Public Health England

Protecting and improving the nation's health

COVID-19 vaccine surveillance report
Week 35

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 a single dose of either vaccine is between 55 and 70% effective against symptomatic disease, with higher levels of protection against severe disease including hospitalisation and death. Additional protection is seen after a second dose. There is now also evidence from a number of studies that the vaccines are effective at protecting against infection and transmission.

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 22 August 2021, the overall vaccine uptake in England for dose 1 was 64.3% and 57.2% for dose 2. In line with the programme rollout, coverage is highest in the oldest age groups.

Based on antibody testing of blood donors, 97.9% 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 143,600 hospitalisations. Analysis on the direct and indirect impact of the vaccination programme on infections and mortality, suggests the vaccination programme has prevented between 23.8 and 24.4 million infections and between 102,500 and 109,500 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. It is important to continue to evaluate the effectiveness of vaccines in the 'real world', as this may differ to clinical trial efficacy. The clinical trials are also performed in order 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. The majority of this data relates to a period when the main circulating virus was the Alpha variant, emerging data on effectiveness against symptomatic disease with the Delta variant is also summarised below. The findings are also summarised in Tables 1 to 3.

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 NIMS and from the COVID Infection Survey. Current evidence is primarily from older adults, who were among the earliest group vaccinated. Estimates of vaccine effectiveness range from around 55 to 70% after 1 dose, with little evidence of variation by vaccine or age group (3, 4, 5). Data on 2 doses is indicates effectiveness of around 65 to 90% (3, 6).

Offer of the Pfizer and Moderna mRNA vaccines to adults aged under 40 years began on 10 May 2021. Early estimates of effectiveness of a single dose of either vaccine indicate a vaccine effectiveness of around 60% after 1 dose of the Pfizer vaccine and around 70% (95% CI: 46 to 86%) after 1 dose of the Moderna vaccine (week 26 Vaccine Surveillance Report).

Data 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 (7).

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 (8).

Effectiveness against hospitalisation

Several studies have estimated the effectiveness against hospitalisation in older adults, all of which indicate higher levels of protection against hospitalisation after a single dose than that seen against symptomatic disease, around 75 to 85% after 1 dose of the Pfizer-BioNTech or Oxford-AstraZeneca vaccine (3, 9, 10, 11). Data on VE against hospitalisation with 2 doses for all ages with the Alpha variant is shown in the week 26 Vaccine Surveillance Report.

Effectiveness against mortality

Data is also emerging which suggests high levels of protection against mortality. Studies linking community COVID-19 testing data, vaccination data and mortality data indicate that both the Pfizer-BioNTech and Oxford-AstraZeneca vaccines are around 70 to 85% effective at preventing death with COVID-19 after a single dose (3, 12). Vaccine effectiveness against mortality with 2 doses of the Pfizer vaccine is around 95 to 99% and with 2 doses of the AstraZeneca vaccine around 75 to 99% (week 26 Vaccine Surveillance Report).

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. With the Pfizer-BioNTech, estimates of effectiveness against infection range from around 55 to 70%, with the Oxford-AstraZeneca vaccine they range from around 60 to 70% (5, 13, 14, 15). With 2 of 2 doses of either vaccine effectiveness against infection is estimated at around 65 to 90% (5, 13).

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).

Table 1. Summary of evidence on vaccine effectiveness against different outcomes (data relate to period when the Alpha variant dominated)

Outcome	Vaccine effectiveness			
	Pfizer-BioNTech		Oxford-AstraZeneca	
	1 dose	2 doses	1 dose	2 doses
Symptomatic disease	55 to 70%	85 to 95%	55 to 70%	70 to 85%
Hospitalisation	75 to 85%	90 to 99%	75 to 85%	80 to 99%
Mortality	70 to 85%	95 to 99%	75 to 85%	75 to 99%
Infection	55 to 70%	70 to 90%	55 to 70%	65 to 90%
Transmission (secondary cases)*	45 to 50%	No data	35 to 50%	No data

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

* effectiveness in reducing symptomatic secondary cases in households of a symptomatic index case

Vaccine effectiveness against the Delta variant

Analysis of routine testing data up to 13 June 2021, linked to sequencing and S-gene target status has been used to estimate vaccine effectiveness against symptomatic disease using a test negative case control design. Methods and detailed results are available in Effectiveness of COVID-19 vaccines against the B.1.617.2 (Delta) variant (18). After a single dose there was an 14% absolute reduction in vaccine effectiveness against symptomatic disease with Delta compared to Alpha, and a smaller 10% reduction in effectiveness after 2 doses (Table 2).

Table 2. Vaccine effectiveness against symptomatic disease for Alpha and Delta variants

Vaccine Status	Vaccine Effectiveness	
	Alpha	Delta
Dose 1	49 (46 to 52)	35 (32 to 38)
Dose 2	89 (87 to 90)	79 (78 to 80)

Vaccine effectiveness against hospitalisation was estimated by evaluating hospitalisation rates via emergency care among symptomatic confirmed cases using survival analysis. This analysis used available data from linkage of symptomatic cases, 12 April to the 10 June 2021 (updated from the previous analysis to 4 June 2021). Hazard ratios for hospitalisation are combined with odds ratios against symptomatic disease from the test negative case control analysis described above to estimate vaccine effectiveness against hospitalisation. Methods and detailed results are available here (19). Similar vaccine effectiveness against hospitalisation was seen with the Alpha and Delta variants (Table 3).

