Public Health England

Protecting and improving the nation's health

COVID-19 vaccine surveillance report
Week 37

Contents

Summary

Four coronavirus (COVID-19) vaccines have now been approved for use in the UK. Rigorous clinical trials have been undertaken to understand the immune response, safety profile and efficacy of these vaccines as part of the regulatory process. Ongoing monitoring of the vaccines as they are rolled out in the population is important to continually ensure that clinical and public health guidance on the vaccination programme is built upon the best available evidence.

Public Health England (PHE) works closely with the Medicines and Healthcare Regulatory Agency (MHRA), NHS England, and other government, devolved administration and academic partners to monitor the COVID-19 vaccination programme. Details of the vaccine surveillance strategy are set on the Public Health England page COVID-19: vaccine surveillance strategy (1). As with all vaccines, the safety of COVID-19 vaccines is continuously being monitored by the MHRA. They conclude that overall, the benefits of COVID-19 vaccines outweigh any potential risks (2).

Vaccine effectiveness

Several studies of vaccine effectiveness have been conducted in the UK which indicate that two doses of vaccine are between 65 and 95% effective at preventing symptomatic disease with COVID-19 with the Delta variant, with higher levels of protection against severe disease including hospitalisation and death. There is some evidence of waning of protection against infection and symptomatic disease over time, though protection against severe disease remains high in most groups at least 5 months after the second dose.

Population impact

The impact of the vaccination programme on the population is assessed by taking into account vaccine coverage, evidence on vaccine effectiveness and the latest COVID-19 disease surveillance indicators. Vaccine coverage tells us about the proportion of the population that have received 1 and 2 doses of COVID-19 vaccines. By 12 September 2021, the overall vaccine uptake in England for dose 1 was 64.8% and 58.9% for dose 2. In line with the programme rollout, coverage is highest in the oldest age groups.

We present data on COVID-19 cases, hospitalisations and deaths by vaccination status.

Based on antibody testing of blood donors, 97.7% of the adult population now have antibodies to COVID-19 from either infection or vaccination compared to 18.9% that have antibodies from infection alone. Over 95% of adults aged 17 or older have antibodies from either infection or vaccination.

The latest estimates indicate that the vaccination programme has directly averted over 230,800 hospitalisations. Analysis on the direct and indirect impact of the vaccination programme on infections and mortality, suggests the vaccination programme has prevented between 24.4 and 24.9 million infections and between 108,600 and 116,200 deaths.

Vaccine effectiveness

Large clinical trials have been undertaken for each of the COVID-19 vaccines approved in the UK which found that they are highly efficacious at preventing symptomatic disease in the populations that were studied. The clinical trials have been designed to be able to assess the efficacy of the vaccine against laboratory confirmed symptomatic disease with a relatively short follow up period so that effective vaccines can be introduced as rapidly as possible. Nevertheless, understanding the effectiveness against different outcomes (such as severe disease and onwards transmission), effectiveness in different subgroups of the population and understanding the duration of protection are equally important in decision making around which vaccines should be implemented as the programme evolves, who they should be offered to and whether booster doses are required.

Vaccine effectiveness is estimated by comparing rates of disease in vaccinated individuals to rates in unvaccinated individuals. Below we outline the latest real-world evidence on vaccine effectiveness from studies in UK populations. We focus on data related to the Delta variant which is currently dominant in the UK. The findings are also summarised in Table 1.

Effectiveness against symptomatic disease

Vaccine effectiveness against symptomatic COVID-19 has been assessed in England based on community testing data linked to vaccination data from the National Immunisation Management System (NIMS), cohort studies such as the COVID Infection Survey and GP electronic health record data. After 2 doses, observed vaccine effectiveness against symptomatic disease with the Delta variant reaches approximately 65 to 70% with AstraZeneca Vaxzevria and 80 to 95% with Pfizer-BioNTech Comirnaty and Moderna Spikevax (3, 4) Vaccine effectiveness is generally slightly higher in younger compared to older age groups. With both Vaxzevria and and Comirnaty, there is evidence of waning of protection over time, most notably among older adults. There is not yet enough follow-up with Spikevax to assess waning (3).

Data (based primarily on the Alpha variant) suggest that in most clinical risk groups, immune response to vaccination is maintained and high levels of VE are seen with both the Pfizer and AstraZeneca vaccines. Reduced antibody response and vaccine effectiveness were seen after 1 dose of vaccine among the immunosuppressed group, however, after a second dose the reduction in vaccine effectiveness is smaller (5).

Analyses by dosing interval suggest that immune response to vaccination and vaccine effectiveness against symptomatic disease improves with a longer (greater than 6 week interval) compared to a shorter interval of 3 to 4 weeks (6, 3)

Effectiveness against hospitalisation

Several studies have estimated vaccine effectiveness against hospitalisation in older all of which indicate higher levels of protection against hospitalisation with all vaccines against the Alpha variant (7, 8, 9, 10). Effectiveness against hospitalisation of over 90% is also observed with the Delta variant with all three vaccines (3). In most groups there is relatively limited waning of protection against hospitalisation over a period of at least 5 months after the second dose. Greater waning appears to occur among those in clinical risk groups (3).

Effectiveness against mortality

High levels of protection (over 90%) are also seen against mortality with all three vaccines and against both the Alpha and Delta variants (7, 11, 3). Relatively limited waning of protection against mortality is seen over a period of at least 5 months.

Effectiveness against infection

Although individuals may not develop symptoms of COVID-19 after vaccination, it is possible that they could still be infected with the virus and could transmit to others. Understanding how effective vaccines are at preventing infection is therefore important to predict the likely impact of the vaccination programme on the wider population. In order to estimate vaccine effectiveness against infection, repeat asymptomatic testing of a defined cohort of individuals is required. Studies have now reported on vaccine effectiveness against infection in healthcare workers, care home residents and the general population (12, 13, 14, 15). With the delta variant, vaccine effectiveness against infection has been estimated at around 65% with Vaxzevria and 80% with Comirnaty (4).

Effectiveness against transmission

As described above, several studies have provided evidence that vaccines are effective at preventing infection. Uninfected individuals cannot transmit; therefore, the vaccines are also effective at preventing transmission. Data from Scotland has also shown that household contacts of vaccinated healthcare workers are at reduced risk of becoming a case, which is in line with the studies on infection (16). There may be additional benefit, beyond that due to prevention of infection, if some of those individuals who become infected despite vaccination are also at a reduced risk of transmitting (for example, because of reduced duration or level of viral shedding). A household transmission study in England found that household contacts of cases vaccinated with a single dose had approximately 35 to 50% reduced risk of becoming a confirmed case of COVID-19. This study used routine testing data so would only include household contacts that developed symptoms and went on to request a test via pillar 2. It cannot exclude asymptomatic secondary cases or mildly symptomatic cases who chose not to request a COVID-19 test (17). Both of these studies relate to a period when the Alpha variant dominated.

Table 1. Summary of evidence on vaccine effectiveness against different outcomes Delta

Outcome	Vaccine effectiveness*		
	Pfizer-BioNTech Cominarty	**AstraZeneca Vaxzevria**	**Moderna Spikevax**
Infection	75-85%	60-70%	
Symptomatic disease	80-90%	65-75%	90-99%
Hospitalisation	95-99%	90-99%	95-99%
Mortality	90-99%	90-95%	

High Confidence	Evidence from multiple studies which is consistent and comprehensive
Medium Confidence	Evidence is emerging from a limited number of studies or with a moderately level of uncertainty
Low Confidence	Little evidence is available at present and results are inconclusive

* Estimates of initial vaccine effectiveness in the general population after a 2 dose course. This typically applies for at least the first 3 to 4 months after vaccination. For some outcomes there may be waning of effectiveness beyond this point.

Population impact

Vaccines typically have both direct effects on those who are vaccinated and indirect effects on the wider population due to a reduced probability that people will come into contact with an infected individual. The overall impact of the vaccination programme may therefore extend beyond that estimated through vaccine effectiveness analysis.

Estimating the impact of a vaccination programme is challenging as there is no completely unaffected control group. Furthermore, the effects of the vaccination programme need to be differentiated from that of other interventions (for example, lockdowns or outbreak control measures), changes in behaviour and any seasonal variation in COVID-19 activity.

PHE and other government and academic partners monitor the impact of the of the vaccination programme on levels of COVID-19 antibodies in the population and different disease indicators, including hospitalisations and mortality. This is done through population-based testing and through modelling which combines vaccine coverage rates in different populations, estimates of vaccine effectiveness and disease surveillance indicators.

