerable as residents of care homes but that they (according to the stakeholders) were forgotten about:

“

... there's a whole gulf of testing support for people who were not a registered care home and that would merit some focus.

“

The learning disability sector was completely let down.

“

I don't think there was a huge amount of understanding about the diversity of our sector.

“

... significant numbers of vulnerable older people, many of whom are in receipt of care and are in lots of ways akin to a residential care home...we really struggled to get them into the testing regime...we ended up with was again a two-tier system in adult social care where lots of people in retirement living [were] unable to get access to testing for them or staff coming in.

“

... knowing where services are, knowing the numbers of people in those services.

“

... it's about making sure that the whole sector's taken into account. I know that some parts of the sector felt the poor relations, whether it was the learning disability [LD] or carers, people who are at home carers...you need to look at the whole sector, not just the care homes, and think why was there a differentiation because at the end of the day these are all vulnerable people, they all needed the same attention.

#### 5.3.4.2.4 Feasibility of the recommendation feasibility for high-testing intensity

One of the recommendations that the evaluation consortium sought to test with the stakeholders was the combination of a high-intensity testing strategy for those working with or who are themselves high-risk individuals with a reduction in the number of changes to the guidance. External stakeholders were questioned whether there was an appetite within the sector, and whether it was feasible, any future pandemic for a high-intensity testing strategy (e.g., daily testing) would be acceptable, to minimise guidance changes and require only individuals who tested positive to isolate.

In general, it was felt that such a strategy, based on current testing availability, would be difficult to implement with vulnerable individuals (particularly those with dementia), but may be feasible if the test was minimally invasive. Daily testing was also noted by the stakeholders as being difficult to implement operationally, with some querying how such a strategy would be implemented:

“

... doing [theoretical] PCR testing everyday, that would be a complete nonstarter.

“

I also would ask what the value of doing LFD testing is everyday.

“

... daily is a very intimidating prospect.

If testing was to focus on staff and not residents, while having a positive impact on residents, there was more consensus among the stakeholders as being something that could be implemented, but the risk of testing fatigue was noted.

“

Very quickly would get people fatigued and fed up.

“

... at that stage testing becomes onerous [asymptomatic testing and people not needing hospital treatment].

Any high-intensity testing regimen that has a considerable impact on the sector would, according to the external and UKHSA stakeholders, require clear parameters and indicators, including what the benefits are:

“

I think people could do a daily test and it would if it was couched as helping to prevent lockdown.

“

What is the benefit for the resident?...if daily testing mitigated against the impact on residents, then I think staff would.

“

... about there being a really clear rationale and people understand why they're doing it and for whose benefit they're doing it for.

“

Are you testing to protect, or are you testing to treat?

“

You'd have to think about the support framework that was in place to enable settings to deliver it.

When discussed with UKHSA stakeholders, they also noted that such a testing strategy for the sector would be dependent on elements such as funding, the testing technology available and, crucially, the epidemiology of the disease, its incubation period etc.

### 5.3.4.3 Key finding two: Policies varied between the adult social care and healthcare sectors

As detailed in our recommendation section in chapter 5, the policies for adult social care differed to those issued for healthcare. Some of the external stakeholders recognised that the policies were based on risk but noted that it was difficult to consolidate the differing policies when both sectors were providing services to vulnerable individuals:

“

... there were periods where bits of guidance were either lessened for the NHS first but not in social care. It was communicated to social care were slightly different.

“

You have to make sure that the NHS and social care operate the same way.

“

... the prevailing view is that the NHS is better.

“

... you need to ... align guidance to the highest standard, not to the lowest standard.

#### 5.3.4.3.1 Sub-theme finding 1: There was particular anger at the lack of testing at the start of the pandemic

Although the discussions with stakeholders were focused on the evaluation period of October 2020 to March 2022, there were sentiments expressed that related to the lack of testing at the onset of the pandemic, in particular the discharging of individuals from hospitals to care homes with no prior testing and the fact that subsequent reports have suggested this had little impact on the introduction of infections into care homes:

“

... you would choose to dispatch somebody from hospital to a residential care setting without being really clear about their COVID status ... that it was fine in the circumstances because it never was and it never will be.

“

... they tried to make the case that basically that hospital transmission into care homes wasn't the main route of transmission ... the problem with that finding is that there wasn't enough testing at the start a couple months and even towards the end of 2020 to be able to make such a conclusion.

“

I accept that transmission into care homes was probably via the community because that's where the transmission was. But there was no need to make that policy decision ... It will not have been the fundamental seeding of all infections into care homes, but they made that policy decision and then they tried to defend it and it's indefensible.

“

... we saved a huge number of people despite the fact that people came out untested out of hospitals.

“

... the primary thing that happened in this pandemic that shouldn't have happened was the accelerated hospital discharges ... it is quite difficult to get the evidence and there is no evidence because no one was doing testing at the time.

“

... people being delivered to care homes really without any sort of prior warning or phone ahead or without accurate sort of testing results, which was always very concerning and, it just kept happening and during crisis.



#### 5.3.4.3.2 Sub-finding theme 2: Care homes were confronted with health professionals who would not provide proof of test results

One of the findings that arose from the stakeholder discussions was that some care homes experienced resistance from NHS colleagues to take a test or show proof of a negative test prior to entering a care home:

“

Particularly from the ambulance teams coming and basically so you know the best examples are NHS colleagues turning up to care homes wanting to go in but refusing to show a negative test because they didn't feel they had to.

“

... we had an absolute battle in our hands with the healthcare professionals, NHS staff, not wanting to be tested, even though the rules were: you come into a care home — you get tested.

“

... we had GPs who would walk through the door and go “I'm not testing.”

“

... but we also have the similar argument with the CQC. So, the regulator didn't seem to think that the regulator needed to provide proof of a negative test to go into a care setting for some reason.

“

... they weren't isolated incidents of other healthcare professionals come into us and not having tested.

“

... you give clarity to healthcare professionals that they're going into a different environment, a different regulatory environment and they need to comply with the rules and regulations associated with that environment.

#### 5.3.4.3.3 Sub-finding theme 3: Reducing testing requirements for visitors when staff were required to continue testing was viewed negatively

As with testing requirements for NHS staff, the external stakeholders noted that changes in testing guidance for visitors (e.g., they no longer needed to test) seemed contradictory when staff were still required to test. They further noted that staff and visitors alike are based in the community, so there was an equal risk of transmission. This fed into the sentiment that care workers are viewed differently to the public or the NHS.

“

... we continue to test staff, but stop testing visitors all of a sudden ... what's the point? You've just kind of taken this ... clear protection and pierced holes all over it.

“

... process of dropping of testing for visitors, well before we stopped testing for staff — absolutely ridiculous!

#### 5.3.4.4 Key finding three: Better-rated CQC homes had higher testing reporting rates and managed outbreaks better than poorer rated care homes

Our analysis has shown that care homes with poorer CQC ratings were associated with reporting fewer test results and discovering outbreaks when they were larger in size. However, there was no correlation between a care home's rating and mortality levels among its residents. Therefore, we sought to explore with stakeholders whether testing guidance in the future should consider CQC rating and how feasible this would be to implement.

A CQC rating is made across five separate domains [38]. A study in Liverpool noted that care homes with a rating of 'poor' in the 'responsive' domain had more outbreaks [39]. A CQC rating is made across five separate domains [38]. A study in Liverpool noted that care homes with a rating of 'poor' in the 'responsive' domain had more outbreaks [39]. Furthermore, a rating is retained by a care home until their next inspection; this can often be a number of years and, during the early stages of the pandemic, inspections ceased [40]. When discussed with stakeholders of care home organisations, they felt that poorer-rated homes often had issues in the 'well-led' or 'safe' domains and tended to struggle more with staffing and were thereby more reliant on agency staff; however, the respondents were extremely cautious and hesitant about guidance being tailored to poorer-rated homes. The larger organisations we

spoke to advised that they had not noticed any differences in reported testing, outbreaks or mortality in their care homes based on their CQC rating. They also noted that were the guidance to be different for homes with different CQC ratings, it would be more challenging to implement.

Nevertheless, our findings demonstrate that consideration should be given (either by the CQC, care providers or local authorities) as to how care homes may be provided with additional support to mitigate the risk of outbreaks being of a larger size when discovered.

#### **5.3.4.4.1 Feasibility of the recommendation feasibility for different guidance based on CQC ratings**

The consensus among stakeholders we spoke to was that providing more targeted or specific guidance to testing based on CQC ratings would not be an approach that would work for the sector. As we have highlighted, there are nuances surrounding a CQC rating, including the domains assessed and the length of time since the last inspection – both of these points were also raised by the stakeholders:

“

If we're going to be doing that approach, we need to have a look at the wider system as to why those care homes are getting those ratings, because it isn't always in the provider's gift for the ratings that they get ...

“

I think actually implementing a set of guidance that varies depending on the care home rating is really, really challenging ... Reason for a poorer rating is then you can understand what the support needs to be.

“

I just think it's not workable. I think the correlation needs to be with the areas of weakness, not the rating. And they're not the same.

“

... hadn't been inspected for two years and had requires improvement would be unfairly penalised under any system like thatm ... why would you treat somebody who is requires improvement differently to somebody who is outstanding because we're all mapping against the same regulations.

“

Service requires improvement services are not usually about the staff, it's about management, it's about, it's about leadership. If you've got a good leader in a service, you will get the right results, even if the building is falling down around your ears, the quality of the service will be based around that leadership model.

“

... you'd need to focus in on homes that were challenged in either the safer or well-led domains rather than the other three ...

“

... it depends on what the what the domain is and the areas of concern are...they may not necessarily be about reporting and leadership ... so that doesn't determine that they won't be good at capturing and reporting.

The stakeholders noted that within their organisations, poorer performing homes were known about, and their poorer performance was generally related to a number of factors, including greater use of agency staff, staff continuity, and having a registered manager who is not as effective as they could be. Conversely, the stakeholders also noted that a care home rated as 'good' may be very strong in implementing infection control measures, but in doing so they may have less time to report test results. They also raised concern about how such guidance could be implemented within their organisation given the spread of ratings among their respective care homes:

“

I think it would be very difficult for large providers to think about how they would then implement and an internal policy and an internal compliance regime that.

“

[A national provider] they'll have a spread of ratings. Can you imagine trying to implement with your staff across something that's different for outstanding versus good versus requires improvement? ... you'd have to write three lots of guidance and training and implementation and then try and remember which one applies to which home at which time.

“

... we would think about where's our weakest managers and where do we need to provide support.

Were such an approach be considered in the future, the stakeholders identified that the mechanism should adopt a supportive lens and not an approach that is deemed to highlight a care home's poor rating, with one stakeholder suggesting that support could include the regulator providing a care home with personnel in instances where they are struggling with staff:

“

... what is the additional support we can give them to ensure that the reporting is accurate?

“

... if it's a stick method ... for whatever reason ... it isn't going to fix the problem. It's going to punish them.

“

... you have to be clear about what support means to a [poorer rated] care home ... it doesn't come forward as support quite often.

“

If you don't have any staff and you can't get staff from somewhere, you've got, you've gotta do things slightly differently, so support would have to be as in bringing bodies into the home that can help rather than criticise what's happening ...

In summary, CQC ratings appear to have had some correlation with reported testing intensities and the ability to identify smaller COVID-19 outbreaks. However, as discussed above and in chapter 5.3.6, a rating is multi-factorial and due to the length of time since the previous inspection, may not be a true representation of the daily workings of a care home. Our findings highlight the scope for further research to determine how additional support may best be provided in the future, beyond bespoke guidance that is tailored to an overall CQC rating alone.

#### **5.3.4.5 Key finding four: Some care homes spread PCR testing of residents throughout the month**

Our findings in chapter 5.3.4 indicate that of the nine largest care homes analysed, the PCR testing regimen was mostly undertaken using a one test per month approach, with a few appearing to show variations in their testing pattern that was not as cyclical.

The guidance for monthly asymptomatic testing was not prescriptive as to how this should be implemented, beyond the requirement for each resident to be tested every 28 days.

##### **5.3.4.5.1 Feasibility of the recommendation for spreading resident testing throughout over the month**

We explored with the stakeholders whether future guidance should suggest spreading out resident testing, for example whether testing 25% of the resident population every week would be feasible for their respective organisations, given the evidence that conducting and registering a test and the logistics associated with testing were time-consuming and created a considerable workload.

Some of the care home organisations we spoke to advised that they undertook testing over a one- or two-day period and this became a 'business as usual' type of operation. It was also seen as a way to provide specific insights into the impact of the infection at that specific moment:

“

We had a testing day and that was what we were focused on.

“

Tells you what's going on in that resident population at that time.

“

... managers were on a roll. I think it feels it's difficult at first, but once you get into a system and a role on it then I think it becomes part of business as usual.

There was a recognition by the stakeholders that for other care homes – depending on their environmental layout or service users – such an approach could be considered:

“

The size of the care home will really impact on how easy it is to test ... if you're a largely dementia care specialist, it's going to be a lot more time consuming than it would be perhaps in another setting ...

“

If you're running one of the multi-site homes and you've got four separate houses, then I think it would be appropriate for them to do it separately. But if you're not, if it's just one home, they really should be all done at the same time.

“

When the experts in infection control and kind of epidemiology would explain to you the rationale, then you can really understand it and you can think about how to apply it.

“

The benefits or options for future guidance to provide option would be beneficial if providing the evidence and rationale behind the options.

“

[guidance suggestions] ... here are a number of good practice examples about how you can do this. Here's the data backing up why it's good to do this ... is there any data to indicate whether doing it 100% of your residents all at once versus 25% of the time is any better?

“

... it's kind of helping people to understand the philosophy behind the testing and how to apply that philosophy to their setting.

The above findings can be linked to the recommendation around guidance, in that it must be clear and have an evidence-based rationale. Alongside suggestions of best practice, this would likely support the ease of implementation of testing in future pandemics.

#### 5.3.4.6 Key finding five: A lack of reporting of results

As noted in chapter 5.3, there was a considerable discrepancy between the numbers of tests distributed and the numbers of tests reported. This was more noticeable with LFD test results, as the reporting of results involved a self-reporting mechanism, whereas a PCR test had to be registered for a result (analysed by a laboratory) to be received by the individual.

Our rapid literature review showed that, for some, the potential loss of income may have been a barrier to reporting test results. This was queried with the external stakeholders, who suggested that in their organisations, and up until the funding from central government ended, staff continued to receive their pay during instances of self-isolation. However, staff's potential loss of income may have been a factor among those who did not receive their full pay:

“

... fear of getting positive tests, reporting that test. Because then that the implications that has on pay and statutory sick pay.

In conversations with internal UKHSA stakeholders, they raised the issue that despite the move away from the manual uploading of spreadsheets, the gov.uk portal continued to present (in their view) too many steps to facilitate the easy recording of results. The external stakeholders also highlighted the amount of work associated with reporting:

“

... people employed people to just do the testing, the ordering, the testing, the logging, the reporting, the follow up.

##### 5.3.4.6.1 Sub-theme finding 1: Staff were more likely to report positive tests only

Our findings suggest that staff were more likely to report a positive result than a negative one:

“

... it's a process that has to be done and sometimes people missed the reporting bit of the process because they didn't view that as the important bit unless they were positive.

“

... you probably wouldn't report a negative as much because you think I'll be fine. I've, you know, I'm negative. I can go and work.

“

I think they just didn't see the value.

#### 5.3.4.6.2 Sub-theme finding 2: Larger organisations implemented internal measures to ensure that reporting was undertaken

Some of the external stakeholders mentioned that as an organisation they set up additional reporting measures, such as an app, with staff required to report their result there as well as via the government channel, or they ensured that two email addresses were inputted, enabling the result to be returned to the individual and to the organisation.

Other providers stated that the message that reporting was required was backed up by their chief executive. Furthermore, stakeholders from larger care home organisations advised that they received reports from DHSC that allowed them to analyse their actual reported numbers of tests versus expected numbers of reported tests. In both cases, this allowed the providers to identify care homes whose reporting was below expected levels; the organisation then provided support accordingly.

#### 5.3.4.6.3 Sub-theme finding 3: A lack of reporting may have been impacted by resources

External stakeholders stated that, in some instances, results may have been reported by staff members to a care home manager or administrator, which did not always translate to the results being uploaded as required. The amount of reporting by care homes was not just about results as they had additional reporting such as capacity tracker to complete. This, alongside the day-to-day workload, may have impacted the amount of reporting that they undertook:

“

... it was capacity, tracker, completion ... it was monitoring the PPE ... we had endless, ridiculous demands on us ... all the time.

“

... that often happened when there wasn't an administrator in the home and they just hadn't been logged.

“

For registered manager it could take hours to fill those blooming forms.

“

We used to have to register every individual separately ... So you would be doing 150 entries. It's line by line.

“

... the inconsistency on the reporting I would put down specifically to the level of intensity ... if they couldn't get the admin supporting ... it was easier not to do it.