Table 3. Vaccine effectiveness against hospitalisation for Alpha and Delta variants

Vaccine Status	Vaccine Effectiveness	
	Alpha	Delta
Dose 1	78 (64 to 87)	80 (69 to 88)
Dose 2	93 (80 to 97)	96 (91 to 98)

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

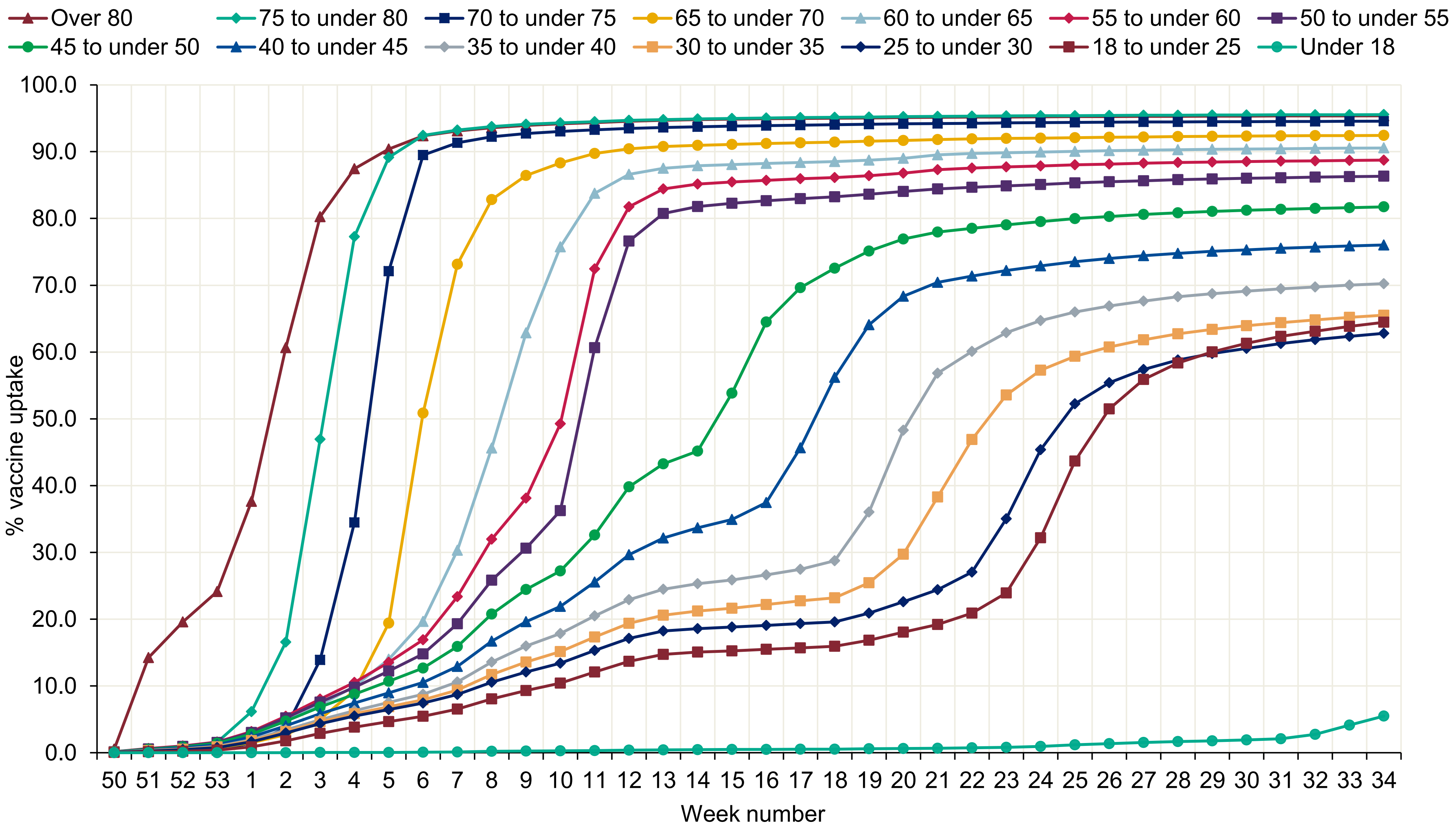
The data in this week's report covers the period from 8 December 2020 to 29 August 2021 (week 34) (Figure 1). It shows the provisional number and percentage of people in England who have had received 1 dose or 2 doses of a COVID-19 vaccination by age group and week since the start of the programme.

Up to 31 July 2021 62,311 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, 43,737 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.