Vaccine coverage

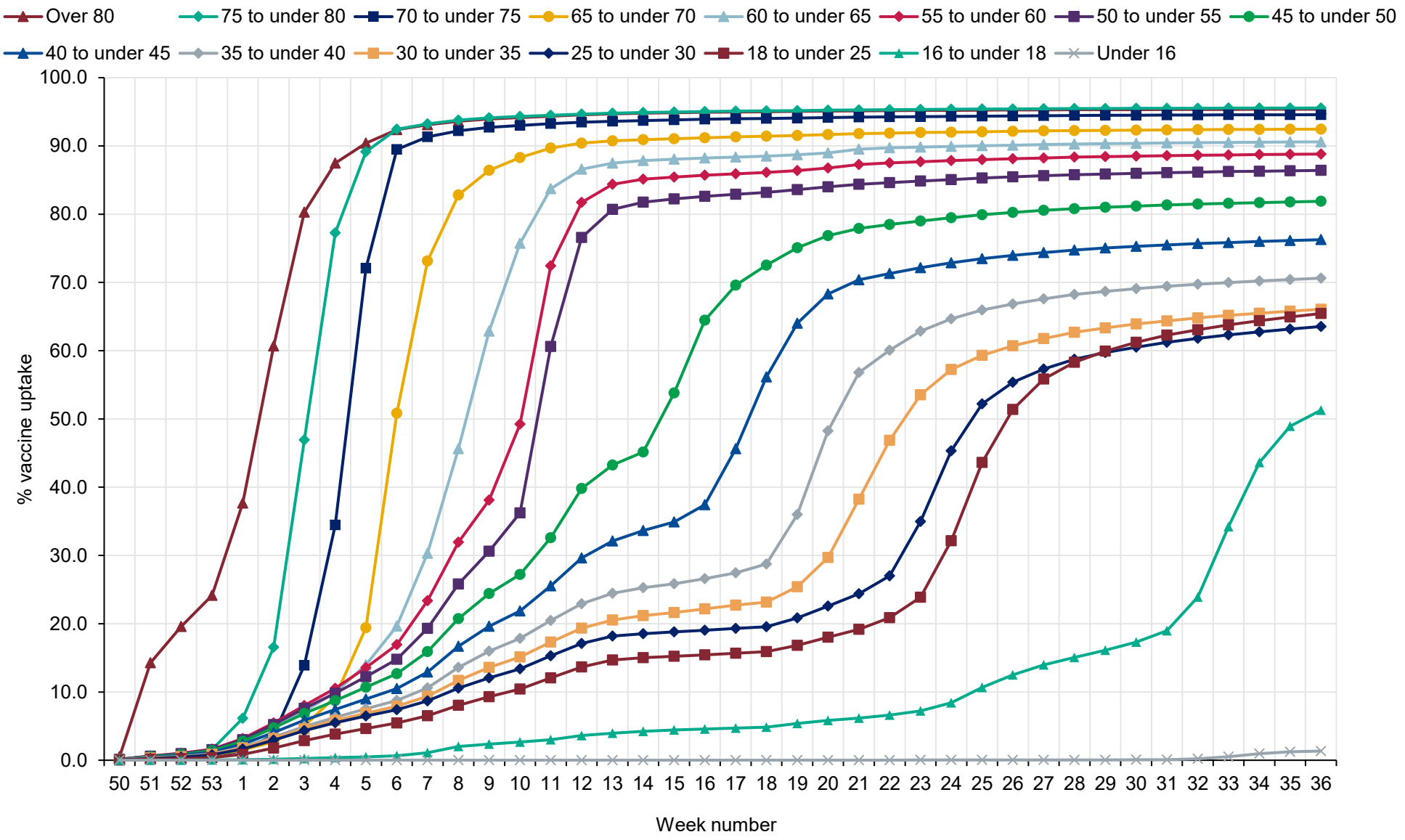
The data in this week's report covers the period from 8 December 2020 to 12 September 2021 (week 36) (Figure 1). It shows the provisional number and percentage of people in England who have had received 1 dose or 2 doses of a COVID-19 vaccination by age group and week since the start of the programme.

Up to 31 August 2021 81,532 women of child-bearing age in England (under 50) who reported that they were pregnant or could be pregnant at the time, received at least 1 dose of COVID-19 vaccination and of these, 65,579 have received their second dose. This is in response to the self-reported pre-screening question "Are you or could you be pregnant?". The true number of pregnant women who have had a COVID-19 vaccination is likely to be greater than this.

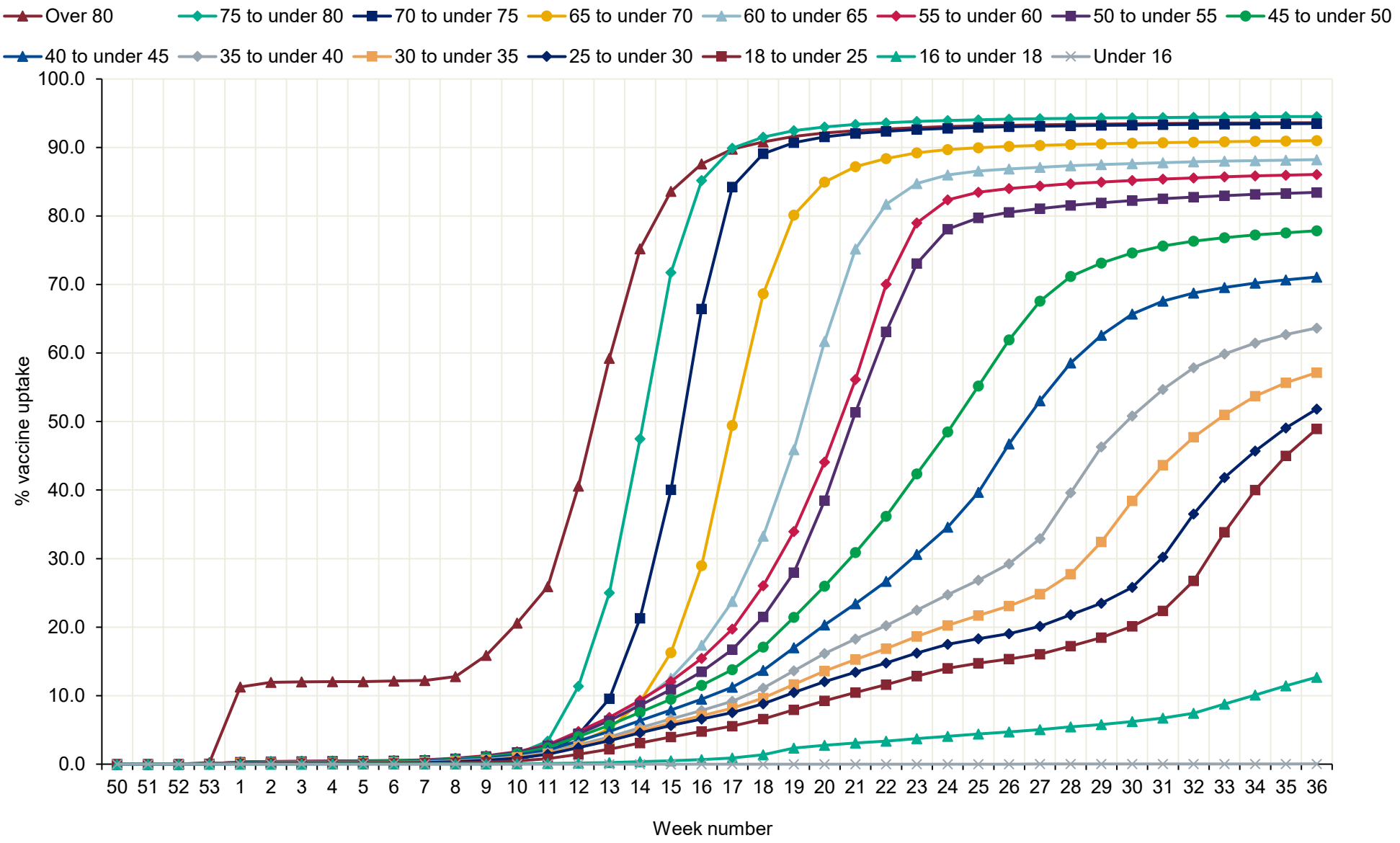
Please note that pregnant women are not a separate priority group as defined by JCVI who have advised that "women who are pregnant should be offered vaccination at the same time as non-pregnant women, based on their age and clinical risk group" therefore comparing vaccine uptake in pregnant women to other vaccination programmes is not currently appropriate. The MHRA closely monitors the safety of COVID-19 vaccine exposures in pregnancy, including Yellow Card reports for COVID-19 vaccines used in pregnancy, for the latest information please see the webpage Coronavirus vaccine – weekly summary of Yellow Card reporting.

Figure 1. Cumulative weekly vaccine uptake by age

a) Dose 1



b) Dose 2


Over 80
75 to under 80
70 to under 75
65 to under 70
60 to under 65
55 to under 60
50 to under 55
45 to under 50
40 to under 45
35 to under 40
30 to under 35
25 to under 30
18 to under 25
16 to under 18
Under 16
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
% vaccine uptake
50 51 52 53 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Week number

Vaccination status

Vaccination status of COVID-19 cases, deaths and hospitalisations by week of specimen date over the past 4 weeks up to week 36 (up to 12 September 2021) are shown in Table 2 to 4 and Figure 2.

Methods

COVID-19 cases and deaths identified through routine collection from the Second Generation Surveillance System (SGSS) and from PHE EpiCell's deaths data as described here, were linked to the National Immunisation Management System (NIMS) to derive vaccination status, using an individual's NHS number as the unique identifier.

Attendance to emergency care at NHS trusts was derived from the Emergency Care DataSet (ECDS) managed by NHS Digital. The same data source was used to identify COVID-19 cases where the attendance to emergency care resulted in admission to an NHS trust.