#### 5.3.4.6.4 Feasibility recommendation to simplify reporting process

As noted in our recommendations, a simple registration and reporting process, built on existing infrastructure, would go some way to reducing the gap between tests distributed and reported. This could also be used to link with indicators and help to obtain a complete picture of infection levels. As the stakeholders noted:

“

... the system's not very supportive.

“

The point of the registration ... you need to make it as easy as a Facebook or an Amazon type interaction ... if we can make it so easy for people to do the right thing, they will ...

“

... you can imagine an app where you ... scan ... done.

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## 5.4 Statistical methods

### 5.4.1 Data

We used a regression modelling approach to empirically probe mechanisms by which changes in testing influence positive test results, which in turn influence deaths. We also used a separate regression approach to explore the factors influencing the level of reported tests. In all of the ensuing analyses, we considered only those care homes monitored by the CQC: to determine this, we downloaded the CQC care directory with filters [1] for each month during the evaluation period and used the unique list of 15,833 care homes as our reference set. Of these, we were able to match 14,805 care homes with testing, COVID-19-related deaths data and the various other sources of data, and it is for this set that all results below are reported (although care homes may have been idiosyncratically dropped from regressions if we were missing data for variables included in these).

As noted in chapter 5, for the purpose of this evaluation, reported PCR indicates the number of tests analysed by the laboratory with the subsequent result available and linked to the individual. For care homes, PCR tests were required to be registered against a care home UON.

The above indicates that approximately 1000 care homes on the CQC register were not matched to data. This may mean that the tests were not recorded/registered in the manner needed, the identifiers required for matching had errors or the directory was not up to date.

Further information regarding the steps we undertook to process and combine the raw data sources can be found in the 'Further methodological details' section.

In Table 1, we summarise the composition of care homes within our dataset. This shows that the vast majority (>75%) of care homes were CQC-rated as 'good'. Care homes whose primary clients were older people ( $\geq 65$  years), who had learning disabilities or who had dementia accounted for more than 88% of the organisations in our dataset. We had just ten organisations listed as independent organisations in our dataset (with the majority listed as 'social care organisations'). A substantial proportion of care homes were nursing homes (>28%).

The CQC ratings we used were the latest recorded ratings for each care home. This could cause issues with causally linking CQC rating with the outcomes we consider if care homes' ratings were changed in response to their performance during the pandemic. However, the CQC suspended the rating of providers or locations throughout the pandemic, and we conducted sensitivity analyses to investigate this further.

**Table 1. Characteristics of modelled care homes.** Note that some categories may overlap, resulting in aggregate counts exceeding the total count.

Variable	Count
Num. observations	1,154,790
Num. care homes	14,805
Num. weeks	78
Num. LTLAs	307
CQC: inadequate	302
CQC: requires improvement	2421
CQC: good	11,197
CQC: outstanding	634
CQC: null or unrated	251
Primary client: older people (65+ years)	7020
Primary client: learning disability	4233
Primary client: dementia	1881
Primary client: mental health	917
Primary client: physical disabilities	269
Primary client: other	485
Type: social care organisation	14,604
Type: independent	10
Type: other	191
Nursing home	4175
Residential home	10,457
Acute home	2
Community home	522

In Table 2, we show summaries of the data at the care home level across all 14,805 care homes included in our analyses across the entire evaluation period. This illustrates the high levels of heterogeneity across the care homes; for example, the median number of total COVID-19-related deaths (= sum of confirmed and suspected COVID-19-related deaths) was 0, with one care home having 41 deaths. There was similar variation in the numbers of positive tests, although the majority of care homes experienced some positive test results throughout the evaluation period. There were a few care homes that reported no tests in residents and/or staff throughout the evaluation period, but the majority included in our dataset did report some test results.

**Table 2: Care home-level summaries of key variables used in modelling.** Each column shows summaries across all 14,805 care homes used in this analysis across the whole evaluation period (October 2020 to March 2022). If observations were missing or incomputable (e.g., if they involved division by zero), they were dropped from the summary. Test intensity refers to the number of tests performed in a week per member of a particular group (e.g., residents or staff).

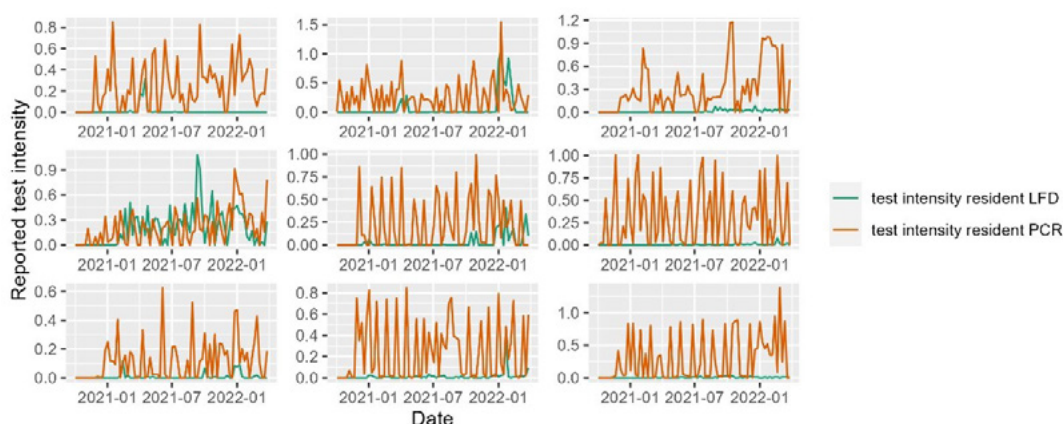
Variable	Min	25% quant.	Median	Mean	75% quant.	Max
Total deaths	0.0	0.0	0.0	1.6	2.0	41.0
Confirmed deaths	0.0	0.0	0.0	1.4	1.0	40.0
Suspected deaths	0.0	0.0	0.0	0.2	0.0	13.0
Num. positives in residents	0.0	2.0	8.0	13.9	21.0	166.0
Num. positives in staff	0.0	9.0	19.0	26.4	36.0	464.0
Num. positives by PCR	0.0	7.0	18.0	26.4	38.0	280.0
Num. positives by LFD	0.0	3.0	8.0	13.8	19.0	329.0
Num. tests by PCR	0.0	800.0	1656.0	2143.9	2954.0	34,464.0
Num. tests by LFD	0.0	590.0	1416.0	2167.4	2950.0	43,395.0
Num. tests in residents	0.0	157.0	423.0	569.2	800.0	6666.0
Num. tests in staff	0.0	1320.0	2701.0	3742.1	5048.0	77,748.0
Test intensity: resident	0.0	0.2	0.3	0.3	0.4	13.8
Test intensity: staff	0.0	1.3	2.1	2.7	3.2	185.1
Test intensity: PCR	0.0	0.9	1.2	1.4	1.7	64.5
Test intensity: LFD	0.0	0.6	1.2	1.6	2.0	133.7
Total residents	0.1	7.8	19.3	23.3	33.4	152.2
Care workers	0.0	13.0	20.2	24.9	31.3	437.0

## 5.4.2 Average tests per member of care homes per week

To understand the variation in reported testing patterns at the care home level, in the following plots, we illustrate how resident and staff testing across both PCR and LFD tests varied throughout the course of the evaluation period for the nine largest care homes (selected to reduce noise in the patterns).

In Figure 1, we show test intensity in residents across LFD (green) and PCR (orange) test types for these nine care homes (we do not show any identifiers to avoid identification of individual care homes). In the majority of instances, the testing intensity (number of tests reported per week divided by the population of interest) of LFDs was substantially below that of PCRs and more sporadic.

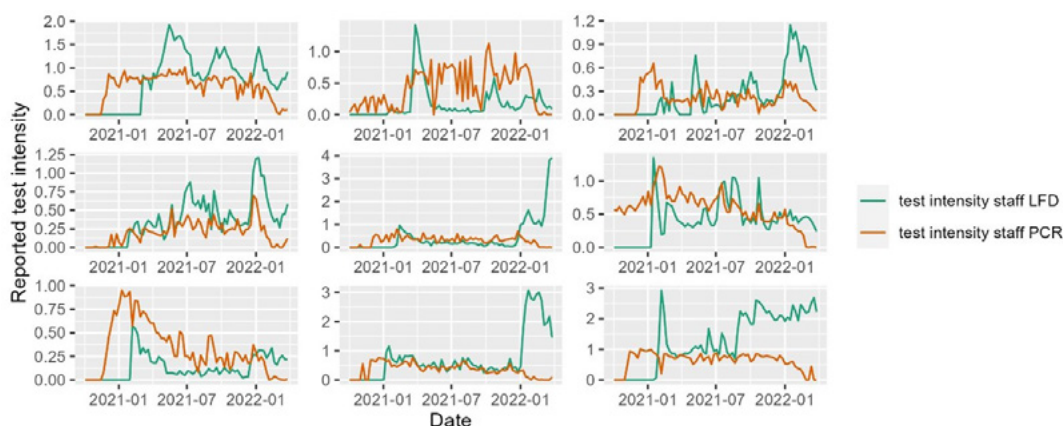
Reported test results for PCRs often displayed a more cyclic pattern of variation with, as the regression results below suggest, a monthly periodicity: presumably representing all/the majority of residents in a care home being tested that week. There were, however, care homes that did not visibly adhere to such a regular testing schedule and, more generally, there was substantial variation in reported resident PCR testing patterns across care homes. These general trends in testing visibly held for small- and mid-sized care homes (please refer to additional results section within this appendix).



**Figure 1. Example of reported LFD and PCR test intensities among residents in large care homes.**

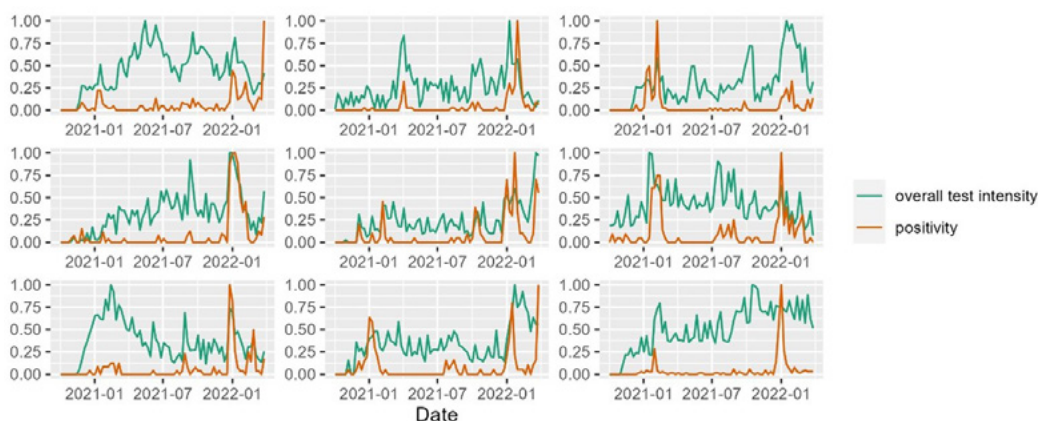
These nine care homes were the nine largest care homes according to the mean total resident count.

In Figure 2, we show the reported test intensities for staff for PCR and LFD tests in the same nine care homes. Reported PCR tests were generally more stable and consistent in staff than for residents, and LFD testing was more regular, albeit with step changes in testing that were possibly associated with changes in recommended testing practices or outbreaks.



**Figure 2. Example of reported LFD and PCR test intensities among staff in large care homes.** These nine care homes were the nine largest care homes according to the mean total resident count.

In Figure 3, we show overall reported testing intensity and overlay the test positivity rate (both variables scaled by dividing the series through by their maxima for each respective care home) in the same nine care homes. In a number of care homes, testing intensity appeared to change rapidly, coincident with/following increases in testing positivity, likely illustrating the enactment of outbreak testing.



**Figure 3. Example of overall reported test intensity and test positivity in large care homes.** Overall test intensity represents the sum of test intensities across resident PCR and LFD testing and staff PCR and LFD testing. Test positivity represents overall test positivity across resident PCR and LFD testing and staff PCR and LFD testing. These care homes were the nine largest care homes according to the mean total resident count. Note that for each care home, the overall test intensity and positivity have been scaled relative to their maxima to aid visual comparison of the two series.

To examine further the factors associated with changes in test reporting intensity, we performed a series of regression analyses: one regression for each of resident PCR, resident LFD, staff PCR and staff LFD. These regressions contained a range of time-varying (e.g., past test intensities and positivity rates) and time-invariant characteristics (e.g., CQC rating and whether a care home was a nursing home). These models were linear regressions with dependent variables given by the corresponding reported testing intensity in a week in a given care home.

In Table 3, we show the results for the resident test intensities for PCR tests (regression (1)) and LFD tests (regression (2)). As illustrated in the above graphs, the temporal patterns in each of these test types were found to be distinct. Whereas LFD testing reporting on a given day was strongly positively correlated with that in the previous week (and the week before), the strongest correlation for PCR test reporting was for the levels of test reporting 4 weeks prior. This further illustrated the monthly periodic pattern shown in Figure 1 for resident PCR test intensities versus the more isolated and transient waves of higher activity for LFDs.

The R2 statistic was considerably lower for the resident PCR regression than for the LFD equivalent, with only around 16% of overall variation reporting intensity explained by the model versus around 39% for the LFD model. This is largely illustrative of the more idiosyncratic test reporting for resident PCR testing that occurred at the care home level and indicates that LFD testing intensity was more predictable (from the specified regression).

The mean reported test intensities across the evaluation period were approximately 0.26 reported tests per resident for PCR and 0.06 per resident for LFD tests (both of these are weekly measures). In both regressions, having a higher average number of positive results per care home member (e.g., across both residents and staff) in the previous week was associated with large increases in the reported test intensity in the following week.

A one-unit change in the average number of positive results per care home member in the previous week was associated with an increase in PCR test reporting intensity of around 0.30, a value comparable to its underlying mean. Similar increases were estimated for LFDs, with a corresponding increase of 0.14. Both of these results are indicative of outbreak testing in care homes. An outbreak was defined as two or more positive (or clinically suspected), linked cases that occurred in the same setting within a 14-day period and that included PCR and LFD results.

These results illustrate the difficulty in determining how changes in testing affected cases, because naïve regressions of positive tests on reported test intensities uncovered a positive association due to the strong response of test intensities to the numbers of positives uncovered (see Table S1), a point to which we return in the next section.

PCR test intensities were positively associated with changes in the local level of prevalence (as measured by the estimated prevalence in the lower-tier local authority (LTLA) encompassing the care home), with increases in prevalence associated with (modest) increases in reported test intensity. This was not mirrored in the LFD test results, where the effect was not (at the 5% level) significantly different from zero.

The association between reported test intensity and CQC rating showed that better-rated care homes tended to have higher reported resident test intensities, with similar trends across both PCR and LFD tests. However, the changes in reported test intensity associated with differences in CQC rating were relatively minor.

Other effects tended to be modest and often of conflicting sign across the two regressions.

**Table 3. Regression results for reported resident PCR and resident LFD test intensities.** Both sets of regression results represent estimates for linear models fitted using ordinary least squares. The parentheses represent 95% confidence intervals for the coefficient estimates.