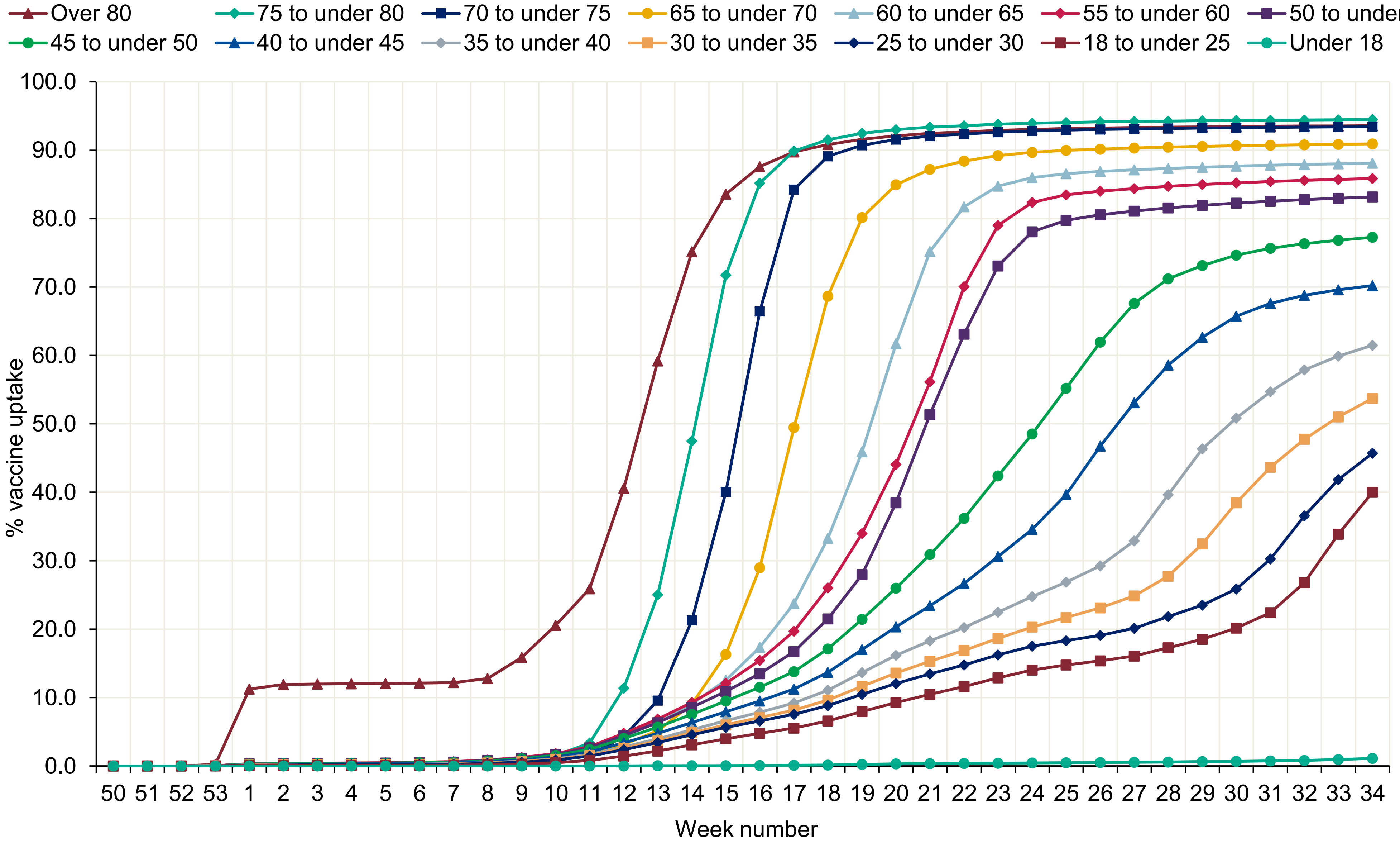
Please note that pregnant women are not a separate priority group as defined by JCVI who have advised that "women who are pregnant should be offered vaccination at the same time as non-pregnant women, based on their age and clinical risk group" therefore comparing vaccine uptake in pregnant women to 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 here.

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
Under 18
% vaccine uptake
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
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
Week number

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 20 August 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 97.9% for the period 26 July to 20 August (weeks 30 to 33) (Figure 2). This compares with 16.4% Roche N seropositivity and 96.2% Roche S seropositivity for the period of 28 June to 23 July (weeks 26 to 29).

The small increases in Roche N over this period reflect increases in case numbers consistent with the pattern observed in other surveillance data. The continuing increase in seropositivity using the Roche S assay reflects the growing proportion of adults who have developed antibodies following vaccination.

Figure 3a and 3b 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 from 23.5% in weeks 26 to 29 to 28.8% in weeks 30 to 33. An increase was also seen in 40 to 49 year olds from 16.4% in weeks 26 to 29 to 20.0% in weeks 30 to 33. Increases were seen in the 30 to 39 year olds from 18.0% in week 26 to 29 to 20.1% in weeks 30 to 33. A similar increase was observed in 50 to 59 year olds from 16.7% in weeks 26 to 29 to 18.6% in weeks 30 to 33. Roche N seropositivity has remained stable across 60 to 69 and 70 to 84 year olds.