ECDS is updated weekly, and cases are linked to these data twice weekly. Data from ECDS are subject to reporting delays as, although NHS trusts may update data daily, the mandatory deadline for submission is by the 21st of every month. This means that for weeks immediately following the 21st of a month, numbers may be artificially low and are likely to be higher in later versions of the report.

Data from ECDS also only report on cases who have been presented to emergency care and had a related overnight patient admission and do not show those who are currently in hospital with COVID-19. As such, it is not appropriate for use for surveillance of those currently hospitalised with COVID-19. In addition, these data will not show cases who were directly admitted as inpatients without presenting to emergency care.

The outcome of overnight inpatient admission following presentation to emergency care, was limited to those occurring within 28 days of the earliest specimen date for a COVID-19 case.

Deaths include those who died (a) within 28 days of the earliest specimen date or (b) within 60 days of the first specimen date or more than 60 days after the first specimen date with COVID-19 mentioned on the death certificate.

The rate of COVID-19 cases, hospitalisation, and deaths in fully vaccinated and unvaccinated groups was calculated using vaccine coverage data for each age group extracted from the National Immunisation Management Service.

Results

The rate of a positive COVID-19 test varies by age and vaccination status. The rate of a positive COVID-19 test is substantially lower in vaccinated individuals compared to unvaccinated individuals up to the age of 39, and in those aged greater than 80. In individuals aged 40 to 79, the rate of a positive COVID-19 test is higher in vaccinated individuals compared to unvaccinated. This is likely to be due to a variety of reasons, including differences in the population of vaccinated and unvaccinated people as well as differences in testing patterns.

The rate of hospitalisation within 28 days of a positive COVID-19 test also increases with age, and is substantially greater in unvaccinated individuals compared to vaccinated individuals.

The rate of death within 28 days or within 60 days of a positive COVID-19 test increases with age, and again is substantially greater in unvaccinated individuals compared to fully vaccinated individuals.

Interpretation of the data

These data should be considered in the context of vaccination status of the population groups shown in the rest of this report. The vaccination status of cases, inpatients and deaths is not the most appropriate method to assess vaccine effectiveness and there is a high risk of misinterpretation. Vaccine effectiveness has been formally estimated from a number of different sources and is described earlier in this report.

In the context of very high vaccine coverage in the population, even with a highly effective vaccine, it is expected that a large proportion of cases, hospitalisations and deaths would occur in vaccinated individuals, simply because a larger proportion of the population are vaccinated than unvaccinated and no vaccine is 100% effective. This is especially true because vaccination has been prioritised in individuals who are more susceptible or more at risk of severe disease. Individuals in risk groups may also be more at risk of hospitalisation or death due to non-COVID-19 causes, and thus may be hospitalised or die with COVID-19 rather than because of COVID-19.

Table 2. COVID-19 cases by vaccination status between week 33 and week 36 2021

Cases reported by specimen date between week 33 and week 36 2021	Total	Unlinked*	Not vaccinated	Received one dose (1-20 days before specimen date)	Received one dose, ≥21 days before specimen date	Second dose ≥14 days before specimen date	Rates among persons vaccinated with 2 doses (per 100,000)	Rates among persons not vaccinated (per 100,000)
Under 18	190,863	16,825	161,418	9,812	1,999	809	458.2	1,362.3
18-29	145,087	15,923	44,455	3,280	50,338	31,091	633.3	1,284.9
30-39	105,839	11,081	31,577	1,225	17,273	44,683	795.9	1,069.8
40-49	98,990	8,593	14,570	426	5,215	70,186	1,157.3	852.6
50-59	84,468	6,559	7,215	145	2,080	68,469	972.1	699.2
60-69	46,557	3,462	2,592	51	766	39,686	699.5	477.7
70-79	26,937	2,012	918	8	260	23,739	512.3	371.1
80+	12,563	1,142	540	9	256	10,616	412.3	424.5

*individuals whose NHS numbers were unavailable to link to the NIMS

** Interpretation of the case rates in vaccinated and unvaccinated population is particularly susceptible to changes in denominators and should be interpreted with extra caution.

Table 3. COVID-19 cases presenting to emergency care (within 28 days of a positive specimen) resulting in an overnight inpatient admission by vaccination status between week 33 and week 36 2021

Cases presenting to emergency care (within 28 days of a positive test) resulting in overnight inpatient admission, by specimen date between week 33 and week 36 2021	Total	Unlinked*	Not vaccinated	Received one dose (1-20 days before specimen date)	Received one dose, ≥21 days before specimen date	Second dose ≥14 days before specimen date	Rates among persons vaccinated with 2 doses (per 100,000)	Rates among persons not vaccinated (per 100,000)
Under 18	539	29	494	13	3	0	0.0	4.2
18-29	635	19	414	17	86	99	2.0	12.0
30-39	848	17	608	14	66	143	2.5	20.6
40-49	903	26	551	10	50	266	4.4	32.2
50-59	1,147	12	533	6	41	555	7.9	51.7
60-69	1,239	14	403	7	50	765	13.5	74.3
70-79	1,517	2	239	3	25	1,248	26.9	96.6
80+	1,528	2	183	1	42	1,300	50.5	143.9

*individuals whose NHS numbers were unavailable to link to the NIMS

Table 4. COVID-19 deaths (a) within 28 days and (b) within 60 days of positive specimen or with COVID-19 reported on death certificate, by vaccination status between week 33 and week 36 2021

(a)

Death within 28 days of positive COVID-19 test by date of death between week 33 and week 36 2021	Total	Unlinked*	Not vaccinated	Received one dose (1-20 days before specimen date)	Received one dose, ≥21 days before specimen date	Second dose ≥14 days before specimen date	Rates among persons vaccinated with 2 doses (per 100,000)	Rates among persons not vaccinated (per 100,000)
Under 18	4	1	3	0	0	0	0.0	0.0
18-29	18	0	13	0	1	4	0.1	0.4
30-39	50	2	36	0	3	9	0.2	1.2
40-49	114	3	75	0	7	29	0.5	4.4
50-59	240	5	126	0	16	93	1.3	12.2
60-69	391	9	132	1	18	231	4.1	24.3
70-79	742	2	156	0	28	556	12.0	63.1
80+	1,402	7	185	4	34	1,172	45.5	145.4

(b)

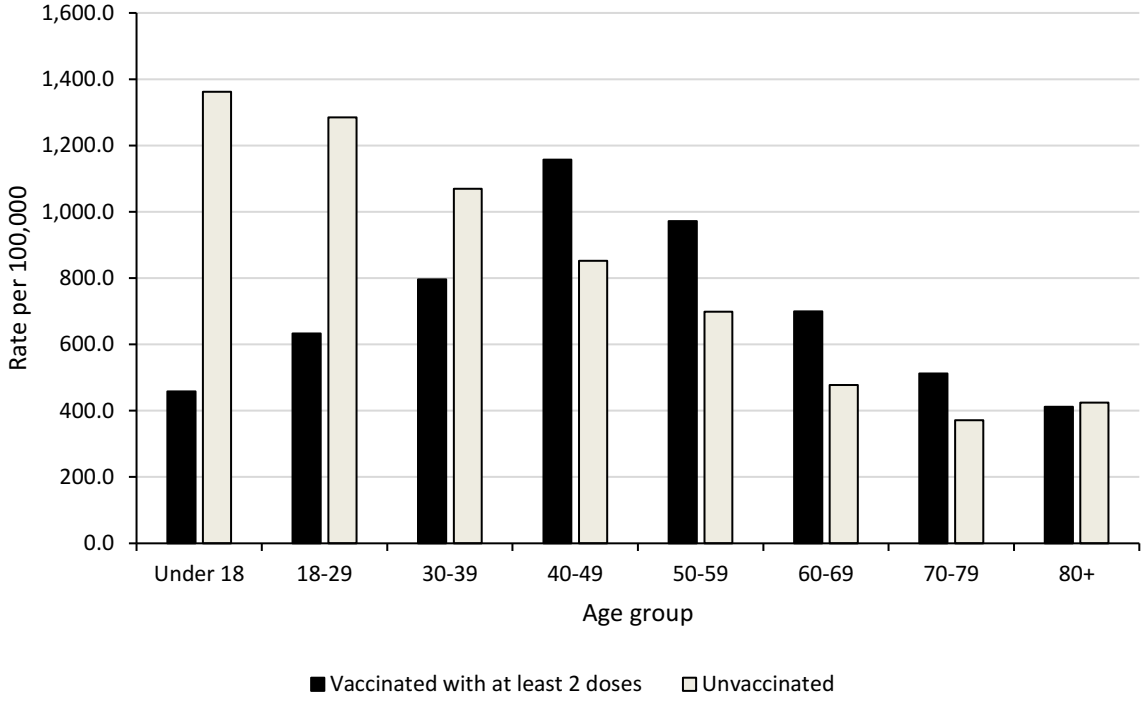
Death within 60 days of positive COVID-19 test** by date of death between week 33 and week 36 2021	Total	Unlinked*	Not vaccinated	Received one dose (1-20 days before specimen date)	Received one dose, ≥21 days before specimen date	Second dose ≥14 days before specimen date	Rates among persons vaccinated with 2 doses (per 100,000)	Rates among persons not vaccinated (per 100,000)
Under 18	5	1	4	0	0	0	0.0	0.0
18-29	26	0	16	1	4	5	0.1	0.5
30-39	63	2	44	0	4	13	0.2	1.5
40-49	149	3	93	0	14	39	0.6	5.4
50-59	294	5	151	0	17	121	1.7	14.6
60-69	474	10	171	1	22	270	4.8	31.5
70-79	841	2	173	0	33	633	13.7	69.9
80+	1,604	7	198	4	46	1,349	52.4	155.7