	Resident PCR testing intensity (1)	Resident LFD testing intensity (2)
Test intensity in residents PCR (lag=1)	0.043*** (0.041, 0.045)	0.008*** (0.007, 0.009)
Test intensity in residents PCR (lag=2)	0.053*** (0.051, 0.055)	
Test intensity in residents PCR (lag=3)	0.041*** (0.039, 0.043)	
Test intensity in residents PCR (lag=4)	0.283*** (0.281, 0.285)	
Test intensity in residents PCR (lag=5)	0.092*** (0.090, 0.094)	
Test intensity in residents LFD (lag=1)	0.046*** (0.043, 0.048)	0.442*** (0.440, 0.444)
Test intensity in residents LFD (lag=2)		0.119*** (0.117, 0.122)
Test intensity in residents LFD (lag=3)		0.047*** (0.044, 0.049)
Test intensity in residents LFD (lag=4)		0.067*** (0.065, 0.069)
Test intensity in residents LFD (lag=5)		0.075*** (0.073, 0.077)
Test intensity in staff PCR (lag=1)	0.042*** (0.042, 0.043)	-0.003*** (-0.003, -0.003)
Test intensity in staff LFD (lag=1)	-0.008*** (-0.009, -0.008)	0.003*** (0.003, 0.003)
Av. number of positives per care home member in previous week (staff and residents)	0.293*** (0.273, 0.314)	0.141*** (0.128, 0.153)



	Resident PCR testing intensity (1)	Resident LFD testing intensity (2)
CQC rating: requires improvement	0.013*** (0.006, 0.020)	0.003 (-0.001, 0.008)
CQC rating: good	0.017*** (0.010, 0.023)	0.007*** (0.002, 0.011)
CQC rating: outstanding	0.030*** (0.022, 0.038)	0.015*** (0.010, 0.020)
CQC rating: null	0.009 (-0.007, 0.025)	0.001 (-0.009, 0.011)
Is nursing home?	0.003** (0.0003, 0.005)	-0.002*** (-0.004, -0.001)
Is independent?	-0.081*** (-0.118, -0.044)	-0.018 (-0.042, 0.005)
Primary clients: older (65+ years) individuals	0.005*** (0.002, 0.008)	-0.010*** (-0.013, -0.008)
Primary clients: individuals with dementia	0.002 (-0.002, 0.007)	-0.010*** (-0.013, -0.008)
Primary clients: individuals with learning disabilities	-0.030*** (-0.033, -0.026)	0.005*** (0.003, 0.007)
Local proportion of Delta variant	0.025** (0.001, 0.050)	-0.008 (-0.024, 0.007)
Local proportion of Omicron variant	0.010 (-0.012, 0.031)	-0.001 (-0.015, 0.012)
Care workers per resident	0.010*** (0.009, 0.012)	-0.001* (-0.002, 0.0001)
Fraction of agency workers	-0.015*** (-0.020, -0.011)	-0.001 (-0.004, 0.002)
Local COVID-19 prevalence	0.900*** (0.676, 1.125)	-0.136* (-0.276, 0.004)
Is a community care home?	0.004 (-0.001, 0.009)	0.005*** (0.001, 0.008)
Is an acute care home?	-0.001 (-0.079, 0.077)	-0.019 (-0.067, 0.030)
Total resident count	0.0004*** (0.0003, 0.0005)	-0.0001*** (-0.0002, -0.0001)
Constant	0.041*** (0.030, 0.053)	0.005 (-0.002, 0.012)
Observations	1,007,126	1,007,126
R <sup>2</sup>	0.161	0.385
Note:	*p<0.1; **p<0.05; ***p<0.01	

In Table 4, we show the corresponding estimates for staff PCR and LFD reported test intensities. For both test types, the testing intensity exhibited strong positive autocorrelation with the previous weeks' test intensities. Also, for both test types, the models were substantially better able to explain the variation in test intensities versus the resident regressions, and the R<sup>2</sup> was above 0.6 for both regressions.

Counterintuitively, for both regressions, higher average numbers of positive results per care home member were associated with decreases in reported test intensity in the following week; it is unclear what mechanism drives this association.

As for the resident models, care homes that had better CQC ratings reported more tests per capita on average. This was most marked for LFD reporting, with care homes rated 'outstanding' had, on average, 0.1 additional tests per capita reported than those rated 'inadequate'. Independent care homes also had substantially higher levels of results registered for staff than other care homes, although we suggest caution in interpreting this result as we had very few such care homes in our dataset (Table 1).

In addition to the resident model above, we included four variables that aimed to capture the impact of key policy shifts for adult social care staff testing (as communicated by UKHSA) on reported staff testing intensity. Specifically, these were the following:

- ▶ **23 December 2020** – introduction of LFD testing in care homes: twice-weekly asymptomatic testing for staff and for all visitors and visiting professionals.
- ▶ **13 April 2021** – after the expansion of regular asymptomatic testing with PCR and/or LFD depending on the sector during the spring of 2021, by 13 April 2021 every social care worker in England had access to regular asymptomatic testing.



- ▶ **15 December 2021** – intensification from twice-weekly LFD testing to thrice-weekly LFD testing for staff in care homes and in high-risk extra care and supported living and day care centres in response to the threat posed by the Omicron variant over the winter.
- ▶ **16 February 2022** – intensification from thrice-weekly to daily LFD testing (also known as ‘testing before starting work each day’ or ‘pre-shift’), in response to the threat posed by peaks in the Omicron variant over the winter.

The variables included in our regressions to represent each of these four policy shifts were binary indicator variables: equal to 0 before the date of the change and equal to 1 afterwards. These indicators are useful for capturing rapid shifts in staff testing occurring immediately following policy updates, but less so if the effects of the policy change were realised more gradually. We included only the 13 April 2021 policy variable in our staff PCR regression, as this was the only policy change affecting staff PCR testing, and our models were unable to attribute changes in testing intensity with the advent of this policy.

For the staff LFD model, we included all four policy variables and found that, of these, the introduction of LFD testing in December 2020 was associated with an average increase in reported LFD test intensity of about 0.1 units; the move to daily (pre-shift) LFD testing in February 2022 was also associated with increased reported LFD testing intensity by about 0.25 units - a large increase relative to its mean. The other two policy changes were not associated with changes in staff testing intensity.

**Table 4. Regression results for reported staff PCR and staff LFD test intensities.** Both sets of regression results represent estimates for linear models fitted using ordinary least squares. The parentheses represent 95% confidence intervals for the coefficient estimates.

	<b>Resident PCR testing intensity (1)</b>	<b>Resident LFD testing intensity (2)</b>
Test intensity in staff PCR (lag=1)	<b>0.568***</b> (0.566, 0.570)	<b>0.144***</b> (0.142, 0.147)
Test intensity in staff PCR (lag=2)	<b>0.219***</b> (0.217, 0.221)	
Test intensity in staff PCR (lag=3)	<b>0.103***</b> (0.101, 0.106)	
Test intensity in staff PCR (lag=4)	<b>0.062***</b> (0.060, 0.064)	
Test intensity in staff PCR (lag=5)	<b>0.035***</b> (0.033, 0.037)	
Test intensity in staff LFD (lag=1)	<b>-0.038***</b> (-0.039, -0.037)	<b>0.538***</b> (0.536, 0.540)
Test intensity in staff LFD (lag=2)		<b>0.117***</b> (0.115, 0.120)
Test intensity in staff LFD (lag=3)		<b>0.099***</b> (0.097, 0.102)
Test intensity in staff LFD (lag=4)		<b>-0.036***</b> (-0.038, -0.034)
Test intensity in staff LFD (lag=5)		<b>0.162***</b> (0.160, 0.164)
Test intensity in resident PCR (lag=1)	<b>0.093***</b> (0.087, 0.098)	<b>0.021***</b> (0.014, 0.029)
Test intensity in resident LFD (lag=1)	<b>-0.006*</b> (-0.013, 0.0004)	<b>0.057***</b> (0.047, 0.066)
Av. number of positives per care home member in previous week (staff and residents)	<b>-1.893***</b> (-1.946, -1.840)	<b>-0.153***</b> (-0.226, -0.079)
CQC rating: requires improvement	<b>0.016*</b> (-0.003, 0.034)	<b>0.038***</b> (0.012, 0.063)
CQC rating: good	<b>0.028***</b> (0.010, 0.046)	<b>0.060***</b> (0.035, 0.084)
CQC rating: outstanding	<b>0.042***</b> (0.021, 0.063)	<b>0.100***</b> (0.071, 0.130)
CQC rating: null	<b>0.035*</b> (-0.007, 0.076)	<b>0.044</b> (-0.014, 0.101)
Is a nursing home?	<b>0.023***</b> (0.016, 0.029)	<b>0.015***</b> (0.006, 0.024)
Is independent?	<b>0.208***</b> (0.112, 0.303)	<b>0.399***</b> (0.267, 0.532)

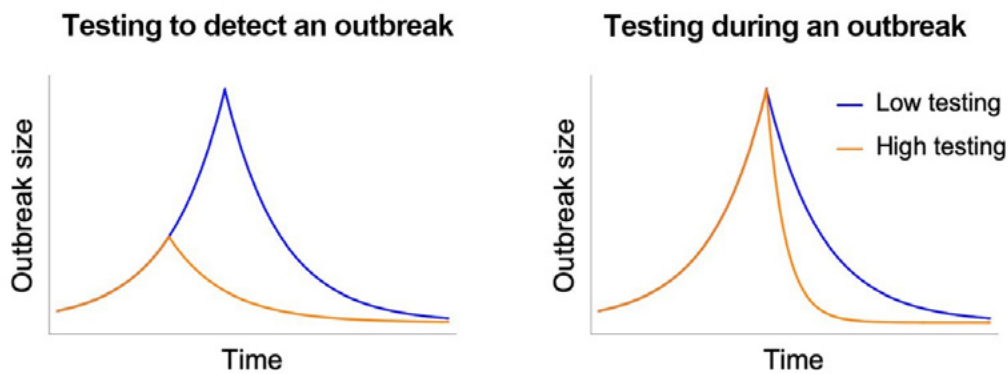
	Resident PCR testing intensity (1)	Resident LFD testing intensity (2)
Primary clients: older (65+ years) individuals	0.004 (-0.005, 0.012)	0.020*** (0.008, 0.032)
Primary clients: individuals with dementia	0.004 (-0.007, 0.015)	0.015** (0.0003, 0.030)
Primary clients: individuals with learning disabilities	0.013*** (0.004, 0.022)	0.039*** (0.027, 0.052)
Local proportion of Delta variant	-0.043 (-0.106, 0.021)	0.001 (-0.088, 0.089)
Local proportion of Omicron variant	0.035 (-0.021, 0.091)	-0.002 (-0.080, 0.076)
Care workers per resident	-0.029*** (-0.034, -0.024)	-0.037*** (-0.044, -0.030)
Fraction of agency workers	0.030*** (0.018, 0.042)	0.022** (0.005, 0.038)
Local COVID-19 prevalence	-0.213 (-0.793, 0.367)	1.132*** (0.325, 1.939)
Is a community care home?	0.006 (-0.008, 0.019)	-0.007 (-0.025, 0.012)
Is an acute care home?	-0.109 (-0.311, 0.092)	-0.178 (-0.458, 0.102)
Total resident count	-0.001*** (-0.001, -0.0004)	-0.001*** (-0.001, -0.0005)
Policy: weekly 2x LFD in staff on 23 December 2020		0.104*** (0.062, 0.146)
Policy: 13 April 2021	-0.029 (-0.082, 0.023)	0.029 (-0.013, 0.070)
Policy: weekly 3x LFD in staff on 15 December 2021		0.014 (-0.042, 0.071)
Policy: daily LFD testing in staff on 16 February 2022		0.251*** (0.205, 0.296)
Constant	0.162*** (0.133, 0.192)	-0.173*** (-0.214, -0.133)
Observations	1,007,126	1,007,126
R <sup>2</sup>	0.619	0.705
Note:	*p<0.1; **p<0.05; ***p<0.01	

### 5.4.3 Reduction in COVID-19 mortality at hypothetical testing rates

To estimate the impact of testing on COVID-19-related resident mortality in care homes, we assumed that the sole impact of testing on deaths was through its impact on COVID-19 cases:

- ▶ By testing staff and residents more frequently at higher coverages, this means outbreaks (or single, isolated cases) can be identified earlier (meaning that outbreaks are smaller – see the left-hand panel in Figure 4).
- ▶ Once an outbreak has been uncovered, higher testing coverages mean that cases can be identified earlier and isolated more effectively, resulting in faster reductions in cases (see the right-hand panel in Figure 4).

Through both of these mechanisms, higher testing coverages should lead to smaller outbreaks of COVID-19 in care homes and, in so doing, lead to a reduction in the number of deaths in residents (and staff). As we only had data for deaths in residents, we focus on this metric here; specifically we focus on total COVID-19-related deaths, equal to the sum of confirmed and suspected COVID-19-related deaths.



**Figure 4: Characterising the two pathways through which our models assume testing influences outbreak dynamics.** In the left-hand plot, we show that higher levels of testing mean that outbreaks are detected earlier, when they are smaller in size (leading to more rapid outbreak control). In the right-hand plot, we show that higher levels of testing during outbreaks leads to more rapid control of outbreaks.

In what follows, we examine positive counts in staff and residents that have been aggregated over reported LFD and PCR tests. It is important to note that we did not have access to unique positives (or unique tests), so we could not determine whether a given case count represents a single individual tested many times or many individuals tested once. While this complicated the interpretation, we were still able to associate changes in testing with changes in positive counts, and then from positive counts to deaths. Additionally, if we assume that the coverage of tests across individuals was, on average, similar across care homes and time, the results we obtained should qualitatively carry over to unique positives. However, repeating these analyses using unique positive counts would constitute useful further work.

#### 5.4.3.1 The association between testing and the size of outbreaks (measured by the number of positive tests) when they are discovered

We investigated how testing intensity in both residents and staff influenced the number of positive tests found in the following week for care homes not in outbreaks in the first week but which uncovered positives in the following week. These regressions took the general form:

$$X_{i,t+1} \sim \text{Poisson}(N_{i,t+1} \theta_{ltla[i],t} \exp(\alpha + \beta_r T_{i,t}^r + \beta_s T_{i,t}^s + \gamma Z_{i,t})),$$

where  $X_{i,t} > 0$  denotes the number of positive tests in care home  $i$  and week  $t$ , and  $N_{i,t} > 0$  denotes the corresponding number of tests conducted;  $0 \leq \theta_{ltla[i]} \leq 1$  denotes the estimated COVID-19 prevalence in the LTLA that encompasses care home  $i$ ;  $T_{i,t}^r$  and  $T_{i,t}^s$  denote the test intensities in residents and staff, respectively; and  $Z_{i,t}$  denotes a vector of additional covariates, including weekly time dummies that account for secular changes in the relationship between tests and positives over time across England. In what follows, we group PCR and LFD tests together for either residents or staff, as these regression results tended to be more stable (although we report results for these separately in our 'additional results' section).

A number of assumptions are inherent in the above equation: that when the local prevalence is zero, there can be no positives; this would be violated should visitors, residents or staff enter the care home from outside the LTLA; it would also be violated due to the presence of false-positive test results (most relevant for LFD tests).

Specifying a Poisson likelihood is a strong assumption: this was chosen because, while negative binomial regressions fit the data better, these models often suffered convergence issues and were numerically unstable. When the negative binomial regressions did converge, however, the odds ratios associated with testing were similar to those of the Poisson model. The above model does not include random intercepts for the individual care homes, as models doing so failed to converge.

The regression results for this model are shown in Table 5; regression (1) shows estimates when the dependent variable was the number of positive results in residents, while regression (2) shows estimates when number of positive results in staff was the dependent variable.

In both regressions, models incorporating diminishing returns from testing provided a more predictive fit to the data than those without it, so, in the results we present, we transformed these variables to account for this. The results of both regressions show that staff testing in the previous week was associated with smaller outbreaks in either residents or staff when they were initially uncovered - in

other words, the outbreaks were detected earlier. Testing in residents was not as strongly associated with the average initial outbreak size in residents and, for staff, had no association with the outcome. These general results broadly held across analyses involving different subsets of regressors (columns (1) and (2) in Tables S2 and S3). We also performed additional analyses where the test intensities were broken down into resident PCR, resident LFD, staff PCR and staff LFD (columns (3) and (4) in Tables S2 and S3). The initial outbreak size in residents was more strongly negatively associated with testing residents in the previous week via LFD than PCR (columns (3) and (4) in Table S2). The initial outbreak size in residents was also negatively associated with staff testing, either via LFD or PCR, with the magnitudes of these effect sizes similar across both test types (columns (3) and (4) in Table S2). The association between the initial outbreak size in staff and either type of resident testing was weak and sometimes of conflicting signs dependent on the regression specification (columns (3) and (4) in Table S3). Testing of staff via LFD was associated with smaller subsequent initial outbreak sizes in staff on average than testing with PCR. In both regressions, we considered the association of CQC rating of care homes with the size of initial outbreaks uncovered, and the base CQC rating to which all estimates are relative is 'inadequate'. Across both models, the general trends were that better-rated care homes tended to uncover smaller outbreaks. In 'outstanding' care homes, the initially detected outbreaks in residents were, on average, 22% smaller than in 'inadequate' care homes; the corresponding figure for staff outbreaks was 14%. These overall trends were qualitatively similar in regressions involving different sets of regressors (column (4) in Tables S2 and S3).

In both regressions, initial outbreaks found in nursing homes were typically smaller when compared with care homes supporting other residential cohorts. A number of time-invariant characteristics were estimated to have associations of conflicting signs across residents and staff (e.g., whether care homes were independent or served older people). However, care homes serving those with learning disabilities generally uncovered larger outbreaks in both staff and residents – likely meaning these outbreaks were detected later. During the Omicron phase, outbreaks also tended to be larger when initially discovered.

The COVID-19 prevalence coefficients are omitted in Table 5 to aid readability and indicated a strong negative association between testing intensity and prevalence. This reflects that there was a nonlinear association between prevalence and testing intensity (as this variable also appeared as an offset), where increases in prevalence have declining impacts as prevalence increases.

Care homes that were larger tended to have smaller outbreaks when they were initially discovered (the effect magnitude here is relatively large size, as it measures the proportional change in outbreak size for a one-person increase in total resident count). It is unclear, however, what mechanism drives this association.

The effect sizes associated with the vaccination variables were relatively small and may reflect the relatively imprecise measures to which we had access (see 'Vaccination information').

Across both models, having either a higher number of care home workers per resident or a higher fraction of agency workers was associated with larger initial outbreak sizes, although these effects were relatively modest.