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 3b). Roche S seropositivity increased first in donors aged 70 to 84 and has plateaued since week 13, reaching 99.8% in weeks 30 to 33. Seropositivity has also plateaued since week 16 for those aged 60 to 69 reaching 99.1% in weeks 30 to 33. Plateauing in Roche S seropositivity has been observed since week 19 in those aged 50 to 59 reaching 99.0% in weeks 30 to 33 2021. A plateauing in seropositivity has recently been observed in the 40 to 49-year olds since week 23 reaching 97.6% in weeks 30 to 33. Plateauing is now being observed in the 30 to 39-year olds, reaching 95.5% in weeks 30 to 33. Increases in seropositivity are still being observed in those aged 17 to 29, increasing from 90.8% in weeks 26 to 29 2021 to 97.1% in weeks 30 to 33 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 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 2. Overall population weighted 4-weekly rolling SARS-CoV-2 antibody seroprevalence (% seropositive) in blood donors from the Roche S and Roche N assays.

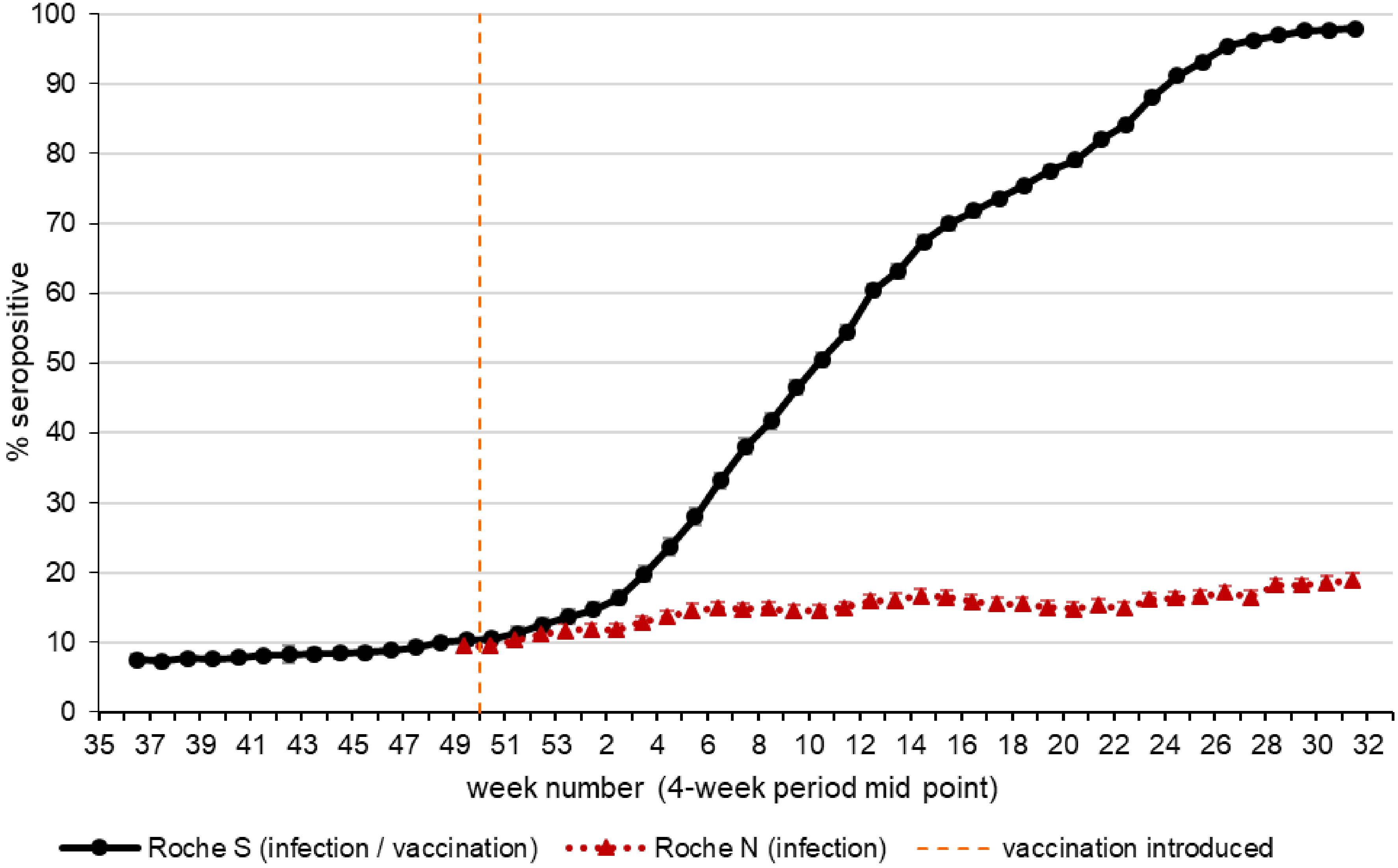
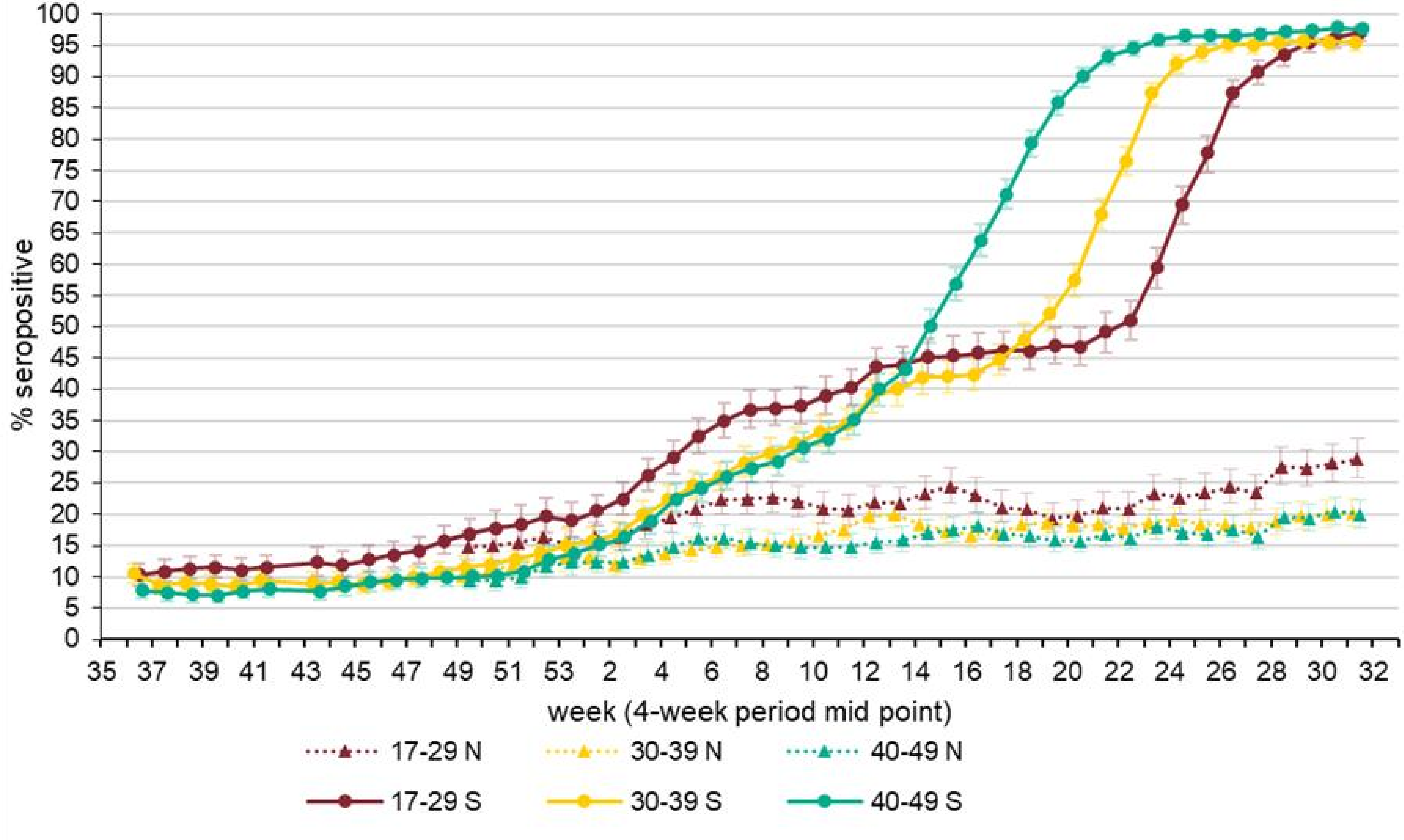
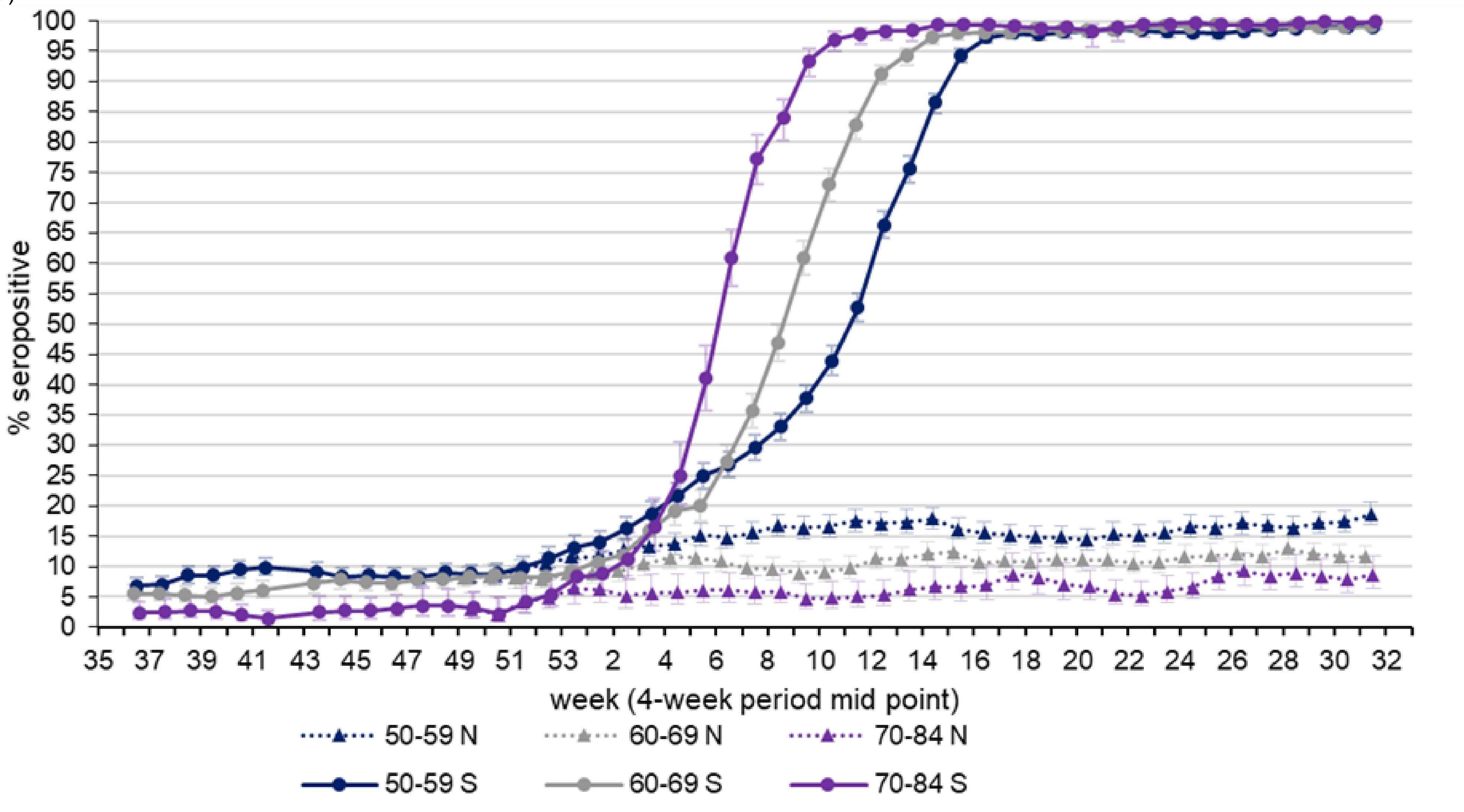