*individuals whose NHS numbers were unavailable to link to the NIMS

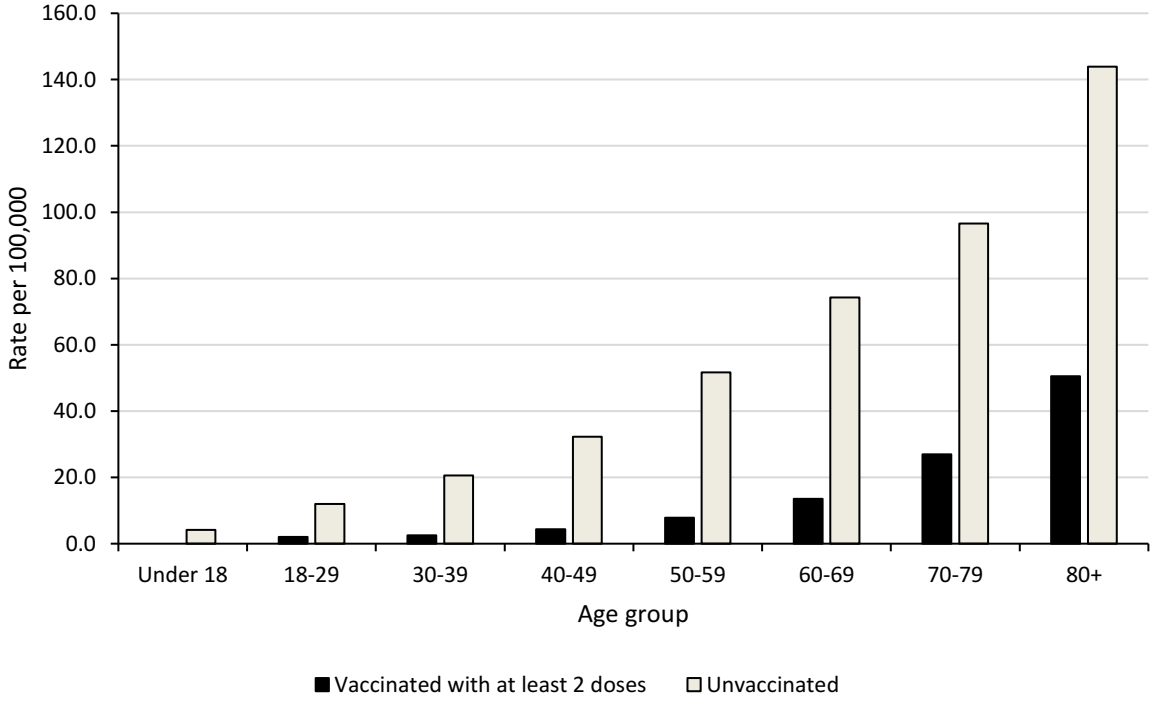
** Number of deaths of people who had had a positive test result for COVID-19 and either died within 60 days of the first positive test or have COVID-19 mentioned on their death certificate

Figure 2. Rates (per 100,000) by vaccination status from week 33 to week 36 2021

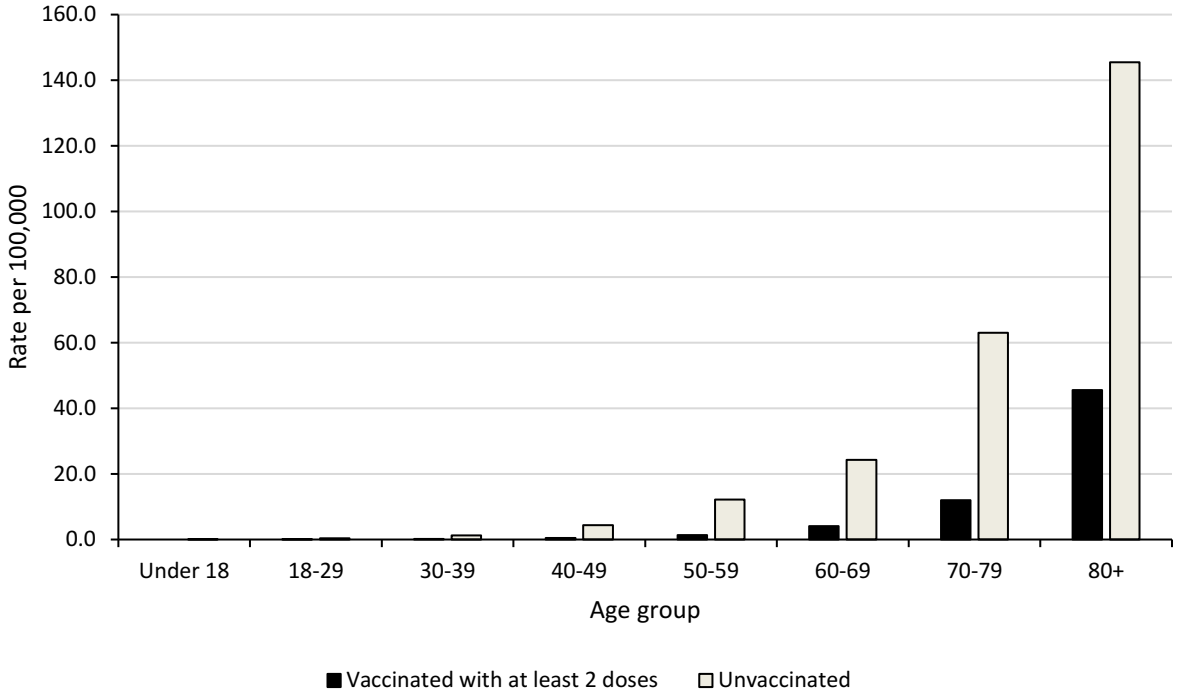
(a) COVID-19 cases



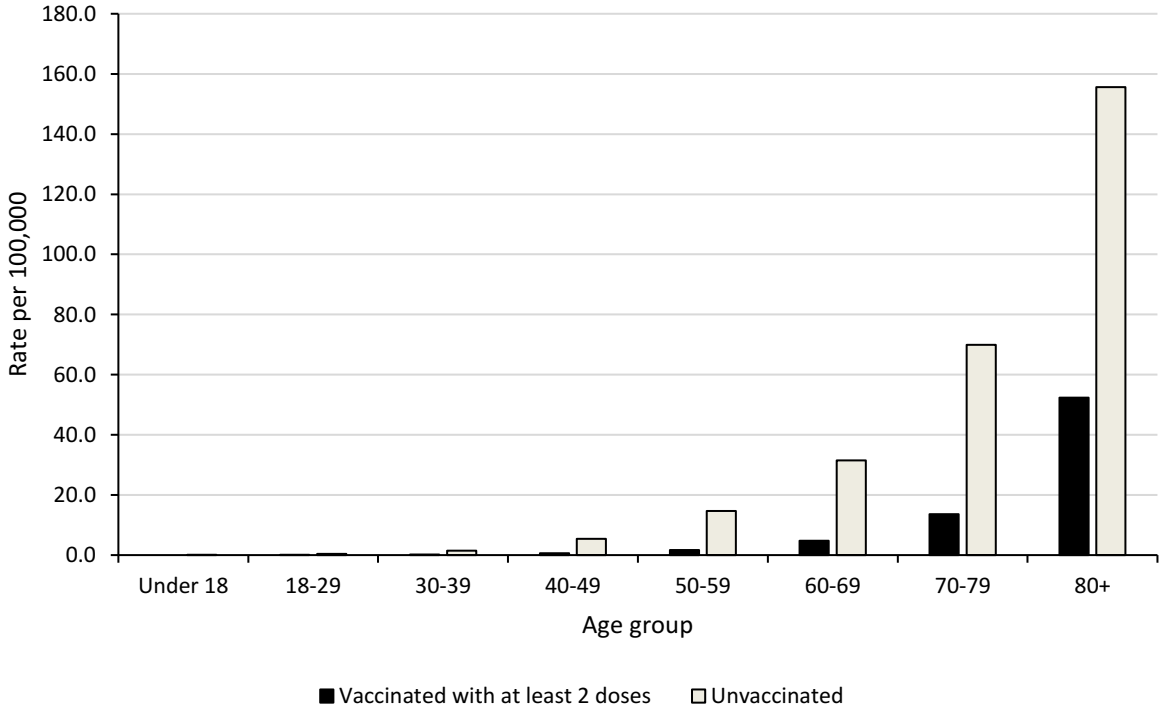
(b) Cases presenting to emergency care (within 28 days of a positive test) resulting in overnight inpatient admission



(c) Death within 28 days of positive COVID-19 test



(d) Death within 60 days of positive COVID-19 test



Vaccine impact on proportion of population with antibodies to COVID-19

PHE monitors the proportion of the population with antibodies to COVID-19 by testing samples provided by healthy adult blood donors aged 17 years and older, supplied by the NHS Blood and Transplant (NHS BT collection). This is important in helping to understand the extent of spread of COVID-19 infection (including asymptomatic infection) in the population and the impact of the vaccine programme. 250 samples from every geographic region in England are tested each week using 2 different laboratory tests, the Roche nucleoprotein (N) and Roche spike (S) antibody assays. This dual testing helps to distinguish between antibodies that are produced following natural COVID-19 infection and those that develop after vaccination. Nucleoprotein (Roche N) assays only detect post-infection antibodies, whereas spike (Roche S) assays will detect both post-infection antibodies and vaccine-induced antibodies. Thus, changes in the proportion of samples testing positive on the Roche N assay will reflect the effect of natural infection and spread of COVID-19 in the population. Increases in the proportion positive as measured by S antibody will reflect both infection and vaccination. Antibody responses reflect infection or vaccination occurring at least 2 to 3 weeks previously given the time taken to generate an antibody response.