**Table 5. Regression results for outbreak size upon discovery.** These results correspond to generalised linear models using a Poisson likelihood and a log-link function with an offset term as described in the text; coefficients and 95% confidence intervals are shown on the exponentiated scale. Estimates of the weekly time dummies and the COVID-19 prevalence effects were both suppressed for readability.

	<b>Resident PCR + LFD positive counts</b>	<b>Staff PCR + LFD positive counts</b>
log(0.1 + test intensity in residents (lag=1))	<b>0.926***</b> (0.916, 0.936)	<b>0.999</b> (0.994, 1.005)
log(0.1 + test intensity in staff (lag=1))	<b>0.745***</b> (0.736, 0.755)	<b>0.662***</b> (0.655, 0.668)
CQC rating: requires improvement	<b>0.990</b> (0.925, 1.056)	<b>0.998</b> (0.952, 1.044)
CQC rating: good	<b>0.904***</b> (0.840, 0.967)	<b>0.948**</b> (0.904, 0.993)
CQC rating: outstanding	<b>0.784***</b> (0.707, 0.861)	<b>0.857***</b> (0.807, 0.907)
CQC rating: null	<b>0.876*</b> (0.732, 1.020)	<b>0.935</b> (0.843, 1.028)
Is a nursing home?	<b>0.915***</b> (0.894, 0.936)	<b>0.939***</b> (0.926, 0.952)
Is an independent care home?	<b>1.036</b> (0.607, 1.465)	<b>1.070</b> (0.889, 1.251)

	<b>Resident PCR + LFD positive counts</b>	<b>Staff PCR + LFD positive counts</b>
Primary clients: older (65+ years) individuals	<b>1.196***</b> (1.159, 1.233)	<b>0.888***</b> (0.868, 0.909)
Primary clients: individuals with dementia	<b>1.251***</b> (1.210, 1.292)	<b>0.929***</b> (0.905, 0.952)
Primary clients: individuals with learning disabilities	<b>1.246***</b> (1.202, 1.290)	<b>1.199***</b> (1.176, 1.222)
Local proportion of Delta variant	<b>1.285</b> (0.698, 1.872)	<b>0.999</b> (0.743, 1.256)
Local proportion of Omicron variant	<b>1.350***</b> (1.197, 1.504)	<b>1.319***</b> (1.223, 1.414)
log (care workers per resident)	<b>1.037***</b> (1.012, 1.063)	<b>1.031***</b> (1.017, 1.045)
Fraction of agency workers	<b>1.077***</b> (1.042, 1.112)	<b>1.071***</b> (1.040, 1.101)
Is a community care home?	<b>0.983</b> (0.930, 1.036)	<b>0.937***</b> (0.909, 0.966)
Is an acute care home?	<b>2.233**</b> (1.491, 2.975)	<b>1.308</b> (0.858, 1.759)
Average number of all vaccine doses per resident	<b>0.990***</b> (0.986, 0.994)	<b>1.001***</b> (1.000, 1.001)
Average number of all vaccine doses per resident	<b>0.993***</b> (0.990, 0.996)	<b>0.988***</b> (0.986, 0.990)
Total resident count	<b>0.981***</b> (0.980, 0.982)	<b>0.980***</b> (0.980, 0.981)
Constant	<b>7.922***</b> (7.777, 8.066)	<b>13.611***</b> (13.527, 13.695)
Observations	64,642	93,485
Note:	*p<0.1; **p<0.05; ***p<0.01	

By conducting an ANOVA analysis on the deviance scores of the regressions shown in Table 5, we were able to approximate the relative contributions of each variable to the overall predictive accuracy of the models, as each variable is added to the regression in turn. These results are shown in Tables S4 (for resident outbreak discovery) and S5 (for staff). These indicate the importance of the testing variables, particularly that staff testing is a strong predictor of outbreak size in the following week. They indicate that CQC ratings have only a moderate impact on the model's predictive power. Including whether a care home was a nursing home in the regression led to large improvements in predictive accuracy, as did accounting for the primary type of client each care home services. Accounting for the local level of the Omicron variant and the size of care homes also substantially improved the model predictions. Accounting for the diminishing impact of increases in prevalence on initial outbreak size also substantially improved the predictions. Including the measure of care home vaccination intensity substantially improved the predictive accuracy, but the results in Table 5 show that these variables have small effect sizes. This is possibly because these vaccination variables were imprecise and mirrored nationwide time trends and, once the weekly time variables were included in the regression, these variables had minimal predictive power.

In Tables S6 (residents) and S7 (staff), we show sensitivity analyses where we perform the same regressions as in Table 5, for three distinct time periods:

- ▶ 1 October 2020 to 31 December 2020, broadly taken to be prior to substantial vaccine-induced immunity
- ▶ 1 January 2021 to 30 November 2021, the pre-Omicron phase
- ▶ 1 December 2021 to 31 March 2022, the Omicron phase

Across all three time periods and across the resident and staff regressions, the association between staff testing and the size of outbreaks when discovered was of consistent sign and of large magnitude. In the staff regression, the association became more pronounced over time. This contrasted with the coefficient for resident testing, whose sign fluctuated for the resident outbreak regressions, and which only became negatively associated with outbreak size during the Omicron phase.

Although the association of CQC rating with outbreak size varied across the time periods and resident and staff regressions, those care homes rated as outstanding consistently had smaller outbreaks (when initially discovered) versus the other cohorts. Generally, the association of CQC rating was greatest in the pre-Omicron phase.

In both the resident and staff regressions (Tables S6 and S7), the association between initial outbreak size and the primary type of client served by the care homes varied throughout the evaluation period, but the signs of effects were maintained throughout. Of particular note, the effect sizes associated with care homes serving primarily older persons (aged 65 years or more) or individuals with dementia declined in the Omicron phase. The association of the fraction of agency workers with initial outbreak size changed sign throughout the evaluation period: in the first period, it was associated with smaller outbreak sizes; in later periods, it was associated with larger ones, across both resident and staff.

#### 5.4.3.2 The association between testing and subsequent outbreak sizes during outbreaks

We investigated how, subsequent to positive cases being found within a care home, the response was able to identify (and presumably isolate) cases, leading to reductions in the size of the outbreaks in subsequent weeks. To do so, we considered only weeks where the previous week had at least one positive case in either staff or residents. The regressions using these data then took the following form:

$$X_{i,t+1} \sim \text{Poisson} \left( N_{i,t+1} \left( \frac{X_{i,t}}{n_{i,t}} \right) \exp(\alpha + \beta_r T_{i,t}^r + \beta_s T_{i,t}^s + \gamma Y_{i,t}) \right),$$

where the variables appearing both here and in part i) have common meaning;  $n_{i,t} > 0$  is the total number of members of care home  $i$  at time  $t$  (e.g., the sum of residents and care workers employed); and  $Y_{i,t}$  represents a vector of additional covariates.

An assumption in the above equation is that, during an outbreak, new cases arise predominantly from previous ones within the care home. While it is possible that, during an outbreak, additional cases could be imported from outside a care home, these introductions may be relatively rare, and we assume that the majority of new cases are due to those occurring in previous weeks. We do, however, allow for importations, through a prevalence term included in the additional covariates.

The results of this regression for positive test counts in residents and staff are shown in Table 6.

In each regression, we include the proportion of positive results in the previous week occurring in residents to account for differential mixing between residents and staff. This shows that positive counts in residents were, on average, higher if the positives in this week occurred mainly in residents and vice versa for staff.

In both regressions, we found a strong association between past testing intensity and positive counts, where higher levels of past testing were associated with fewer positives. This effect was particularly strong for past staff testing on staff outbreaks and for past resident testing on resident outbreaks – again, this supports the hypothesis that these groups tended to associate more with themselves as opposed to intergroup mixing.

If a substantial proportion of individuals in a care home are infected in a given week, the number of positives in the following weeks could be low because there were few susceptible individuals left to infect. If large outbreaks were accompanied by high levels of testing, this would then make it appear (falsely) as if a high testing intensity drove down infections. To investigate this hypothesis, we performed an additional regression where we included the average number of infections per care home member in the previous week (Table S8). In both resident and staff regressions, this regressor was significant and negatively associated with outbreak size. As this regressor also appears in the offset term, the negative association does not indicate a negative impact of tests in the previous week on those in the current week but indicates that there were diminishing returns to the impact of positives on future transmission. One possible mechanism for these diminishing returns could be, as discussed, the depletion of susceptible individuals. The impact of incorporating this additional regressor was to reduce the effect size associated with testing, but the effects remained of the same sign and the general trends were the same (e.g., that testing in residents had the largest negative association with future outbreak size in residents and that testing in staff had the largest negative association with future outbreaks in staff). In what follows, we continue our discussion of the model shown in Table 6, as it is easier to intuit than the sensitivity analysis shown in Table S8.

Care homes with higher CQC ratings were associated with better control of outbreaks. On average, care homes rated outstanding had a 9% reduction in weekly resident positives versus inadequate care homes; the corresponding figure was 11% for staff positives.

Care homes that served older individuals or those with dementia patients experienced slower declines in outbreak size, on average.

The Delta variant epidemic wave was strongly associated with the ability of care homes to control outbreaks, with positive counts in residents during the main Delta wave being roughly 50% fewer in subsequent weeks (the figure was similar for staff positives). The effect associated with the Omicron variant epidemic wave was less marked and of opposing signs across residents and staff.



In both regressions, having more care workers per resident was associated with strong reductions in the size of outbreaks in following weeks; the effect was, by construction (as models with diminishing returns to care workers per resident fit the data better), declining with the number of care workers.

In both regressions, increases in the LTLA-level prevalence were associated with increased positives (this estimate is omitted from the regression table for readability), presumably through further introductions of cases into care homes from either the most likely route, e.g., staff, visiting professionals or visitors, or potentially through new admissions or residents returning from being outside of the care home for a period of time. The effect size here was large but reflected the scale of prevalence (0-1) and that, typically, prevalence was low (typically less than 0.01).

**Table 6. Regression results for determinants of outbreak size during outbreaks.** These results correspond to generalised linear models using a Poisson likelihood and a log-link function with an offset term as described in the text; coefficients and 95% confidence intervals are shown on the exponentiated scale. Estimates of the weekly time dummies and the COVID-19 prevalence effects were both suppressed for readability.

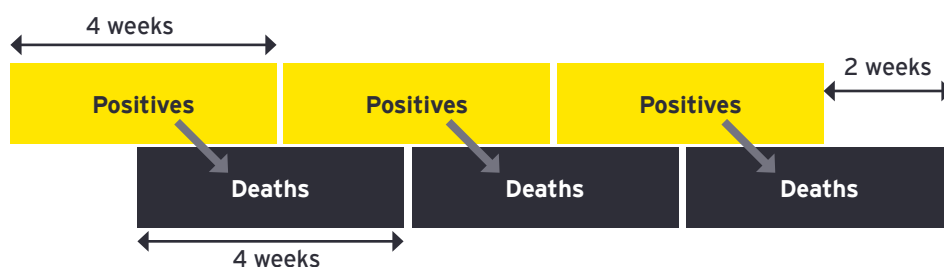
	<b>Resident PCR + LFD positive counts (1)</b>	<b>Staff PCR + LFD positive counts (2)</b>
Fraction of positives in residents (lag=1)	<b>1.512***</b> (1.491, 1.532)	<b>0.606***</b> (0.590, 0.623)
log(0.1 + test intensity in residents (lag=1))	<b>0.675***</b> (0.669, 0.681)	<b>0.894***</b> (0.889, 0.898)
log(0.1 + test intensity in staff (lag=1))	<b>0.729***</b> (0.721, 0.738)	<b>0.488***</b>
CQC: requires improvement	<b>0.971</b> (0.930, 1.012)	<b>0.917***</b> (0.881, 0.953)
CQC: good	<b>0.959**</b> (0.919, 0.999)	<b>0.913***</b> (0.878, 0.948)
CQC: outstanding	<b>0.907***</b> (0.861, 0.953)	<b>0.894***</b> (0.856, 0.932)
CQC: null	<b>0.962</b> (0.873, 1.051)	<b>0.954</b> (0.888, 1.020)
Is a nursing home?	<b>0.935***</b> (0.923, 0.947)	<b>1.040***</b> (1.030, 1.049)
Is independent?	<b>1.089</b> (0.895, 1.282)	<b>1.003</b> (0.912, 1.094)
Primary clients: older (65+ years) individuals	<b>1.318***</b> (1.295, 1.342)	<b>1.049***</b> (1.033, 1.066)
Primary clients: individuals with dementia	<b>1.303***</b> (1.278, 1.328)	<b>1.056***</b> (1.038, 1.074)
Primary clients: individuals with learning disabilities	<b>0.962**</b> (0.931, 0.992)	<b>0.916***</b> (0.896, 0.936)
Local proportion of Delta variant	<b>0.507**</b> (-0.116, 1.131)	<b>0.455***</b> (-0.017, 0.928)
Local proportion of Omicron variant	<b>0.936*</b> (0.864, 1.007)	<b>1.095***</b> (1.041, 1.149)
log (care workers per resident)	<b>0.699***</b> (0.683, 0.715)	<b>0.568***</b> (0.556, 0.580)
Fraction of agency workers	<b>1.010</b> (0.982, 1.038)	<b>0.959***</b> (0.934, 0.984)
Is a community care home?	<b>1.022</b> (0.993, 1.052)	<b>1.026***</b> (1.007, 1.046)
Is an acute care home?	<b>1.103</b> (0.559, 1.647)	<b>0.870</b> (0.420, 1.320)
Av. doses of all vaccines per resident	<b>0.985***</b> (0.982, 0.987)	<b>0.999*</b> (0.998, 1.000)
Av. doses of all vaccines per staff	<b>0.994***</b> (0.992, 0.995)	<b>1.000</b> (0.999, 1.001)
Total resident count	<b>1.003***</b> (1.003, 1.003)	<b>1.005***</b> (1.004, 1.005)
Constant	<b>0.391***</b> (0.241, 0.541)	<b>0.458***</b> (0.337, 0.580)
Observations	117,988	164,546
Note:	*p<0.1; **p<0.05; ***p<0.01	

In Tables S9 and S10, we investigate the stability of key regression coefficients by time period, considering the same three periods as in Tables S6 and S7.

In all time periods, the effect size of testing in residents was of the same sign and relatively stable – this was true for both the resident regression (Table S9) and staff regression (Table S10). This was also the case for the effect size associated with testing in staff, although in the staff regressions, the association between testing in staff and outbreak size became more pronounced over the course of the evaluation period. Across both regressions, there was heterogeneity in the association of CQC rating with outbreak size. In the first period, the inadequate care homes fared relatively well in the resident regression, with minimal differences in the staff regression. In the pre-Omicron period, the order was the same as in our main regression, with outstanding care homes faring best. In the final period, there was little association across CQC ratings and outbreak size. Across all periods, the effect size associated with serving primarily older persons or those with dementia was positive and of similar size; for both of these factors, the effect sizes were greater in the first period and greater for the resident regressions. The association between the number of care workers per resident and outbreak size was of the same sign (negative) across each of the time periods and relatively stable.

#### 5.4.3.3 Deaths associated with reported positive COVID-19 test results

We investigated the factors influencing whether positive COVID-19 cases became deaths by considering four-week blocks for aggregating positives and deaths (which were chosen to overlap by two weeks in the middle, with future deaths depending on the previous cases), to account for the delay between a case being detected and death, should it occur. This is illustrated in Figure 5.



**Figure 5. Blocked design of positives to deaths regression.**

By using this design, we could, in principle, miss deaths from positives that occurred either more than 2 weeks after the positive was reported (e.g., the blue block in Figure 5). We could also misattribute deaths to a particular block if the delay from testing positive to death was either short or long. However, we view this as a largely unavoidable smoothing of the data, which would remain for any other choice of block size. An improved analysis would consider individual-level paired testing and deaths data (to which we did not have access).

These regressions took the form:

$$X_{i,t+1} \sim \text{Poisson} \left( N_{i,t+1} \left( \frac{X_{i,t}}{n_{i,t}} \right) \exp(\alpha + \beta_r T_{i,t}^r + \beta_s T_{i,t}^s + \gamma Y_{i,t}) \right),$$

where NB denotes a negative binomial distribution;  $D_{i,t} > 0$  denotes the count of COVID-19-related deaths (either total deaths or confirmed deaths) in a given block;  $X_{i,t-1} > 0$  denotes the positive count in residents only in the previous block;  $W_{i,t}$  represents various covariates that affect whether positives become deaths; and  $\kappa > 0$  denotes the overdispersion parameter, where, as  $\kappa \rightarrow \infty$ , this regression becomes Poissonian.

A factor of key importance in extrapolating from positives to deaths in residents is the type of individual whom a care home serves. In Figure 6, we show the association between positives and cases across care homes serving different types of individuals. This shows that, in those primarily serving older patients or those with dementia, there was a strong positive association between positives and deaths, likely reflecting the underlying (and well-documented) frailty of these populations to severe COVID-19 outcomes. In other populations, the association was markedly weaker. To account for these differences in regressions, we include dummy variables for some of the larger categories of care homes in this plot. Figure S3 shows the same data but allows nonlinear regression lines for each panel. This illustrates a domed relationship between positives and deaths. Because of this, we include the number of positives as an additional covariate in our regressions; as it appears already in the offset, this additional term allows for non-monotonic relationships.