Figure 3. Population weighted 4-weekly rolling SARS-CoV-2 antibody seroprevalence (% seropositive) in blood donors from the Roche S and Roche N assays by a) age groups 17 to 29, 30 to 39 and 40 to 49, b) age group 50 to 59, 60 to 69 and 70 to 84.

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
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

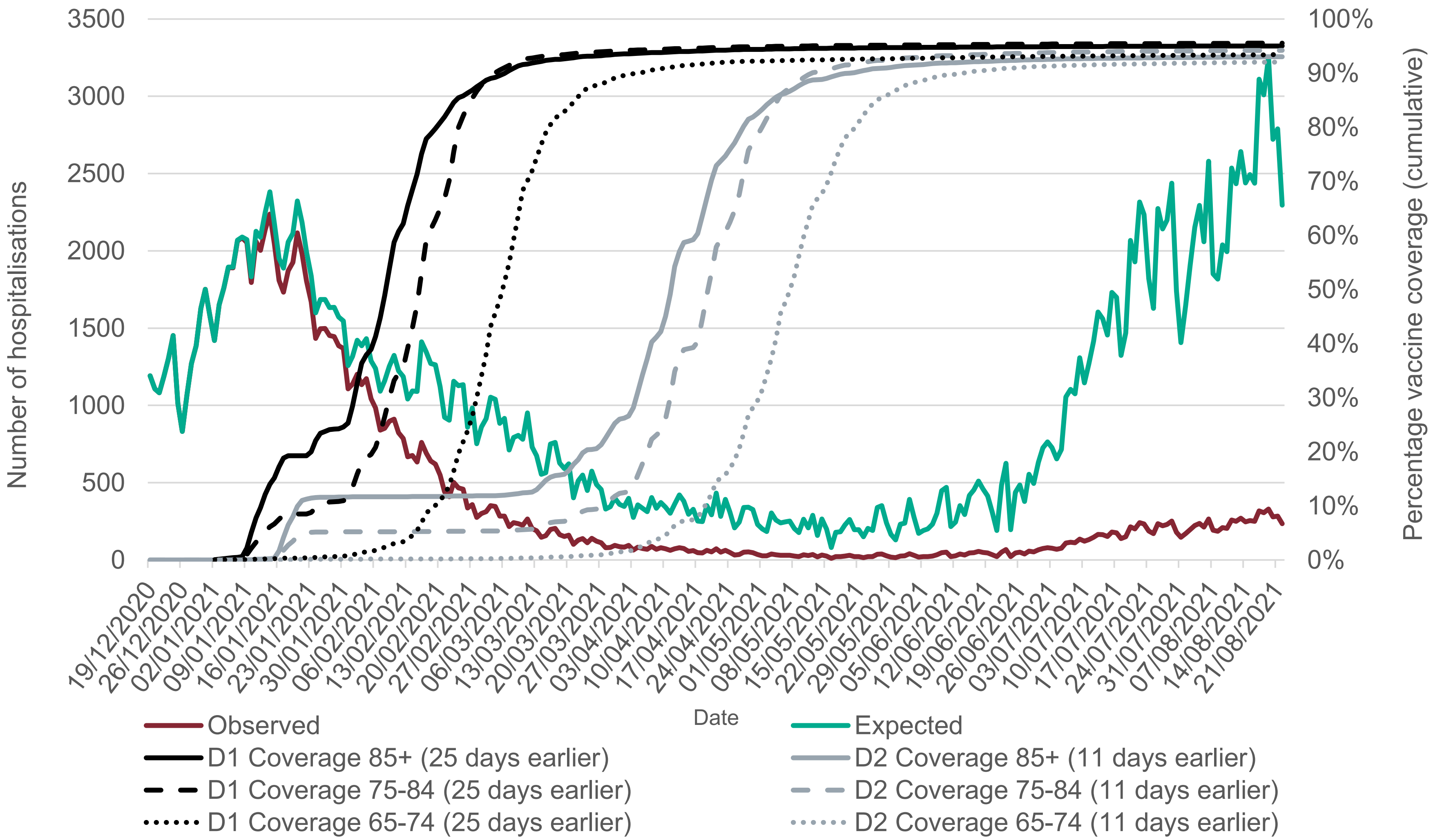
The number of hospitalisations averted by vaccination, can be estimated by considering vaccine effectiveness against hospitalisation, vaccine coverage and observed hospitalisations and through modelling using a range of parameters.