In this report, we present the results using a 4-weekly average, of testing samples up to 3 September 2021, which takes account of the age and geographical distribution of the English population. Overall, the proportion of the population with antibodies using the Roche N and Roche S assays respectively were 18.9% and 97.7% for the period 12 August to 3 September (weeks 32 to 35) (Figure 3). This compares with 18.1% Roche N seropositivity and 97.6% Roche S seropositivity for the period of 12 July to 6 August (weeks 28 to 31).

The continuing increase in seropositivity using the Roche S assay reflects the growing proportion of adults who have developed antibodies following vaccination.

Figure 4a and 4b show the proportion of the population with antibodies by age group. Recent increases in N seropositivity has been observed in some age groups. Roche N seropositivity in individuals aged 17 to 29 years increased slightly from 27.3% in weeks 28 to 31 to 28.7% in weeks 32 to 35. Small increases were observed in the 30 to 39 year olds from 19.6% in weeks 28 to 31 to 21.5% in weeks 32 to 35 and in 40 to 49 years olds from 19.6% in weeks 28 to 31 to 20.4% in weeks 32 to 35. Similarly, small increases were also observed in 50 to 59 year olds from 17.1% in weeks 28 to 31 to 17.9% in weeks 32 to 35 and in individuals aged 60 to 69 from 11.7% in weeks 28 to 31 to 12.2% in weeks 32 to 35. Roche N seropositivity decreased in 70 to 84 year olds from 8.2% in weeks 28 to 31 to 7.2% in weeks 32 to 35.

The pattern of increases in Roche S seropositivity which are observed follow the roll out of the vaccination programme with the oldest age groups offered vaccine first. (Figure 4b). Roche S seropositivity increased first in donors aged 70 to 84 and has plateaued since week 13, reaching 99.0% in weeks 32 to 35. Seropositivity has also plateaued since week 16 for those aged 60 to 69 reaching 99.1% in weeks 32 to 35. Plateauing in Roche S seropositivity has been observed since week 19 in those aged 50 to 59 reaching 99.0% in weeks 32 to 35 2021. A plateauing in seropositivity has been observed in the 40 to 49-year olds since week 23 reaching 97.8% in weeks 32 to 35. Plateauing has been observed in the 30 to 39 year olds from week 28 reaching 96.6% in weeks 32 to 35. A plateauing in seropositivity has recently been observed in the 17 to 29 year olds reaching 95.8% in weeks 32 to 35 2021.

The impact of the vaccination programme is clearly evident from the increases in the proportion of the adult population with antibodies based on Roche S testing. This is was evident initially amongst individuals aged 50 years and above who were prioritised for vaccination as part of the phase 1 programme and since week 15 in younger adults and below as part of phase 2 of the vaccination programme.

Figure 3. Overall population weighted 4-weekly rolling SARS-CoV-2 antibody seroprevalence (% seropositive) in blood donors from the Roche S and Roche N assays.