**Figure 6. Associations between the number of positives and the number of deaths by the primary client type served by care homes.** In this plot, the points indicate block-level observations for a particular care home; the blue lines represent linear regression fits assuming a linear relationship between numbers of positives and numbers of deaths.

In Table 7, we report the results of this regression analysis for either total COVID-19-related deaths (middle column) or confirmed COVID-19-related deaths (right-hand column).

This illustrates that care homes which primarily served older persons or those with dementia had a substantially elevated risk of death from a given positive; those care homes primarily serving individuals with learning disabilities or mental health issues had lower risks.

In addition, nursing homes had a higher rate of death, and, after accounting for block-level variation (one dummy variable for each month block), neither variant types nor vaccination had a strong influence on deaths. Unlike for the previous regressions, CQC rating was not associated with the outcome. Having a greater fraction of agency workers was associated with worse outcomes.

Having more care workers per resident was associated with a reduced risk of death following a positive case being reported.

**Table 7. Regression results for determinants of resident COVID-19-related deaths.** These results correspond to generalised linear models using a negative binomial likelihood and a log-link function with an offset term as described in the text; coefficients and 95% confidence intervals are shown on the exponentiated scale. Estimates of the time dummy coefficients for each block are suppressed for readability. Estimates for acute care homes have been dropped from the output since they had extremely high uncertainty reflecting the low numbers of such care homes in our dataset.

	Total resident COVID-19-related deaths (1)	Confirmed resident COVID-19-related deaths (2)
Num. of positives in residents	0.997** (0.995, 1.000)	0.998 (0.996, 1.001)
Primary clients: individuals with learning disabilities	0.254*** (-0.003, 0.510)	0.278*** (0.001, 0.555)
Primary clients: older (65+ years) individuals	2.200*** (2.004, 2.395)	2.382*** (2.168, 2.597)
Primary clients: individuals with dementia	2.208*** (2.009, 2.408)	2.336*** (2.118, 2.555)
Primary clients: individuals with mental health issues	0.672*** (0.397, 0.947)	0.726** (0.428, 1.023)
Primary clients: individuals with physical disabilities	1.151 (0.873, 1.430)	1.273 (0.973, 1.574)
CQC rating: requires improvement	1.061 (0.894, 1.228)	1.170* (0.988, 1.353)
CQC rating: good	1.043 (0.881, 1.204)	1.155 (0.978, 1.332)
CQC rating: outstanding	1.005 (0.815, 1.195)	1.121 (0.914, 1.327)
CQC rating: null	1.086 (0.721, 1.451)	1.261 (0.874, 1.648)

	<b>Total resident COVID-19-related deaths (1)</b>	<b>Confirmed resident COVID-19-related deaths (2)</b>
Is a nursing home?	<b>1.247***</b> (1.202, 1.292)	<b>1.235***</b> (1.187, 1.283)
Is independent?	<b>1.847*</b> (1.140, 2.555)	<b>1.804</b> (1.055, 2.552)
Is a community care home?	<b>0.858**</b> (0.725, 0.991)	<b>0.862**</b> (0.720, 1.003)
Local proportion of Delta variant	<b>4.367</b> (1.726, 7.009)	<b>5.957</b> (3.198, 8.716)
Local proportion of Omicron variant	<b>0.871</b> (0.372, 1.371)	<b>0.861</b> (0.305, 1.416)
Av. doses of all vaccines per resident	<b>0.991</b> (0.979, 1.003)	<b>0.994</b> (0.982, 1.006)
Fraction of agency workers	<b>1.137**</b> (1.038, 1.236)	<b>1.134**</b> (1.028, 1.240)
Care workers per resident	<b>0.904***</b> (0.849, 0.959)	<b>0.900***</b> (0.841, 0.959)
Care workers absent	<b>0.999</b> (0.996, 1.002)	<b>0.999</b> (0.996, 1.003)
Constant	<b>0.025***</b> (-0.422, 0.473)	<b>0.020***</b> (-0.452, 0.492)
Observations	33,536	33,536
kappa	<b>1.883***</b> (0.083)	<b>1.756***</b> (0.080)
Note:	*p<0.1; **p<0.05; ***p<0.01	

#### 5.4.3.4 Deaths averted under hypothetical testing and care worker scenarios

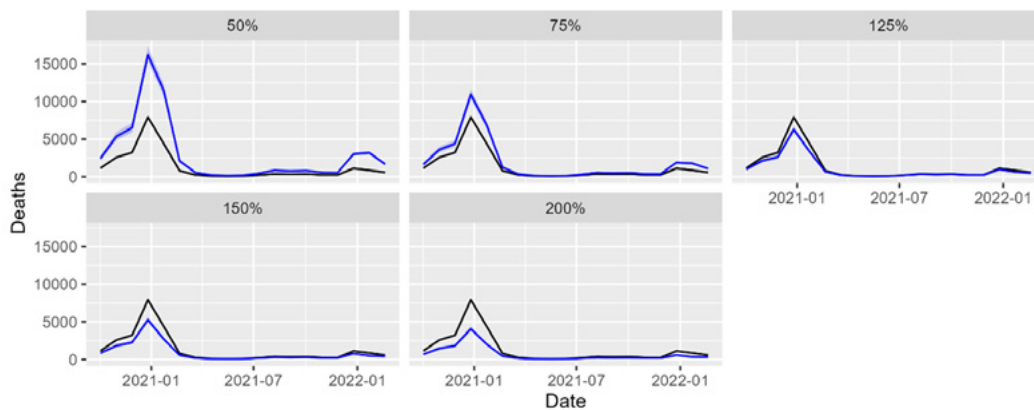
We used the fitted regression models describing outbreak discovery and outbreak control together with the model for COVID-19-related deaths to estimate the number of such deaths that would occur under counterfactual testing and care worker scenarios. Inherently, our approach is statistical opposed to being mechanism-based and, because of this, a number of additional assumptions were required to produce reasonable projections. We outline these in the 'Further methodological details' section. A key assumption of all of our projections is that our regression model estimates represent causal effects, which is unlikely to be true and suggests caution in interpreting our results.

We provide measures of uncertainty in our projections, which are solely based on the uncertainty in the negative binomial regressions that link positive test results with deaths. This, however, likely understates the true uncertainty in the projections, as it fails to account for uncertainty in the structure of the models. It also fails to account for the inherent uncertainty in epidemic dynamics, which is particularly acute in care homes, where the relatively few individuals in each care home means that the individual epidemics in each care home would unfold in a relatively unpredictable manner.

#### 5.4.3.5 Deaths averted across testing scenarios

Figure 7 shows our model-predicted estimates (blue lines with uncertainty shown as shading) of total COVID-19-related deaths in care homes in adult social care across five scenarios: testing at 50%, 75%, 125%, 150% and 200% of its historical levels. In each of the scenarios considered, we assume that both resident and staff testing is inflated or deflated by the same ratio. The black lines show the reported level of total COVID-19-related deaths in all CQC-monitored care homes.

Reductions in testing were associated with increased COVID-19-related deaths: with a testing intensity at 50% of the true levels, we estimate that deaths would increase by 32,160 (uncertainty interval (UI): 27,200-37,740), a 129% increase (UI: 109%-152%) in COVID-19 deaths; with testing at 75%, we estimate an increase of 11,910 (UI: 8500-15,700; corresponding percentage change in deaths: 48% with UI: 34%-63%). An increase in testing levels by 25% would have reduced deaths by 4680 (UI: 2270-6810; 18% (UI: 9%-27%) of overall deaths averted). At higher levels of testing, our models predict great, albeit diminishing, deaths averted, but we are cautious in overinterpreting our findings here, as the scenarios considered are far from what occurred.



**Figure 7. Projected COVID-19-related total deaths under hypothetical testing scenarios.** Each plot shows the actual deaths (black lines) and the projected lines (blue lines) with associated uncertainty (see Methods). Each panel corresponds to a different counterfactual testing scenario when the numbers of tests were at the levels shown at the top of each panel relative to the historical levels: e.g., 75% means that testing (in both residents and staff) was at 75% of its factual level.

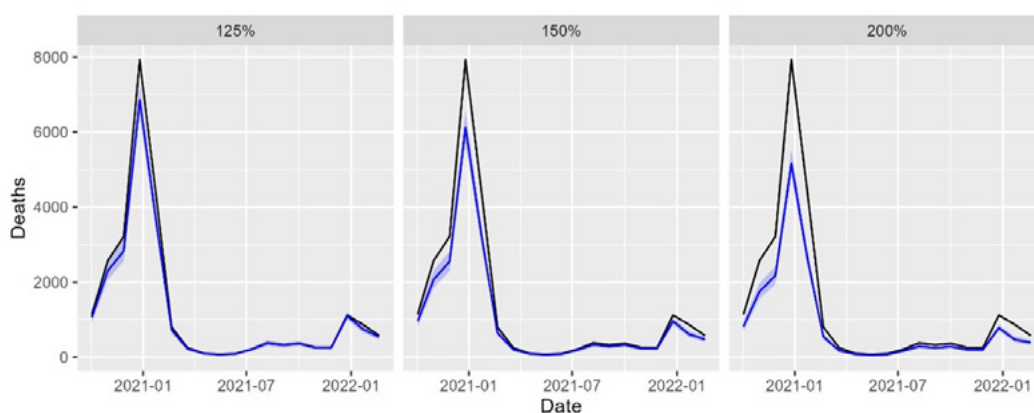
We performed a sensitivity analysis where we used the outbreak models (Table S8), which allowed for nonlinear effects of past positives (e.g., if there was depletion of susceptible individuals). These models estimated smaller but still marked effects of testing on COVID-19-related deaths (Figure S4). Under a 50% reduction in testing, this model predicted that deaths would increase by 27,660 (UI: 23,000–32,900), a 111% increase. For a 25% reduction, deaths would increase by 40% (UI: 27%–55%). For a 25% increase in testing, this projection indicated that 15% of deaths would have been averted (UI: 5%–24%); and for a 50% increase, 28% of deaths would have been averted (UI: 19%–36%).

#### 5.4.3.6 Deaths averted across care worker scenarios

We also considered how increases in the number of care workers could have influenced COVID-19-related deaths in care homes within adult social care. Our regression estimates examining the influences of test positivity indicate that having more care workers per resident was associated with slightly larger initial outbreaks being uncovered but faster reductions in outbreak size following their initial discovery. Our regression model, which determines deaths from test positives in residents, indicates that care homes with higher number of care workers per resident had lower rates of death.

In Figure 8, we show our model-projected estimates of deaths under three counterfactual scenarios, with care workers increased by 25%, 50% and 100%.

We estimate that an increase in care workers per resident by 25% would have averted 2800 deaths (UI: 280–5050), a percentage decrease of 11% (UI: 1%–20%). If care workers per resident were increased by 50%, 5260 deaths (UI: 2880–7360) would have been averted (equating to 21%; UI: 12%–30%). If care workers per resident were doubled, more than 8000 COVID-19-related deaths would have been averted.



**Figure 8. Projected COVID-19-related total deaths under hypothetical care worker scenarios.** Each plot shows the actual deaths (black lines) and the projected lines (blue lines) with associated uncertainty (see Methods). Each panel corresponds to a different counterfactual scenario when the numbers of care workers per resident were at the levels shown at the top of each panel relative to the historical levels, e.g., 125% means that the number of care workers per resident was increased by 25% from its factual level.

In Figure S5, we show the results of a sensitivity analysis where we used the outbreak models, allowing for nonlinear relationships with past positives (Table S8). These projections estimated a slightly smaller influence of changes to the number of care workers per resident on COVID-19-related deaths. A 25% increase in care workers per resident would reduce deaths by 8% (UI: -3% to 17%) and a 50% increase would reduce deaths by 17% (UI: 7%-26%).

#### 5.4.4 Key limitations

Predicting COVID-19-related deaths in care home residents under counterfactual responses is inherently complex. The thousands of individual care homes are generally small, and the outbreaks thus start and evolve in each of them in highly unpredictable ways. Care homes are also diverse, with the responses they made and their characteristics and dynamics imperfectly measured. Our analysis represents a first step towards estimating the impact of testing on COVID-19-related deaths in care home residents, but it has a number of important limitations, which we discuss in this section.

We used the fitted regression models describing outbreak discovery and outbreak control together with the model for COVID-19-related deaths in residents to estimate the number of such deaths that would have occurred under counterfactual testing and care worker scenarios. However, because we did not have a mechanistic model that links outbreak response to changes in the size of epidemics (and the number of positive test results), we were required to make a number of additional assumptions, which we outline in the 'Further methodological details' section.

Future work should consider the use of more epidemiologically informed, mechanistic, individual-based models that describe the evolution of outbreaks in care homes and how changes to testing or the number of workers may affect their course. The regression model results that we present here should be useful in parameterising such models.

One key characteristic of outbreaks in care homes is that there is a small number of individuals who could become infected; this number initially diminishes and later increases as individual-level immunity is gained then subsequently wanes following recovery from infection. We attempted to proxy for the depletion of susceptible individuals in our regression models by allowing non-monotonic impacts of the previous week's positives on subsequent infections: models including these effects did predict fewer deaths averted due to testing, but the differences in effect sizes were modest (Figure S4). This may be because the typical number of positive tests occurring per week (if positive tests were recorded) was generally small compared with the overall care home size. It may also be because we made additional assumptions when projecting deaths, which aimed to account for the depletion of susceptible individuals (see 'Further methodological details' section). An individual-level mathematical model that considered individuals' dynamic shifts in immunity (following either natural infection or vaccination) would be a useful tool to further probe how changes to outbreak responses would affect deaths.

A crucial assumption we make when predicting how changes to testing or numbers of care home workers would affect COVID-19-related deaths is that our regression results represent causal effects. While we have attempted to control for important confounders, there is a range of factors that we could not accurately measure (such as individual immunity - our measure of vaccine coverage was imprecise as we did not have access to individual-level care home memberships) and thus could not be precisely modelled. Additionally, while our models may reflect reasonable associations across all care homes on average, it is likely that these associations would vary idiosyncratically across individual care homes. The models we fitted did not generally include such effect modification at the care-home level, either because the models incorporating such random effects did not converge (likely due to the often limited number of observations at the care home level) or because the models could not be fitted owing to the extensive computational resources required to fit these models to these large datasets. Because of this, our predictions may mischaracterise counterfactual outcomes at the individual care home level or for particular segments of care homes, and we do not present any predictions at these levels. Instead, we focus on predictions on aggregate numbers of deaths.

An additional limitation of our analysis is that we did not have access to data determining the unique number of positives (e.g., the count of residents or staff testing positive) or unique numbers of individuals tested in a particular week and care home. Instead, our data represent the total numbers of positive test results and total number of tests reported. Because of this, we cannot determine whether a given number of positives represents the total count of distinct individuals testing positive or whether it represents the same few infected individuals tested multiple times. While this data issue muddied the mechanistic interpretation of our regression models, we made projections of deaths conditional on a particular number of positive tests in residents, not positive individual residents. This likely added variance to our predictions, but it should not necessarily bias them. A future analysis using unique positives and tests would however be useful to confirm these results.



Our analysis does not consider the impact of false-positives. Particularly during time periods when there was low transmission, it is likely that a number of isolated occurrences of positive tests represented not outbreaks but false-positive results (particularly if the test were conducted via LFD). These faux outbreaks would not evolve like real ones, and the outbreak responses could thus be wasteful. However, because full outbreak responses required a number of positive test results in order to be enacted, these occurrences may have been relatively rare. Our models did not allow for a different response of COVID-19-related deaths to false-positives versus true-positives, therefore it is possible that, particularly during low transmission periods, our statistical models overstated the influence of testing on deaths. But, as these were periods defined by relatively few cases (and COVID-19-related deaths) and the model predictions were similarly so (see Figure 7), it is unlikely that this effect would lead the model predictions to strongly overstate the number of deaths.

Testing without accompanying changes in behaviour or actions following positive test results, for example through the isolation of positive cases, cannot affect COVID-19 outcomes. Our projections implicitly assume that these accompanying effects remain in place under changes to the level of testing. We performed analyses on subdivisions of the evaluation period (Tables S6, S7, S9 and S10) that did show some evidence of variation in the effect size associated with testing, which may be due to changes in behaviour of staff/residents following positive test results.

## 5.4.5 Further methodological details

### 5.4.5.1 Interpolation of time-varying care home data

We obtained care home-specific, time-varying covariate data from the NHS NECS Capacity Tracker [2]. For each covariate of interest, we extracted weekly time series data from the capacity tracker data file, using the 'weekly\_last\_updated' column as the time value; when a single week had multiple observations, we took the mean of the observations. We extrapolated the first and last observations in the time series to the beginning and end of the evaluation period, assuming that the value of the covariate remained constant before the first observation and after the last observation. For care homes with data missing in certain weeks, we used linear interpolation to obtain values for the covariate for the missing weeks.