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 22 August 2021 based on the direct effect of vaccination and vaccine coverage rates, are that around 143,600 hospitalisations have been prevented in those aged 65 years and over in England (approximately 36,100 admissions in those aged 65 to 74, 58,800 in those aged 75 to 84, and 48,700 in those aged 85 and over) as a result of the vaccination programme (Figure 4). 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 143,600 hospitalisations averted is likely to be an underestimate.

Please note this analysis will be updated every 2 weeks.

Figure 4. Plot of daily observed and expected COVID-19 hospitalisations in adults aged 65 and over



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 (20). 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 (21), with the most recent results on which the figures here are based is currently available at COVID-19: nowcast and forecast (22).

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 (23). 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 5). The total impact is then calculated by comparing the infection and mortality estimates with vaccination versus the simulated outcomes without vaccination (Figure 6; Table 4).

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 two 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 (i.e. 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 105,900 deaths and 24,088,000 infections have been prevented as a result of the COVID-19 vaccination programme, up to 20 August. Please note this analysis has not been updated since last week's report.

Table 4. Inferred reduction in infections and mortality as the result of vaccination up to 20 August 2021. (Infections are rounded to the nearest 1,000, deaths to the nearest 100.)

Model	Outcome	Reduction
ONS/Death	Infection	24,088,000 [23,802,000 to 24,372,000]
ONS/Death	Mortality	105,900 [102,500 to 109,500]

Figure 5. Inferred and predicted incidence, mortality and prevalence with and without vaccination in England. This is presented on a log scale