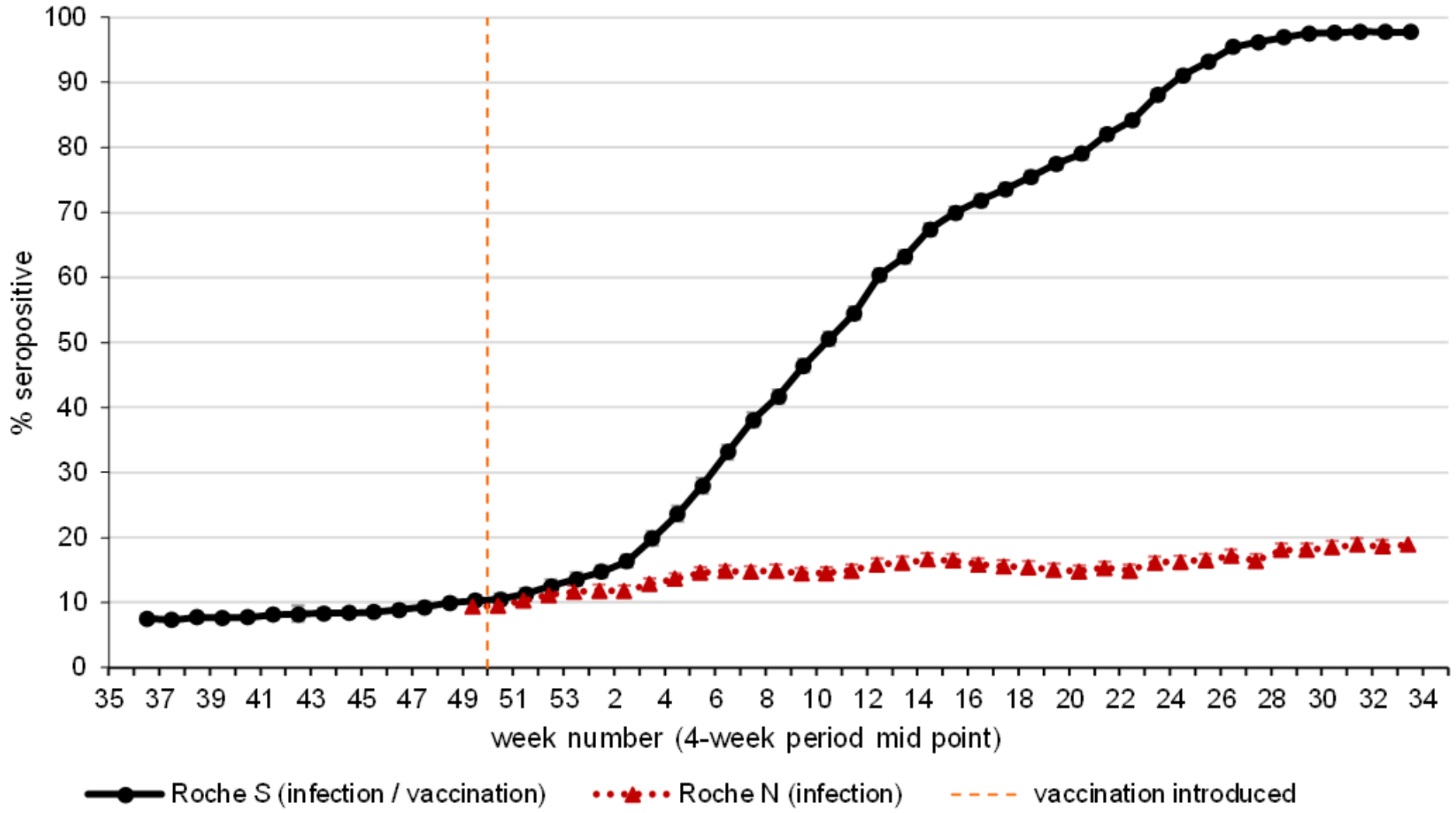
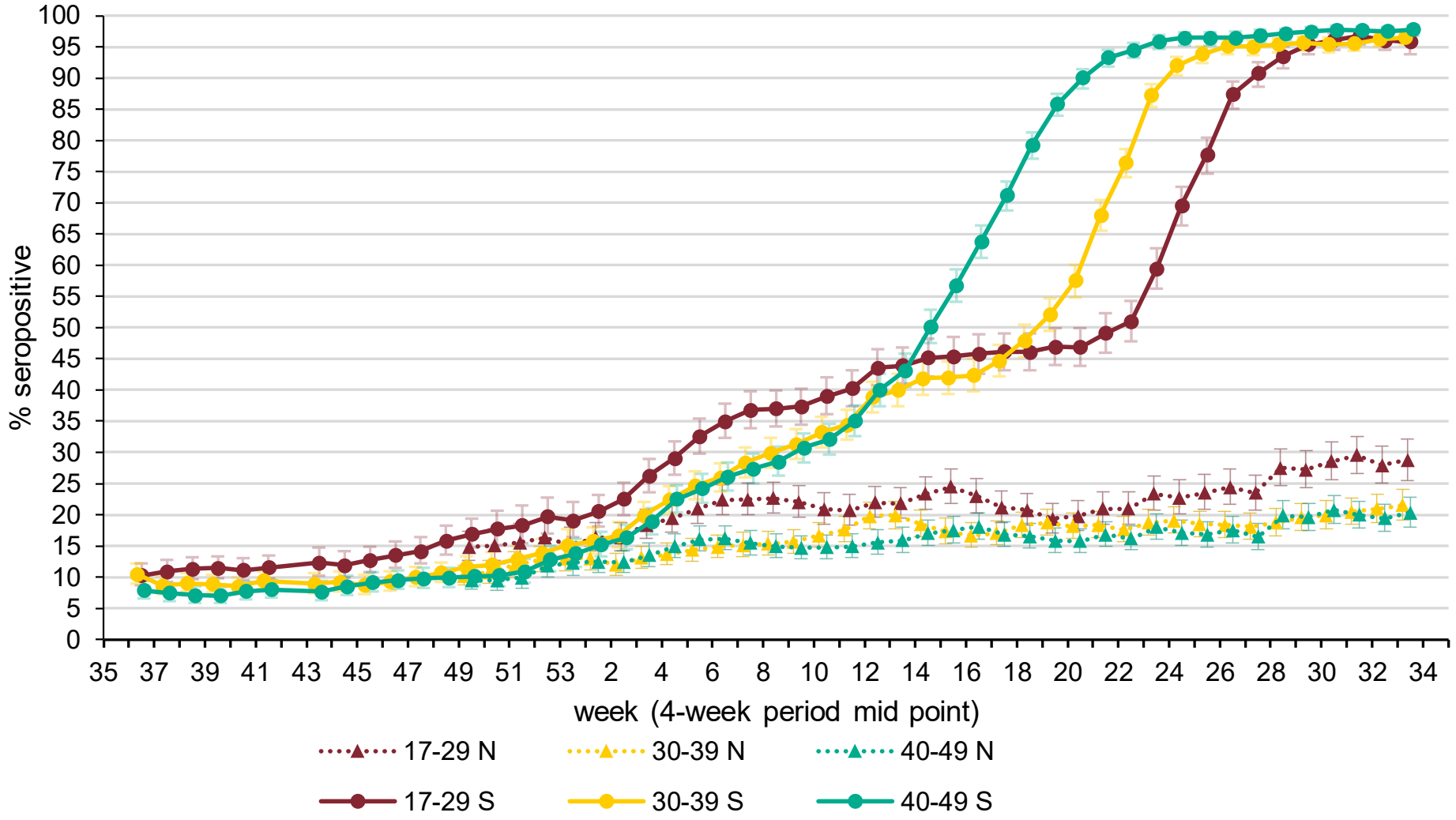
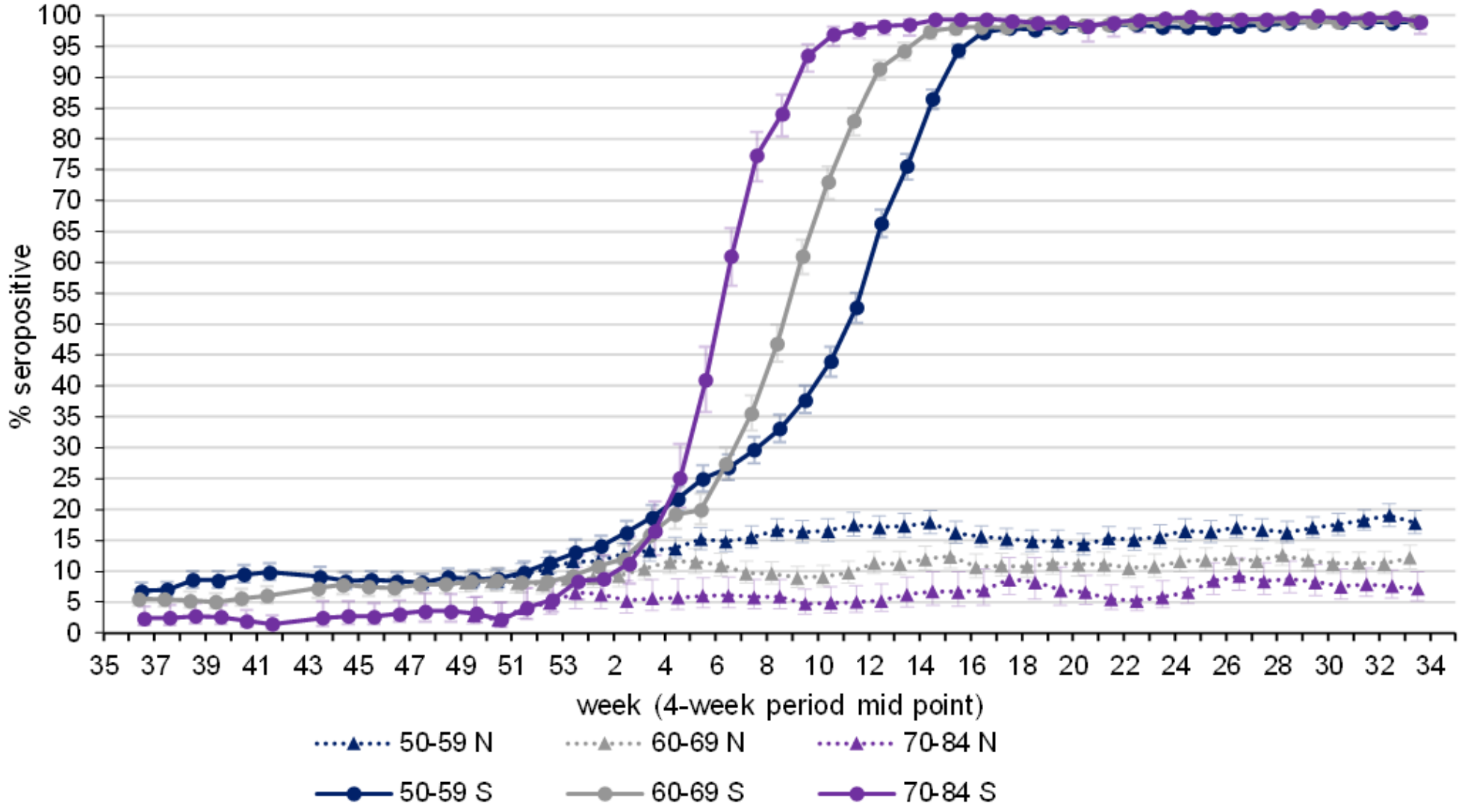


Figure 4. Population weighted 4-weekly rolling SARS-CoV-2 antibody seroprevalence (% seropositive) in blood donors from the Roche S and Roche N assays by a) age groups 17 to 29, 30 to 39 and 40 to 49, b) age group 50 to 59, 60 to 69 and 70 to 84.

a)



b)


% seropositive
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
35 37 39 41 43 45 47 49 51 53 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
week (4-week period mid point)
50-59 N
60-69 N
70-84 N
50-59 S
60-69 S
70-84 S

Direct impact on hospitalisations

The number of hospitalisations averted by vaccination, can be estimated by considering vaccine effectiveness against hospitalisation, vaccine coverage and observed hospitalisations and through modelling using a range of parameters.

For the week 35 report the vaccine effectiveness estimates used in the model were updated to use more recent vaccine effective estimates. The vaccine effectiveness estimates used in previous reports were slightly lower than the current estimates, therefore an increase in the number of hospitalisations averted was seen in the week 35 report compared to previous reports.

PHE estimates to 5 September 2021 based on the direct effect of vaccination and vaccine coverage rates, are that around 178,900 hospitalisations have been prevented in those aged 65 years and over in England (approximately 46,500 admissions in those aged 65 to 74, 73,800 in those aged 75 to 84, and 58,600 in those aged 85 and over) as a result of the vaccination programme (Figure 5).

From week 36, we are adding the analysis on hospitalisations averted in 45 to 64 years. PHE estimates to 5 September 2021 based on direct effects of vaccination and coverage rates show that around 51,900 hospitalisations have been prevented in this age group. This age group is inclusive of healthy individuals and at risk groups, the latter prioritised earlier in the campaign.