Using this approach, we considered the following variables from the NECS Capacity Tracker file: 'total\_resident\_count', 'care\_workers\_employed', 'care\_workers\_absent', 'agency\_care\_workers\_employed', 'aprons\_pressure', 'masks\_pressure', and 'is\_visiting\_allowed'.

### 5.4.5.2 Vaccination information

To approximate the level of vaccination in a care home's residents or staff members, we summed the total number of doses administered at a particular care home (Dose 1, Dose 2, Dose 3, Booster, and Spring 2022), by staff or resident, and divided this by the number of staff members ('care\_workers\_employed') or residents ('total\_resident\_count') in particular weeks. This measure was a relatively crude metric of vaccination coverage, as it failed to account for any turnover in the care home memberships over time. However, we lacked data on individual care home memberships, so our measure likely overstated the level of vaccination coverage - particularly so for those care homes with a high turnover of residents or staff.

### 5.4.5.3 Merging of testing data and deaths data

We obtained COVID-19 testing data from UKHSA, in which individual tests and their results were listed. Each test was associated to a particular care home by its Site ID ('siteid') and Site Name ('sitename'). We also obtained data from the CQC for the number of weekly COVID-19-related deaths per care home reported to the CQC, with each care home indicated by its Location ID and Location Name. (Some care homes appeared in our reference set but had zero deaths and thus did not appear in our deaths data; however, for these care homes we also had Location ID and Location Name information from the CQC Care Directory with filters.) Because a care home's Site ID (testing data) and Location ID (deaths data) are different identifiers, we merged testing and deaths data using the 'dim\_satellite\_organisations' file (obtained from UKHSA), which contains for each care home a 'legacy\_carehome\_id' (equivalent to Location ID from deaths data) and an 'organisation\_id' (equivalent to 'siteid' from testing data).

### 5.4.5.4 Merging of testing/deaths data with other covariates

We merged time-varying data from the NECS Capacity Tracker using the 'cqc\_id' (equivalent to Location ID). We merged non-time-varying care home metadata from NECS using the 'cqc\_id' (equivalent to Location ID). We merged vaccination data using the 'OrganisationId' (equivalent to Site ID).

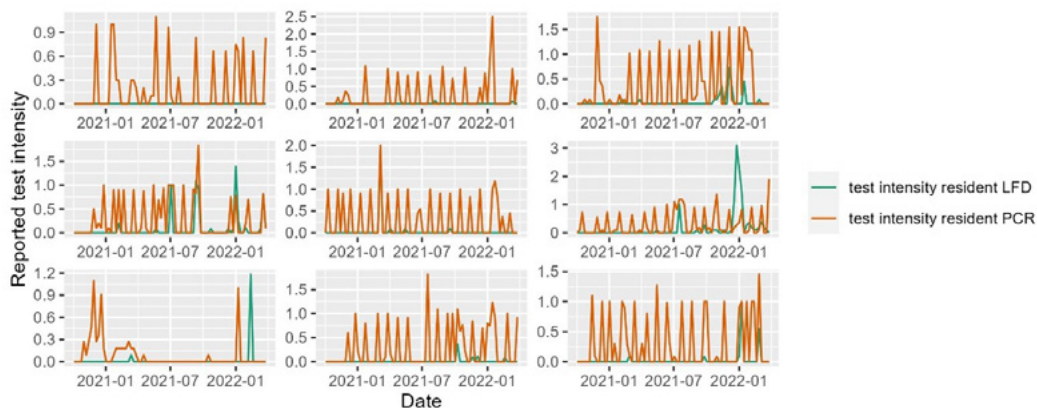
#### 5.4.5.5 Estimating COVID-19-related deaths averted from our statistical model fits

The models fitted to analyse determinants of the initial outbreak sizes broadly indicated that increases in testing in the previous week were associated with smaller average outbreak sizes in the week they were discovered. This does not have direct causal interpretation; instead, we interpret it as changes in testing influence when outbreaks are discovered – if they are discovered earlier, they are generally smaller. Lacking a mechanistic model of outbreak evolution and the impact of testing on its dynamics, however, we chose not to change the timing of outbreaks in care homes in response to counterfactual changes in testing or the number of care home workers per resident and instead used the regression results to modify the size of the outbreaks when they were discovered. Because our models are likely poorly predictive at the individual care home level, we did not use the fitted models to directly determine how the size of an outbreak (metered by the number of positive test results) would respond to counterfactual changes in testing or care home workers. Instead, we used the odds ratios associated with the testing or care home worker variables to inflate (say, in the case of lowered testing) or deflate (if testing were increased) the number of positives. To prevent outbreaks exceeding the size of care homes, we capped any projected positives at the total number of care home residents. We recognise that it is actually possible for the number of positives to exceed the size of the care home, if individuals are tested (and found positive) more than once. This was, however, an extremely rare occurrence in our data (occurring in <0.3% of care-home weeks), so we do not think this an unreasonable cap. Following such weeks where this threshold was reached, we assumed that the week following would have zero positives, representing depletion of susceptible individuals. We recognise that natural immunity would likely confer greater durations of protection against infection than this but, because our data represented positives opposed to unique cases, we chose not to impose further weeks of zero positives. By doing so, we may overstate the effect of testing in scenarios where testing is reduced. However, we did perform sensitivity analyses using models incorporating diminishing returns to past positives (Table S8), which showed a reduced but still substantial effect of reductions in testing on COVID-19-related deaths.

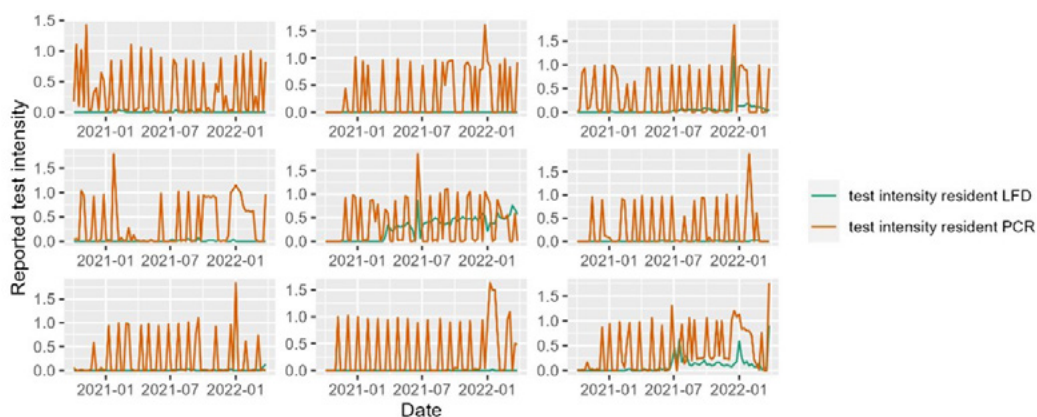
Using our outbreak models, we were able to inflate or deflate the number of positives occurring in weeks when, in the previous week, there were positives at that care home. It should be noted that the number of positives in the previous week could, in any counterfactual scenario, have changed as described in the above paragraph – in these circumstances, we inflated the number of positives in the week following by the ratio of the new positives count divided by the factual. We additionally used the odds ratios associated with the variables in question (either the testing variables or care worker variables) to further increase or decrease cases. It is important to note that as these odds ratios were never zero, it was not possible to fully arrest an outbreak by this mechanism (if that outbreak had not ended by that week in reality). Nor was it possible to, in (say) a situation where testing was reduced, revive an outbreak that in reality had ended in a particular week. To appropriately model either of these two circumstances, a more mechanistic model of care home epidemics would be necessary. By preventing either of these two circumstances from occurring (and additionally by ignoring the variability inherent in a Poisson regression model by focusing only on deterministic changes to the raw positive counts), the uncertainty in our projections is overly narrow and our projections themselves may mischaracterise actual outcomes. As for outbreak discovery, we capped the number of positives at the total care home size and assumed positives in the week following were zero.

With estimates of the number of positives for each week for each care home under the counterfactual testing or care worker scenarios, we then used these as inputs to our model for COVID-19-related total deaths (Table 7). The models we fitted for COVID-19-related deaths used a negative binomial likelihood and determined that there were high degrees of overdispersion (kappa values in Table 7: small values indicate overdispersion). To incorporate uncertainty in our predictions, we randomly sampled 1000 times from the negative binomial distribution using the mean predictions of these models and estimated overdispersion parameters. We then multiplied these deaths by the ratio of the actual COVID-19-related deaths to those predicted by the model when testing or care workers per resident were at their factual values (which we denote ratio: true-to-predicted), to account for any systematic under- or over-prediction of the model. For any care-home weeks not present in our model due to the presence of missing values, we assumed that counterfactual deaths would be inflated by ratio: true-to-predicted and the ratio of the predictions of the model with the change in the variable of interest (e.g., testing or care workers per resident) to the model with no such changes. We then took the 2.5% to 97.5% quantiles of the samples aggregated with the (single) deterministic predictions for the missing rows as our uncertainty intervals and the 50% quantile as the middle value. These then were further inflated by the 4-week block-specific ratio of care home deaths across all CQC-monitored care homes during the evaluation period to those which were modelled; this presumes that those unmodelled care homes were missing at random from our dataset.

## 5.4.6 Additional results



**Figure S1. Example resident reported test intensity with LFD and PCR in small care homes.** These nine care homes were the 9000th-9008th largest care homes (of those with more than ten residents) according to mean total resident count.



**Figure S2. Example resident reported test intensity with LFD and PCR in mid-sized care homes.** These nine care homes were the 1000th-1008th largest care homes (of those with more than ten residents) according to mean total resident count.

Table S1. Naïve regressions of numbers of positives in residents on lagged resident and staff tests. Both regressions were Poisson models using log-links with no offset terms; coefficients and 95% confidence intervals are on the exponentiated scale.

	Resident PCR + LFD positives count (1)	Staff PCR + LFD positives count (2)
Test intensity in residents (lag=1)	1.507*** (1.507, 1.508)	1.405*** (1.405, 1.405)
Test intensity in staff (lag=1)	0.867*** (0.867, 0.867)	1.035*** (1.035, 1.035)
Constant	0.007* (-0.0002, 0.013)	0.000 (-0.00000, 0.00000)
Observations	1,093,275	1,093,275
Note:	*p<0.1; **p<0.05; ***p<0.01	

**Table S2. Outbreak discovery in residents – sensitivity analyses.** The dependent variable was the (non-zero) number of positives in residents in a given week if the previous week had zero positives. These results correspond to generalised linear models using a Poisson likelihood and a log-link function; coefficients and 95% confidence intervals are shown on the exponentiated scale. Estimates of the weekly time dummies and the effects associated with local COVID-19 prevalence are suppressed for readability.

	Resident LFD + PCR positives count			
	1 (1)	2 (2)	3 (3)	4 (4)
log(0.1 + test intensity in residents (lag=1))	0.943*** (0.933, 0.953)	0.926*** (0.916, 0.936)		
log(0.1 + test intensity in staff (lag=1))	0.775*** (0.766, 0.784)	0.745*** (0.736, 0.755)		
CQC: requires improvement		0.990 (0.925, 1.056)		0.999 (0.934, 1.065)
CQC: good		0.904*** (0.840, 0.967)		0.918*** (0.855, 0.982)
CQC: outstanding		0.784*** (0.707, 0.861)		0.812*** (0.735, 0.889)
CQC: null		0.876* (0.732, 1.020)		0.857** (0.713, 1.001)
Is nursing home?		0.915*** (0.894, 0.936)		0.910*** (0.889, 0.931)
Is independent?		1.036 (0.607, 1.465)		1.074 (0.645, 1.504)
Primary clients: older (65+) individuals		1.196*** (1.159, 1.233)		1.181*** (1.144, 1.218)
Primary clients: individuals with dementia		1.251*** (1.210, 1.292)		1.234*** (1.193, 1.275)
Primary clients: individuals with learning disabilities		1.246*** (1.202, 1.290)		1.278*** (1.234, 1.322)
Local proportion of Delta variant		1.285 (0.698, 1.872)		1.293 (0.705, 1.882)
Local proportion of Omicron variant		1.350*** (1.197, 1.504)		1.376*** (1.222, 1.529)
log (care workers per resident)		1.037*** (1.012, 1.063)		1.034*** (1.009, 1.060)
Fraction of agency workers		1.077*** (1.042, 1.112)		1.078*** (1.043, 1.114)
Is community care home?		0.983 (0.930, 1.036)		0.983 (0.930, 1.036)
Is acute care home?		2.233** (1.491, 2.975)		2.137** (1.395, 2.879)
Av. doses of all vaccines per resident		0.990*** (0.986, 0.994)		0.993*** (0.989, 0.996)
Av. doses of all vaccines per staff		0.993*** (0.990, 0.996)		0.994*** (0.991, 0.997)
Total resident count		0.981*** (0.980, 0.982)		0.981*** (0.980, 0.982)
log(0.1 + PCR test intensity in residents (lag=1))			0.987** (0.976, 0.997)	0.991* (0.980, 1.001)
log(0.1 + LFD test intensity in residents (lag=1))			0.879*** (0.862, 0.897)	0.820*** (0.802, 0.837)
log(0.1 + PCR test intensity in staff (lag=1))			0.819*** (0.807, 0.830)	0.808*** (0.797, 0.819)
log(0.1 + LFD test intensity in staff (lag=1))			0.861*** (0.852, 0.870)	0.833*** (0.824, 0.842)
Constant	3.012*** (2.888, 3.136)	7.922*** (7.777, 8.066)	1.776*** (1.646, 1.906)	3.913*** (3.763, 4.062)
Observations	65,389	64,642	65,389	64,642
Note:	*p<0.1; **p<0.05; ***p<0.01			

**Table S3. Outbreak discovery in staff – sensitivity analyses.** The dependent variable was the (non-zero) number of positives in staff in a given week if the previous week had zero positives. These results correspond to generalised linear models using a Poisson likelihood and a log-link function; coefficients and 95% confidence intervals are shown on the exponentiated scale. Estimates of the weekly time dummies and the effects associated with local COVID-19 prevalence are suppressed for readability.

	Staff LFD + PCR positives count			
	1 (1)	2 (2)	3 (3)	4 (4)
log(0.1 + test intensity in residents (lag=1))	0.987*** (0.982, 0.993)	0.999 (0.994, 1.005)		
log(0.1 + test intensity in staff (lag=1))	0.735*** (0.729, 0.742)	0.662*** (0.655, 0.668)		
CQC: requires improvement		0.998 (0.952, 1.044)		1.000 (0.954, 1.045)
CQC: good		0.948** (0.904, 0.993)		0.954** (0.909, 0.998)
CQC: outstanding		0.857*** (0.807, 0.907)		0.875*** (0.825, 0.925)
CQC: null		0.935 (0.843, 1.028)		0.891** (0.799, 0.984)
Is nursing home?		0.939*** (0.926, 0.952)		0.928*** (0.915, 0.941)
Is independent?		1.070 (0.889, 1.251)		1.072 (0.891, 1.253)
Primary clients: older (65+) individuals		0.888*** (0.868, 0.909)		0.882*** (0.861, 0.902)
Primary clients: individuals with dementia		0.929*** (0.905, 0.952)		0.916*** (0.893, 0.940)
Primary clients: individuals with learning disabilities		1.199*** (1.176, 1.222)		1.204*** (1.181, 1.227)
Local proportion of Delta variant		0.999 (0.743, 1.256)		1.016 (0.759, 1.273)
Local proportion of Omicron variant		1.319*** (1.223, 1.414)		1.298*** (1.202, 1.393)
log(care workers per resident)		1.031*** (1.017, 1.045)		1.050*** (1.036, 1.064)
Fraction of agency workers		1.071*** (1.040, 1.101)		1.054*** (1.024, 1.085)
Is community care home?		0.937*** (0.909, 0.966)		0.930*** (0.902, 0.959)
Is acute care home?		1.308 (0.858, 1.759)		1.135 (0.684, 1.585)
Av. doses of all vaccines per resident		1.001*** (1.000, 1.001)		1.001*** (1.001, 1.001)
Av. doses of all vaccines per staff		0.988*** (0.986, 0.990)		0.991*** (0.989, 0.993)
Total resident count		0.980*** (0.980, 0.981)		0.980*** (0.980, 0.981)
log(0.1 + PCR test intensity in residents (lag=1))			0.971*** (0.966, 0.977)	1.002 (0.996, 1.007)
log(0.1 + LFD test intensity in residents (lag=1))			1.041*** (1.030, 1.052)	0.974*** (0.964, 0.985)
log(0.1 + PCR test intensity in staff (lag=1))			0.951*** (0.944, 0.959)	0.878*** (0.871, 0.885)
log(0.1 + LFD test intensity in staff (lag=1))			0.744*** (0.739, 0.750)	0.710*** (0.704, 0.716)
Constant	3.950*** (3.882, 4.018)	13.611*** (13.527, 13.695)	2.258*** (2.186, 2.331)	6.404*** (6.317, 6.492)
Observations	94,558	93,485	94,558	93,485
Note:	*p<0.1; **p<0.05; ***p<0.01			

**Table S4. Analysis of deviance for the resident outbreak discovery model.** This yields the reduction in residual deviance gained by adding each variable in turn (starting from the top) to the regression, so large values of 'deviance' indicate a larger gain in predictive power.