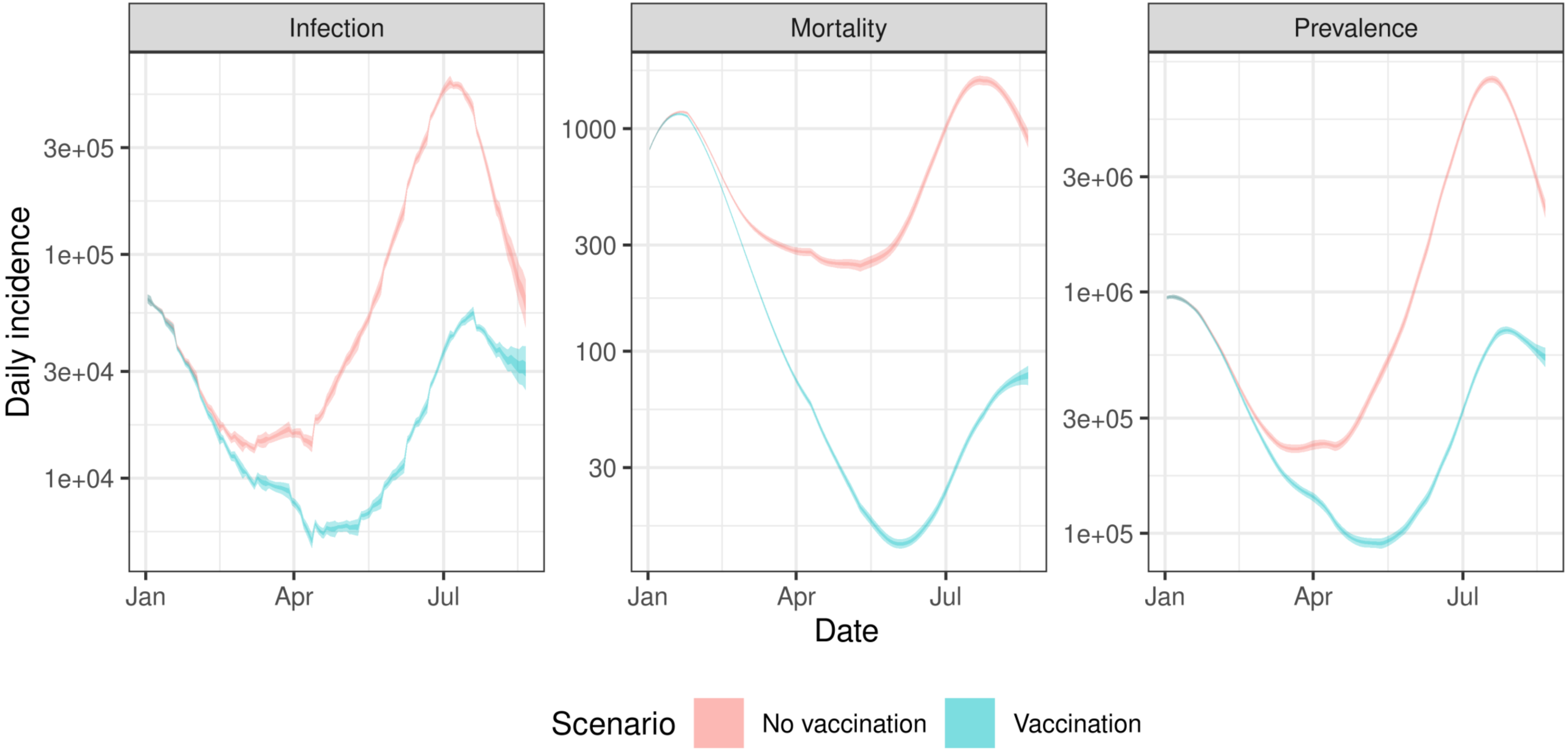
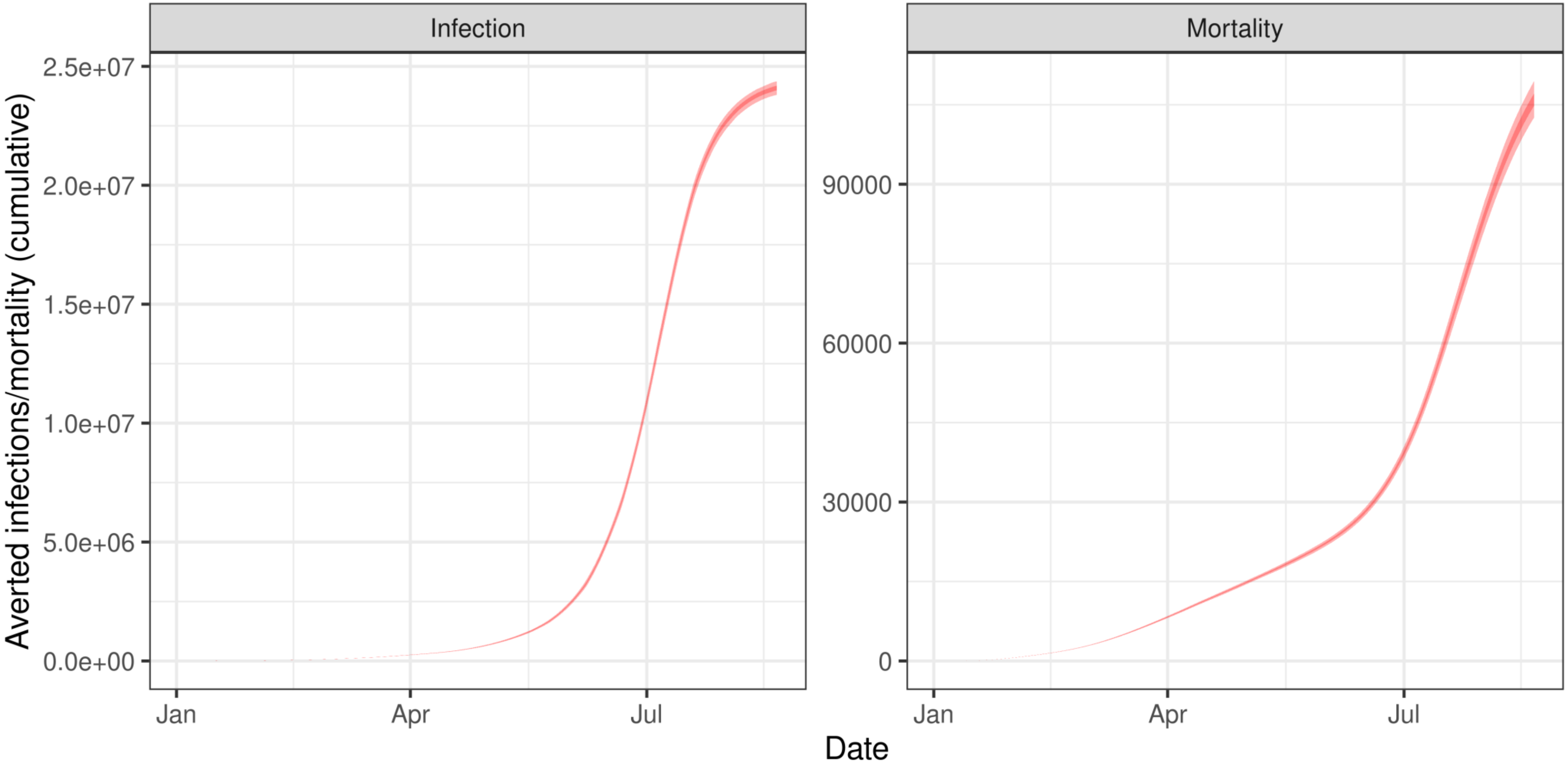


Figure 6. Averted number of infections (left) and deaths (right) due to vaccination (cumulatively)



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