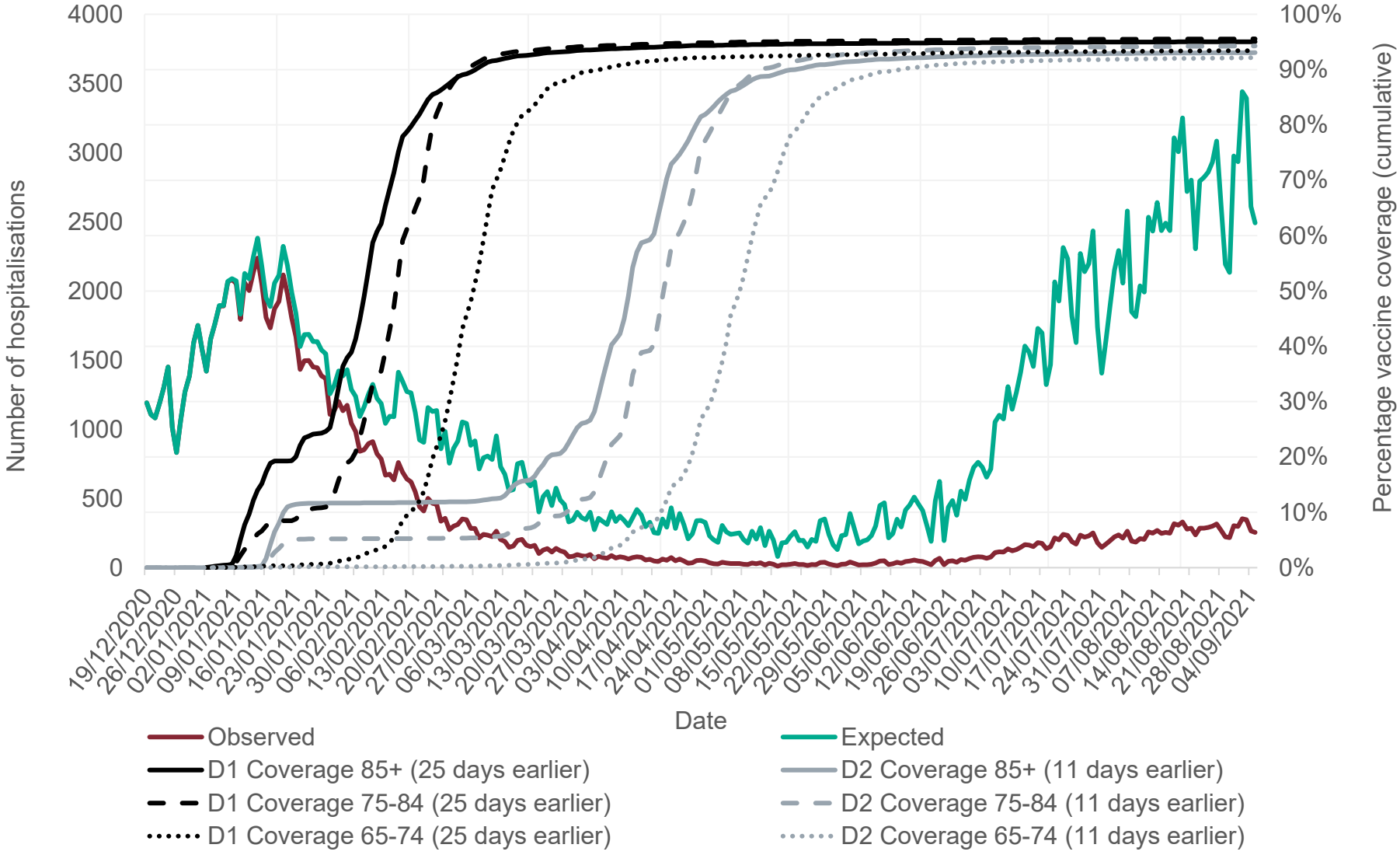
In total, around 230,800 hospitalisations have been prevented in those aged 45 years and over up to 5 September 2021.

There is increasing evidence that vaccines prevent infection and transmission. The indirect effects of the vaccination programme will not be incorporated in this analysis, therefore the figure of 230,800 hospitalisations averted is likely to be an underestimate.

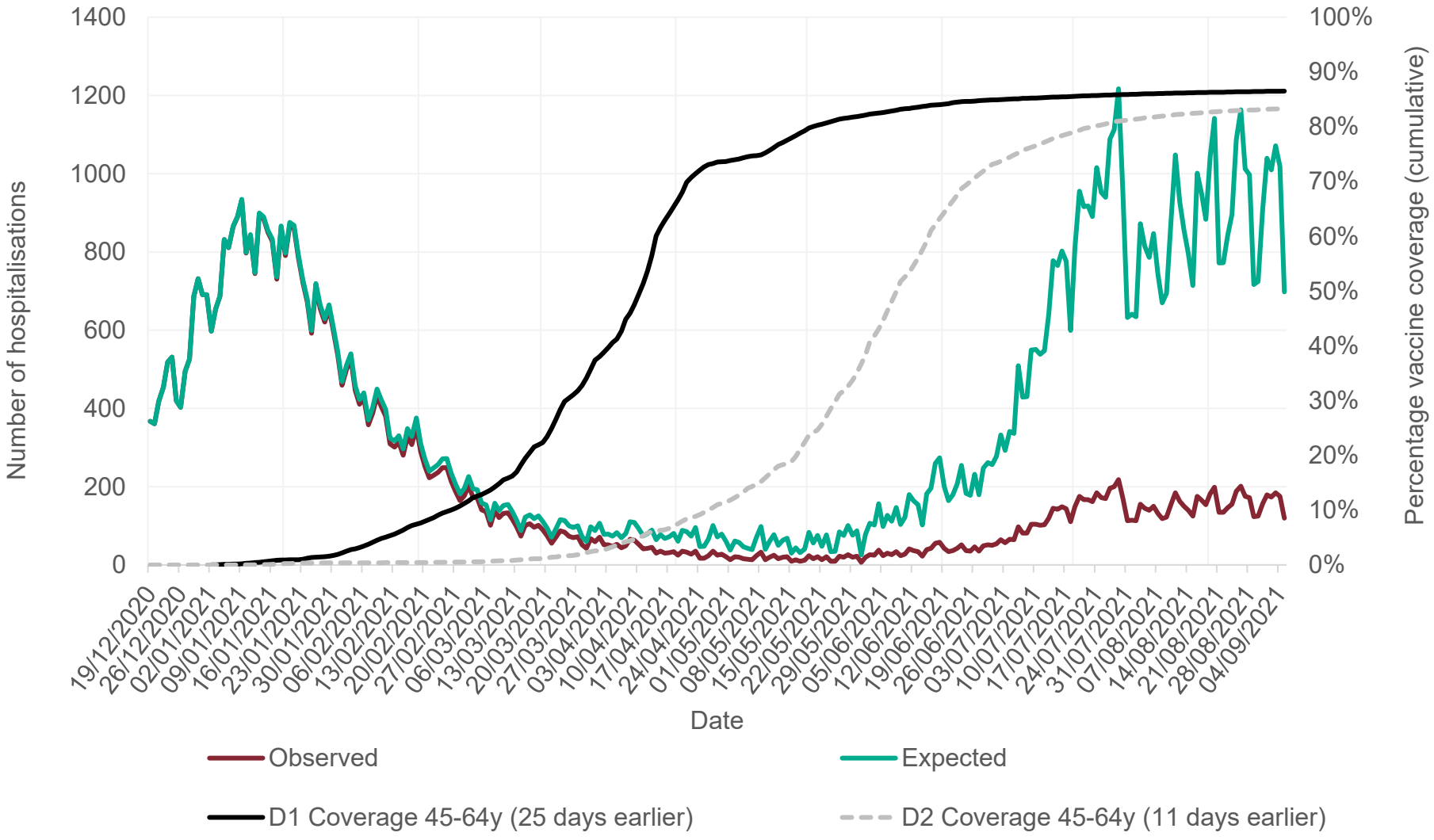
Please note this analysis will be updated every 2 weeks.

Figure 5. Plot of daily observed and expected COVID-19 hospitalisations in (a) adults aged 65 and over (b) adults aged 45 to 64

(a)



(b)


Number of hospitalisations
Percentage vaccine coverage (cumulative)
Date
Observed
Expected
D1 Coverage 45-64y (25 days earlier)
D2 Coverage 45-64y (11 days earlier)

Direct and indirect impact on infection and mortality

The PHE and Cambridge real-time model has been used to track the COVID-19 infection throughout the pandemic, providing key epidemic insights, including estimation of the reproduction number, R, to the Scientific Pandemic Influenza subgroup on Modelling (SPI-M) and to the Scientific Advisory Group on Emergencies (SAGE). The application to data from the first wave has been published in Real-time nowcasting and forecasting of COVID-19 dynamics in England: the first wave (18). Since the first wave, the model has been constantly improved to capture the pandemic activity as it develops, in particular to account for the impacts, both direct and indirect, of the vaccination programme. The direct impact of vaccination is the number of deaths saved in those that get infected, whereas the indirect effect incorporates the additional prevention of infections. The history of real-time modelling outputs can be found at Nowcasting and Forecasting of the COVID-19 Pandemic (19), with the most recent results on which the figures here are based is currently available at COVID-19: nowcast and forecast (20).

Vaccination rates in the model are based on the actual number of doses administered, and the vaccine is assumed to reduce susceptibility to COVID-19 as well as mortality once infected. Estimates for vaccine efficacy are based on the best available published results (21). The model is fitted to both ONS prevalence and daily COVID-19 mortality data in England, resulting in posterior samples for a range of epidemiological parameters. To infer the impact of vaccination, the posterior samples are used to simulate the number of infections and deaths that would have occurred without vaccination (Figure 6). The total impact is then calculated by comparing the infection and mortality estimates with vaccination versus the simulated outcomes without vaccination (Figure 7; Table 5).

The no-vaccination scenario assumes that no other interventions are implemented to reduce incidence and mortality. Therefore, the findings presented here should be interpreted as the impact of the vaccination programme on infection and mortality assuming no additional non-pharmaceutical interventions were implemented. In practice, it is impossible to predict what interventions would have been implemented in the absence of vaccination, although it is reasonable to assume that lockdown measures would have remained in place for substantially longer and that new lockdown measures would have been put into place to reduce the pandemic's impact. Similarly, it is likely that people's behaviour would have changed in response to the rising cases and deaths.