Variable	Degrees of freedom (df)	Deviance	Residual df	Residual deviance	Significance level
NULL	NA	NA	64641	154508.2	NA
log(0.1 + test intensity in residents (lag=1))	1	2596.9	64640	151911.3	***
log(0.1 + test intensity in staff (lag=1))	1	5401.5	64639	146509.7	***
CQC: requires improvement	1	23.2	64638	146486.6	***
CQC: good	1	25.5	64637	146461.0	***
CQC: outstanding	1	96.5	64636	146364.5	***
CQC: null	1	9.9	64635	146354.6	***
Is nursing home?	1	1668.5	64634	144686.1	***
Is independent?	1	0.1	64633	144686.0	
Primary clients: older (65+) individuals	1	100.9	64632	144585.1	***
Primary clients: individuals with dementia	1	396.4	64631	144188.7	***
Primary clients: individuals with learning disabilities	1	295.1	64630	143893.6	***
Local proportion of Delta variant	1	40.8	64629	143852.8	***
Local proportion of Omicron variant	1	1684.7	64628	142168.1	***
log(care workers per resident)	1	575.0	64627	141593.1	***
Fraction of agency workers	1	41.5	64626	141551.6	***
Local COVID-19 prevalence	1	6487.0	64625	135064.6	***
Is community care home?	1	10.3	64624	135054.2	***
Is acute care home?	1	4.3	64623	135050.0	**
Av. doses of all vaccines per resident	1	1157.1	64622	133892.9	***
Av. doses of all vaccines per staff	1	483.9	64621	133409.0	***
Total resident count	1	4276.6	64620	129132.4	***
Week time dummies	76	5799.8	64544	123332.6	***

**Table S5. Analysis of deviance for the staff outbreak discovery model.** This yields the reduction in residual deviance gained by adding each variable in turn (starting from the top) to the regression, so large values of 'deviance' indicate a larger gain in predictive power.

Variable	Degrees of freedom (df)	Deviance	Residual df	Residual deviance	Significance level
NULL	NA	NA	93484	186843.1	NA
log(0.1 + test intensity in residents (lag=1))	1	1964.3	93483	184878.8	***
log(0.1 + test intensity in staff (lag=1))	1	16871.1	93482	168007.7	***
CQC: requires improvement	1	0.1	93481	168007.6	
CQC: good	1	112.2	93480	167895.4	***
CQC: outstanding	1	127.0	93479	167768.4	***
CQC: null	1	16.6	93478	167751.7	***
Is nursing home?	1	5985.7	93477	161766.1	***
Is independent?	1	14.2	93476	161751.9	***
Primary clients: older (65+) individuals	1	2719.3	93475	159032.6	***
Primary clients: individuals with dementia	1	4442.0	93474	154590.6	***
Primary clients: individuals with learning disabilities	1	945.0	93473	153645.7	***
Local proportion of Delta variant	1	873.2	93472	152772.5	***
Local proportion of Omicron variant	1	10161.4	93471	142611.1	***



Variable	Degrees of freedom (df)	Deviance	Residual df	Residual deviance	Significance level
log(care workers per resident)	1	1249.6	93470	141361.5	***
Fraction of agency workers	1	37.6	93469	141323.9	***
Local COVID-19 prevalence	1	10006.1	93468	131317.8	***
Is community care home?	1	82.8	93467	131235.0	***
Is acute care home?	1	4.7	93466	131230.3	**
Av. doses of all vaccines per resident	1	28.6	93465	131201.7	***
Av. doses of all vaccines per staff	1	842.7	93464	130358.9	***
Total resident count	1	10459.3	93463	119899.6	***
Week time dummies	76	16948.2	93387	102951.4	***

**Table S6. Outbreak discovery in residents – date sensitivity analyses.** The dependent variable was the (non-zero) number of positives in residents in a given week if the previous week had zero positives. Each regression corresponds to data from a distinct time-period, as indicated above the columns. These results correspond to generalised linear models using a Poisson likelihood and a log-link function; coefficients and 95% confidence intervals are shown on the exponentiated scale. Estimates of the weekly time dummies are suppressed for readability.

	Resident LFD + PCR positives count		
	1 October 2020 to 31 December 2020 (1)	1 January 2021 to 30 November 2021 (2)	1 December 2021 to 31 March 2022 (3)
log(0.1 + test intensity in residents (lag=1))	1.063*** (1.032, 1.095)	0.992 (0.976, 1.007)	0.861*** (0.847, 0.875)
log(0.1 + test intensity in staff (lag=1))	0.746*** (0.725, 0.768)	0.734*** (0.717, 0.750)	0.747*** (0.733, 0.761)
CQC: requires improvement	1.158* (0.990, 1.326)	0.792*** (0.700, 0.885)	1.185*** (1.071, 1.298)
CQC: good	1.031 (0.868, 1.193)	0.717*** (0.629, 0.806)	1.102* (0.991, 1.213)
CQC: outstanding	0.875 (0.673, 1.077)	0.575*** (0.462, 0.688)	1.014 (0.887, 1.141)
CQC: null	0.915 (0.447, 1.383)	0.838* (0.639, 1.037)	0.890 (0.653, 1.128)
Is nursing home?	0.848*** (0.795, 0.901)	1.011 (0.978, 1.044)	0.850*** (0.818, 0.881)
Is independent?	0.00002 (-192.781, 192.781)	0.645 (-0.011, 1.300)	1.535 (0.963, 2.107)
Primary clients: older (65+) individuals	1.285*** (1.184, 1.386)	1.324*** (1.265, 1.384)	1.015 (0.962, 1.068)
Primary clients: individuals with dementia	1.546*** (1.436, 1.656)	1.356*** (1.290, 1.422)	1.046 (0.986, 1.105)
Primary clients: individuals with learning disabilities	1.212*** (1.088, 1.336)	1.229*** (1.157, 1.301)	1.295*** (1.233, 1.358)
Local proportion of Delta variant		1.525 (0.942, 2.108)	0.00001*** (-3.516, 3.516)
Local proportion of Omicron variant		0.000 (-75.175, 75.175)	1.095 (0.941, 1.248)
log(care workers per resident)	0.979 (0.920, 1.038)	0.906*** (0.866, 0.947)	1.210*** (1.171, 1.250)
Fraction of agency workers	0.772*** (0.575, 0.968)	1.062*** (1.018, 1.107)	1.137*** (1.071, 1.202)
Local COVID-19 prevalence	0.000*** (0.000,0.000)	0.000*** (0.000,0.000)	0.00003*** (0.000,0.000)
Is community care home?	1.096 (0.976, 1.217)	0.930 (0.843, 1.018)	0.966 (0.885, 1.047)
Is acute care home?		2.173 (0.786, 3.560)	3.327*** (2.446, 4.207)
Av. doses of all vaccines per resident	0.779** (0.554, 1.005)	0.999 (0.994, 1.005)	0.993*** (0.989, 0.998)
Av. doses of all vaccines per staff	0.952 (0.862, 1.042)	0.988*** (0.981, 0.996)	0.991*** (0.987, 0.994)

	Resident LFD + PCR positives count		
	1 October 2020 to 31 December 2020 (1)	1 January 2021 to 30 November 2021 (2)	1 December 2021 to 31 March 2022 (3)
Total resident count	0.981*** (0.979, 0.982)	0.978*** (0.977, 0.979)	0.985*** (0.984, 0.986)
Constant	11.500*** (11.262, 11.739)	55.644*** (55.511, 55.777)	3.325*** (3.131, 3.520)
Observations	8,183	32,915	23,544
Note:	*p<0.1; **p<0.05; ***p<0.01		

**Table S7. Outbreak discovery in staff - date sensitivity analyses.** The dependent variable was the (non-zero) number of positives in staff in a given week if the previous week had zero positives. Each regression corresponds to data from a distinct time-period, as indicated above the columns. These results correspond to generalised linear models using a Poisson likelihood and a log-link function; coefficients and 95% confidence intervals are shown on the exponentiated scale. Estimates of the weekly time dummies are suppressed for readability.

	Staff LFD + PCR positives count		
	1 October 2020 to 31 December 2020 (1)	1 January 2021 to 30 November 2021 (2)	1 December 2021 to 31 March 2022 (3)
log(0.1 + test intensity in residents (lag=1))	0.989 (0.971, 1.007)	1.014*** (1.005, 1.022)	0.998 (0.990, 1.006)
log(0.1 + test intensity in staff (lag=1))	0.836*** (0.821, 0.851)	0.661*** (0.651, 0.672)	0.582*** (0.573, 0.592)
CQC: requires improvement	0.979 (0.853, 1.106)	0.933** (0.863, 1.002)	1.036 (0.966, 1.107)
CQC: good	0.963 (0.841, 1.085)	0.882*** (0.815, 0.950)	0.990 (0.922, 1.058)
CQC: outstanding	0.923 (0.783, 1.062)	0.782*** (0.707, 0.857)	0.920** (0.843, 0.996)
CQC: null	0.650** (0.265, 1.036)	0.880* (0.740, 1.019)	1.002 (0.869, 1.136)
Is nursing home?	0.870*** (0.833, 0.907)	0.939*** (0.920, 0.959)	0.945*** (0.926, 0.965)
Is independent?	1.169 (0.689, 1.650)	1.021 (0.775, 1.267)	1.153 (0.830, 1.477)
Primary clients: older (65+) individuals	0.904*** (0.843, 0.965)	0.911*** (0.879, 0.942)	0.854*** (0.824, 0.884)
Primary clients: individuals with dementia	0.997 (0.928, 1.066)	0.943*** (0.907, 0.978)	0.883*** (0.847, 0.918)
Primary clients: individuals with learning disabilities	1.251*** (1.181, 1.320)	1.222*** (1.186, 1.257)	1.151*** (1.117, 1.185)
Local proportion of Delta variant		0.940 (0.681, 1.199)	0.015*** (-1.570, 1.599)
Local proportion of Omicron variant		0.000 (-36.937, 36.937)	1.122** (1.026, 1.217)
log(care workers per resident)	1.301*** (1.262, 1.340)	1.060*** (1.039, 1.082)	0.883*** (0.861, 0.904)
Fraction of agency workers	0.786*** (0.661, 0.910)	1.096*** (1.056, 1.136)	1.058** (1.013, 1.102)
Local COVID-19 prevalence	0.000*** (0.000,0.000)	0.000*** (0.000,0.000)	0.000*** (0.000,0.000)
Is community care home?	0.960 (0.883, 1.038)	0.913*** (0.869, 0.957)	0.967 (0.923, 1.010)
Is acute care home?	0.637 (-0.241, 1.515)	1.577 (0.775, 2.378)	1.722 (1.028, 2.416)
Av. doses of all vaccines per resident	0.941 (0.844, 1.039)	0.999 (0.996, 1.002)	1.001*** (1.000, 1.001)
Av. doses of all vaccines per staff	0.980 (0.917, 1.044)	0.977*** (0.973, 0.981)	0.999 (0.997, 1.001)
Total resident count	0.978*** (0.977, 0.979)	0.978*** (0.978, 0.979)	0.984*** (0.983, 0.984)

	Staff LFD + PCR positives count		
	1 October 2020 to 31 December 2020 (1)	1 January 2021 to 30 November 2021 (2)	1 December 2021 to 31 March 2022 (3)
Constant	24.648*** (24.489, 24.807)	34.970*** (34.879, 35.061)	5.451*** (5.349, 5.554)
Observations	12,033	47,323	34,129
Note:	*p<0.1; **p<0.05; ***p<0.01		

**Table S8. Regression results for determinants of weekly outbreak size in residents and staff (measured by number of positives) during outbreaks: sensitivity analysis.** These results correspond to generalised linear models using a Poisson likelihood and a log-link function; coefficients and 95% confidence intervals are shown on the exponentiated scale. Estimates of the weekly time dummies and effect size associated with local COVID-19 prevalence are suppressed for readability.

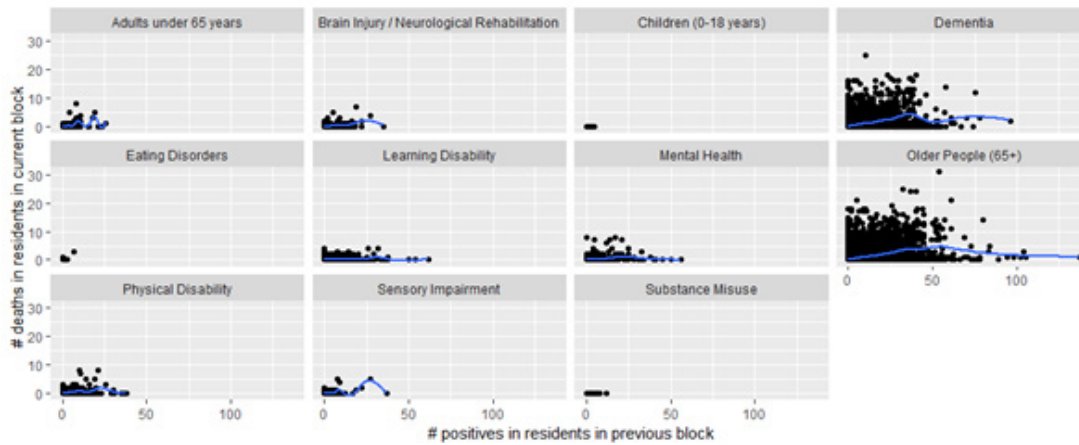
	Resident PCR + LFD positives count (1)	Staff PCR + LFD positives count (2)
Num. positives/care home member (lag=1)	0.274*** (0.236, 0.313)	0.193*** (0.159, 0.227)
Fraction of positives in residents (lag=1)	1.676*** (1.656, 1.695)	0.782*** (0.766, 0.799)
log(0.1 + test intensity in residents (lag=1))	0.719*** (0.712, 0.725)	0.933*** (0.929, 0.938)
log(0.1 + test intensity in staff (lag=1))	0.767*** (0.759, 0.776)	0.528*** (0.521, 0.535)
CQC: requires improvement	0.937*** (0.896, 0.979)	0.911*** (0.875, 0.947)
CQC: good	0.916*** (0.876, 0.956)	0.903*** (0.868, 0.938)
CQC: outstanding	0.850*** (0.804, 0.896)	0.879*** (0.841, 0.917)
CQC: null	0.880*** (0.791, 0.969)	0.925** (0.859, 0.991)
Is nursing home?	0.921*** (0.909, 0.933)	1.018*** (1.009, 1.028)
Is independent?	1.111 (0.917, 1.304)	1.072 (0.980, 1.163)
Primary clients: older (65+) individuals	1.316*** (1.292, 1.339)	1.039*** (1.023, 1.055)
Primary clients: individuals with dementia	1.305*** (1.280, 1.330)	1.058*** (1.041, 1.076)
Primary clients: individuals with learning disabilities	0.991 (0.961, 1.022)	0.948*** (0.928, 0.968)
Local proportion of Delta variant	0.519** (-0.105, 1.142)	0.449*** (-0.024, 0.922)
Local proportion of Omicron variant	0.931* (0.859, 1.003)	1.072** (1.018, 1.126)
log(care workers per resident)	0.753*** (0.737, 0.770)	0.617*** (0.605, 0.629)
Fraction of agency workers	1.028* (1.000, 1.055)	0.987 (0.962, 1.012)
Is community care home?	1.016 (0.987, 1.046)	1.024** (1.004, 1.044)
Is acute care home?	0.974 (0.430, 1.518)	0.766 (0.316, 1.216)
Av. doses of all vaccines per resident	0.983*** (0.980, 0.985)	0.997*** (0.996, 0.999)
Av. doses of all vaccines per staff	0.995*** (0.993, 0.996)	1.001 (1.000, 1.002)
Total resident count	1.001*** (1.001, 1.001)	1.003*** (1.002, 1.003)
Constant	0.488*** (0.338, 0.639)	0.531*** (0.409, 0.653)
Observations	117,988	164,546
Note:	*p<0.1; **p<0.05; ***p<0.01	

**Table S9. Regression results for determinants of weekly outbreak size in residents (measured by number of positives) during outbreaks: time-period sensitivity analysis.** These results correspond to generalised linear models using a Poisson likelihood and a log-link function; coefficients and 95% confidence intervals are shown on the exponentiated scale. Estimates of the weekly time dummies are suppressed for readability. Note that the Omicron variant variable and local COVID-19 prevalence have been dropped from these regressions as the coefficients associated with these variables were unrealistically large, likely reflecting the small sample sizes and lack of variation among these variables within certain periods.