Consequently, over time the state of the actual pandemic and the no-vaccination pandemic will become increasingly less comparable. For example, recent results from the no-vaccination scenario show that the pandemic in the absence of vaccination and additional interventions would have peaked due to natural immunity. Therefore, reinfections will become more important, but data on the risk and severity of reinfections is still lacking. Similarly, the arrival and spread of new strains will be different in the 2 scenarios, making it harder to predict what would have happened in the no-vaccination

scenario. This means that the comparison shown here becomes less meaningful as time goes on.

In conclusion, this means that the no-vaccination scenario captures what would have happened in the absence of additional interventions to mitigate the pandemic, public behaviour had stayed the same, and the timing of the introduction of new viral strains (that is, the delta variant) had not changed. Results should be interpreted accordingly.

The work presented in this section is joint work completed by PHE and Cambridge University's MRC Biostatistics Unit.

Estimates suggest that 112,300 deaths and 24,702,000 infections have been prevented as a result of the COVID-19 vaccination programme, up to 27 August. Please note this analysis has not been updated since last week's report.

Table 5. Inferred reduction in infections and mortality as the result of vaccination up to 27 August 2021. (Infections are rounded to the nearest 1,000, deaths to the nearest 100).

Model	Outcome	Reduction
ONS/Death	Infection	24,702,000 [24,465,000 to 24,966,000]
ONS/Death	Mortality	112,300 [108,600 to 116,200]

Figure 6. Inferred and predicted incidence, mortality and prevalence with and without vaccination in England. This is presented on a log scale

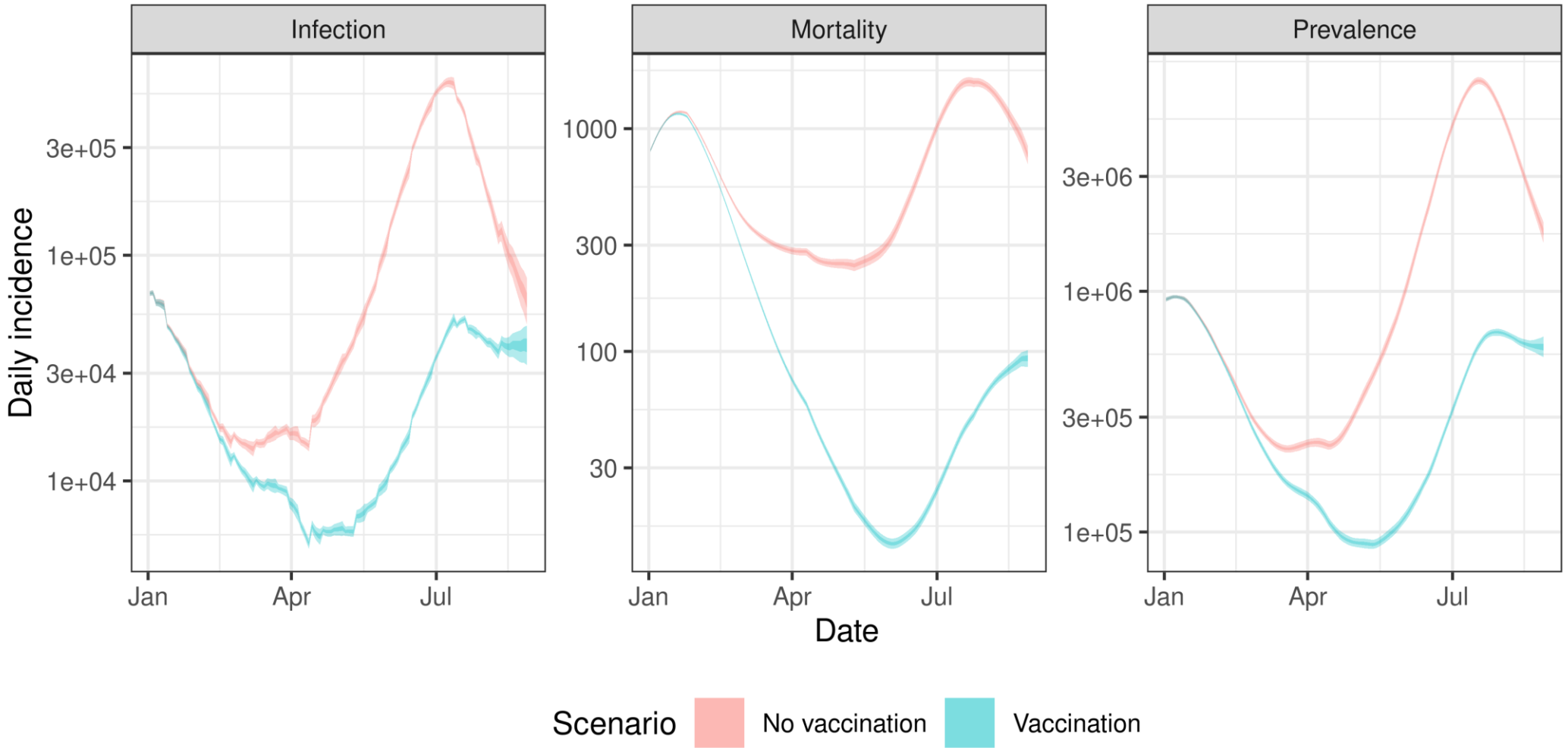
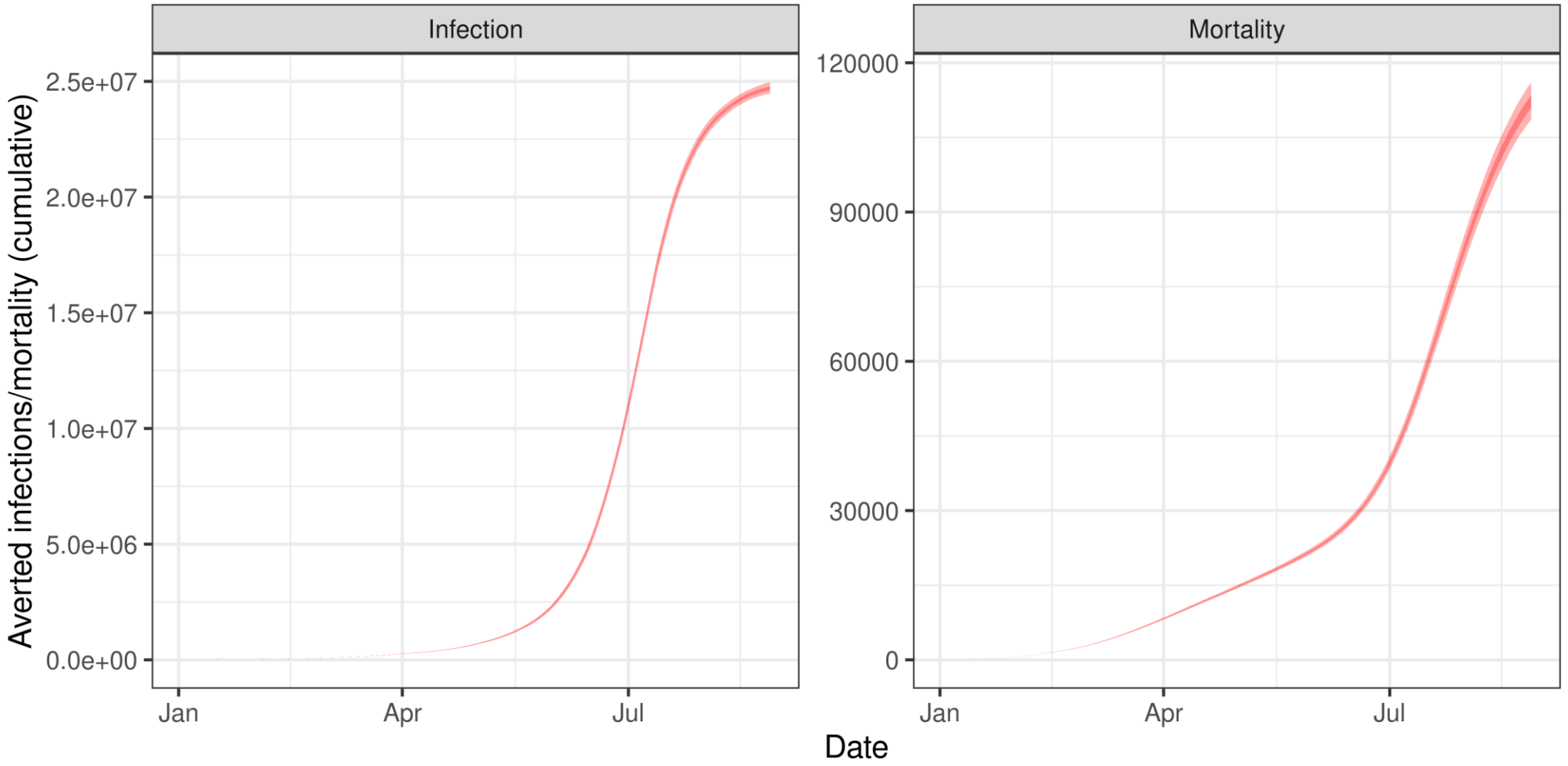


Figure 7. Averted number of infections (left) and deaths (right) due to vaccination (cumulatively)



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Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-leading science, research, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

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