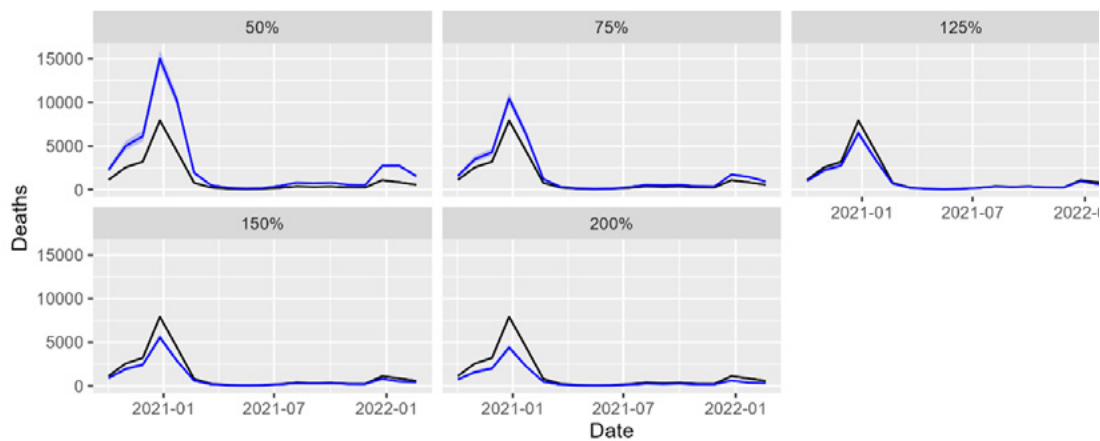
	<b>1 October 2020 to 31 December 2020 (1)</b>	<b>1 January 2021 to 30 November 2021 (2)</b>	<b>1 December 2021 to 31 March 2022 (3)</b>
Fraction of positives in residents (lag=1)	1.278*** (1.212, 1.344)	1.521*** (1.485, 1.557)	1.500*** (1.473, 1.527)
log(0.1 + test intensity in residents (lag=1))	0.729*** (0.707, 0.752)	0.702*** (0.691, 0.714)	0.658*** (0.650, 0.666)
log(0.1 + test intensity in staff (lag=1))	0.719*** (0.683, 0.756)	0.792*** (0.777, 0.808)	0.700*** (0.690, 0.711)
CQC: requires improvement	1.328*** (1.162, 1.494)	0.839*** (0.774, 0.904)	1.003 (0.946, 1.060)
CQC: good	1.362*** (1.199, 1.525)	0.807*** (0.744, 0.869)	1.006 (0.951, 1.061)
CQC: outstanding	1.170* (0.990, 1.350)	0.775*** (0.700, 0.850)	0.957 (0.895, 1.020)
CQC: null	1.306 (0.945, 1.668)	1.057 (0.886, 1.228)	0.899* (0.788, 1.010)
Is nursing home?	0.904*** (0.866, 0.942)	0.933*** (0.911, 0.954)	0.937*** (0.922, 0.952)
Is independent?	0.818 (0.353, 1.283)	1.541*** (1.246, 1.836)	0.913 (0.604, 1.221)
Primary clients: older (65+) individuals	1.607*** (1.523, 1.692)	1.348*** (1.306, 1.390)	1.219*** (1.189, 1.249)
Primary clients: individuals with dementia	1.475*** (1.385, 1.565)	1.242*** (1.196, 1.288)	1.259*** (1.227, 1.291)
Primary clients: individuals with learning disabilities	0.919 (0.812, 1.026)	0.830*** (0.773, 0.886)	1.039* (1.001, 1.078)
Local proportion of Delta variant		0.635 (0.007, 1.262)	0.001*** (-2.883, 2.885)
log (care workers per resident)	0.626*** (0.575, 0.677)	0.603*** (0.574, 0.632)	0.789*** (0.767, 0.811)
Fraction of agency workers	0.704*** (0.524, 0.885)	1.014 (0.967, 1.061)	1.031 (0.993, 1.069)
Is community care home?	0.840*** (0.744, 0.936)	1.139*** (1.086, 1.192)	1.005 (0.966, 1.043)
Is acute care home?	1.797 (-0.167, 3.761)	0.806 (-0.174, 1.787)	1.838* (1.144, 2.532)
Av. doses of all vaccines per resident	1.007 (0.938, 1.077)	0.979*** (0.973, 0.985)	0.991*** (0.988, 0.993)
Av. doses of all vaccines per staff	1.030 (0.993, 1.067)	0.988*** (0.982, 0.995)	0.991*** (0.990, 0.993)
Total resident count	1.001* (1.000, 1.002)	1.003*** (1.003, 1.004)	1.004*** (1.003, 1.004)
Constant	0.333*** (0.097, 0.568)	1.363*** (1.279, 1.447)	0.392*** (0.243, 0.541)
Observations	11,111	51,026	55,851
Note:	*p<0.1; **p<0.05; ***p<0.01		

**Table S10. Regression results for determinants of weekly outbreak size in staff (measured by number of positives) during outbreaks: time-period sensitivity analysis.** These results correspond to generalised linear models using a Poisson likelihood and a log-link function; coefficients and 95% confidence intervals are shown on the exponentiated scale. Estimates of the weekly time dummies are suppressed for readability. Note that the Omicron variant variable and local COVID-19 prevalence have been dropped from these regressions as the coefficients associated with these variables were unrealistically large, likely reflecting the small sample sizes and lack of variation among these variables within certain periods.

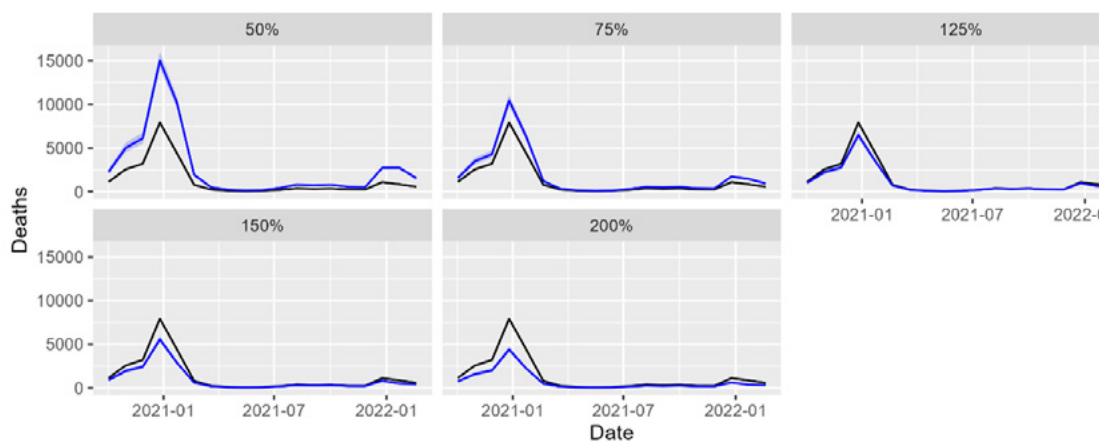
	<b>1 October 2020 to 31 December 2020 (1)</b>	<b>1 January 2021 to 30 November 2021 (2)</b>	<b>1 December 2021 to 31 March 2022 (3)</b>
Fraction of positives in residents (lag=1)	<b>1.010</b> (0.950, 1.070)	<b>0.933***</b> (0.902, 0.965)	<b>0.466***</b> (0.445, 0.487)
log(0.1 + test intensity in residents (lag=1))	<b>0.816***</b> (0.796, 0.835)	<b>0.883***</b> (0.873, 0.893)	<b>0.910***</b> (0.904, 0.915)
log(0.1 + test intensity in staff (lag=1))	<b>0.673***</b> (0.641, 0.706)	<b>0.574***</b> (0.560, 0.587)	<b>0.445***</b> (0.437, 0.454)
CQC: requires improvement	<b>1.147*</b> (1.001, 1.292)	<b>0.809***</b> (0.746, 0.872)	<b>0.971</b> (0.925, 1.017)
CQC: good	<b>1.111</b> (0.970, 1.253)	<b>0.766***</b> (0.705, 0.827)	<b>0.988</b> (0.943, 1.033)
CQC: outstanding	<b>1.028</b> (0.873, 1.183)	<b>0.758***</b> (0.690, 0.827)	<b>0.976</b> (0.927, 1.024)
CQC: null	<b>0.795</b> (0.432, 1.158)	<b>0.761***</b> (0.599, 0.924)	<b>1.049</b> (0.973, 1.125)
Is nursing home?	<b>1.014</b> (0.977, 1.050)	<b>0.994</b> (0.975, 1.013)	<b>1.053***</b> (1.041, 1.064)
Is independent?	<b>1.144</b> (0.809, 1.478)	<b>1.082</b> (0.900, 1.264)	<b>0.972</b> (0.861, 1.083)
Primary clients: older (65+) individuals	<b>1.136***</b> (1.067, 1.204)	<b>1.090***</b> (1.056, 1.125)	<b>1.029***</b> (1.009, 1.048)
Primary clients: individuals with dementia	<b>1.168***</b> (1.094, 1.242)	<b>1.077***</b> (1.039, 1.114)	<b>1.041***</b> (1.020, 1.062)
Primary clients: individuals with learning disabilities	<b>0.894***</b> (0.812, 0.975)	<b>0.853***</b> (0.811, 0.895)	<b>0.941***</b> (0.918, 0.965)
Local proportion of Delta variant		0.585** (0.109, 1.060)	0.003*** (-1.959, 1.964)
log(care workers per resident)	<b>0.679***</b> (0.634, 0.723)	<b>0.549***</b> (0.526, 0.573)	<b>0.567***</b> (0.552, 0.581)
Fraction of agency workers	<b>0.687***</b> (0.540, 0.834)	<b>0.959</b> (0.904, 1.013)	<b>0.972**</b> (0.943, 1.000)
Is community care home?	<b>0.959</b> (0.884, 1.035)	<b>1.052**</b> (1.011, 1.092)	<b>1.024*</b> (1.000, 1.047)
Is acute care home?	<b>0.843</b> (-0.139, 1.825)	<b>1.607</b> (0.987, 2.228)	<b>0.547</b> (-0.329, 1.424)
Av. doses of all vaccines per resident	<b>0.965</b> (0.902, 1.028)	<b>0.984***</b> (0.979, 0.990)	<b>1.000</b> (0.999, 1.001)
Av. doses of all vaccines per staff	<b>0.981</b> (0.946, 1.017)	<b>1.005***</b> (1.001, 1.009)	<b>1.000</b> (0.999, 1.001)
Total resident count	<b>1.004***</b> (1.003, 1.004)	<b>1.006***</b> (1.006, 1.007)	<b>1.004***</b> (1.004, 1.005)
Constant	<b>0.291***</b> (0.094, 0.488)	<b>0.970</b> (0.893, 1.047)	<b>0.331***</b> (0.215, 0.447)
Observations	15,778	72,467	76,301
Note:	*p<0.1; **p<0.05; ***p<0.01		



**Figure S3. Associations between the number of positives and the number of COVID-19-related total deaths, by primary client type served by care homes.** In this plot, the points indicate block-level observations for a particular care home; the blue lines represent linear regression fits assuming a generalised additive model (the default chosen by ggplot2) between numbers of positives and numbers of deaths.



**Figure S4. Projected COVID-19-related total deaths under counterfactual testing scenarios: sensitivity analysis.** Each plot shows the actual deaths (black lines) and the projected lines (blue lines) with associated uncertainty (see Methods). Each panel corresponds to a different counterfactual testing scenario when the numbers of tests were at the levels shown at the top of each panel relative to the historical levels: e.g., 75% means that testing (in both residents and staff) was at 75% of its factual level. This projection was made using the outbreak models incorporating diminishing returns to lagged positives (shown in Table S8).



**Figure S5. Projected COVID-19-related total deaths under counterfactual care worker scenarios: sensitivity analysis.** Each plot shows the actual deaths (black lines) and the projected lines (blue lines) with associated uncertainty (see Methods). Each panel corresponds to a different counterfactual testing scenario when the numbers of care workers per resident were at the levels shown at the top of each panel relative to the historical levels: e.g., 125% means that the number of care workers per resident was increased by 25% from its factual level. This projection was made using the outbreak models incorporating diminishing returns to lagged positives (shown in Table S8).



## 5.4.7 Appendix 5.4 references

1. Care Quality Commission. Using CQC data. 2023 [2 March 2023]; Available from: <https://www.cqc.org.uk/about-us/transparency/using-cqc-data>.
2. NECS. Capacity Tracker - Insight for Care. nd [2 March 2023]; Available from: <https://www.necsu.nhs.uk/capacity-tracker/>.

## 5.5 Economic analysis and findings

An evaluation of the impact of testing in care homes on mortality in residents was performed. A statistical analysis of the effectiveness of the current testing levels (baseline) was compared with the effectiveness of testing at 50%, 75%, 125%, 150% and 200% of the actual testing volume. The costs of these reduced and increased volumes were adjusted accordingly, assuming that the overhead and indirect costs remained the same, regardless of testing volume. Only the direct costs and direct overhead costs were proportionally adjusted.

The statistical analysis estimated that the testing in care home averted 24,000 and 8600 more deaths than if testing had been performed at 50% and 75%, respectively, of the actual testing volume. If testing had been performed at 125%, 150% or 200% of the actual level, 4000, 6600 or 9500 more deaths could have been averted, respectively, during the entire evaluation period (October 2020 to March 2022). Using data for the hospitalisation fatality ratio (HFR), the number of hospitalisations was estimated. This was then used to estimate the cost savings from reduced hospitalisations and the QALYs gained compared with actual testing rates. Table 1 summarises the input parameters and sources. A sensitivity analysis that tested the sensitivity of the outcome to the QALYs for death was conducted and presented in figure 5-10 in chapter 5 as the shaded area, with a minimum and maximum value of QALY for deaths of 4.98 and 8.8 respectively (Table 1).

See appendix 2.3 for methodology and details on cost and volumes.

**Table 1. Data inputs and assumptions for the testing service in adult social care.**

Parameter	Value	Source
Hospitalisation fatality ratio (HFR)	20.13	Calculated from ONS data (deaths/hospitalisations) [1]
QALYs for death	6.78 (4.98-8.8)	[2, 3]
QALYs for hospitalisations	0.201	[2, 3]
QALYs for ICU admission	0.15	[2, 3]
QALYs for symptomatic COVID-19 infections	0.008	[4]
Proportion of hospitalised patients with major manifestations	0.41 ( $\geq 19$ years) 0.2 ( $\leq 18$ years)	Statistical analysis (healthcare)
Proportion of hospitalised patients with pneumonia	0.42 ( $\geq 19$ years) 0.11 ( $\leq 18$ years)	Statistical analysis (healthcare)
Proportion of hospitalised patients with major manifestations or pneumonia in ICU	0.11 ( $\geq 19$ years) 0.9 ( $\leq 18$ years)	Statistical analysis (healthcare)
Cost of hospitalisation (GBP)	2771 3138	NHS Schedule of Costs [5]
Cost of hospitalisation with major manifestations (GBP)	4507 8606	NHS Schedule of Costs [5]

**Table 2. Summary of the costs and cost-effectiveness of the testing programme in care homes compared with hypothetical changes in the testing volume for FY21, FY22 and the full evaluation period.**

Comparator	Baseline compared with percentage testing volume				
	50%	75%	125%	150%	200%
Full evaluation period (October 2020-March 2022)					
Cost (GBP billions) <sup>1</sup>	2.56	3.18	4.41	5.03	6.26
Cost per death averted, in residents only, due to testing (GBP)	38,300	51,700	131,600	154,100	210,200
Cost per QALY gained from deaths averted in residents due to testing <sup>2</sup>	5,700	7,600	19,400	22,700	31,000
FY21 (October 2020-March 2022)					
Cost (GBP billions) <sup>1</sup>	1.40	1.75	2.45	2.76	3.45
Cost per death averted, in residents only, due to testing (GBP)	28,300	39,300	84,800	103,000	142,500
Cost per QALY gained from deaths averted in residents due to testing (GBP) <sup>2</sup>	4,200	5,800	12,500	15,200	21,000
FY22 (April 2021-March 2022)					
Cost (GBP billions) <sup>1</sup>	1.16	1.44	1.99	2.05	2.74
Cost per death averted, in residents only, due to testing (GBP)	68,000	84,700	411,100	396,600	507,200
Cost per QALY gained from deaths averted in residents due to testing (GBP) <sup>2</sup>	10,000	12,500	60,600	58,500	74,800

<sup>1</sup>Baseline (actual) costs: FY21 = GBP 2.09 billion; FY22 = GBP 1.71 billion; full evaluation period = GBP 3.80 billion

<sup>2</sup>A QALY value of 6.78 per death was used

FY, financial year; QALY, quality-adjusted life-year

### 5.5.1 Appendix 5.5 references

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