UK Health Security Agency

COVID-19 vaccine surveillance report

Week 11

17 March 2022

Contents

Executive 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.
UK Health Security Agency (UKHSA), formerly 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 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 against different COVID-19 variants. Vaccine effectiveness against symptomatic disease with the Omicron variant is substantially lower than against the Delta variant, with rapid waning. However, protection against hospitalisation remains high, particularly after 3 doses.

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 one, 2 and 3 doses of COVID-19 vaccines. By 13 March 2022, the overall vaccine uptake in England for dose 1 was 69.5% and for dose 2 was 65.1%. Overall vaccine uptake in England in people with at least 3 doses was 50.6%. 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. **This raw data should not be used to estimate vaccine effectiveness** as the data does not take into account inherent biases present such as differences in risk, behaviour and testing in the vaccinated and unvaccinated populations. Vaccine effectiveness is measured in other ways as detailed in the Vaccine effectiveness section below.

Based on antibody testing of blood donors, 99.3% of the adult population have antibodies to COVID-19 from either infection or vaccination compared to 36.0% that have antibodies from infection alone.

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.

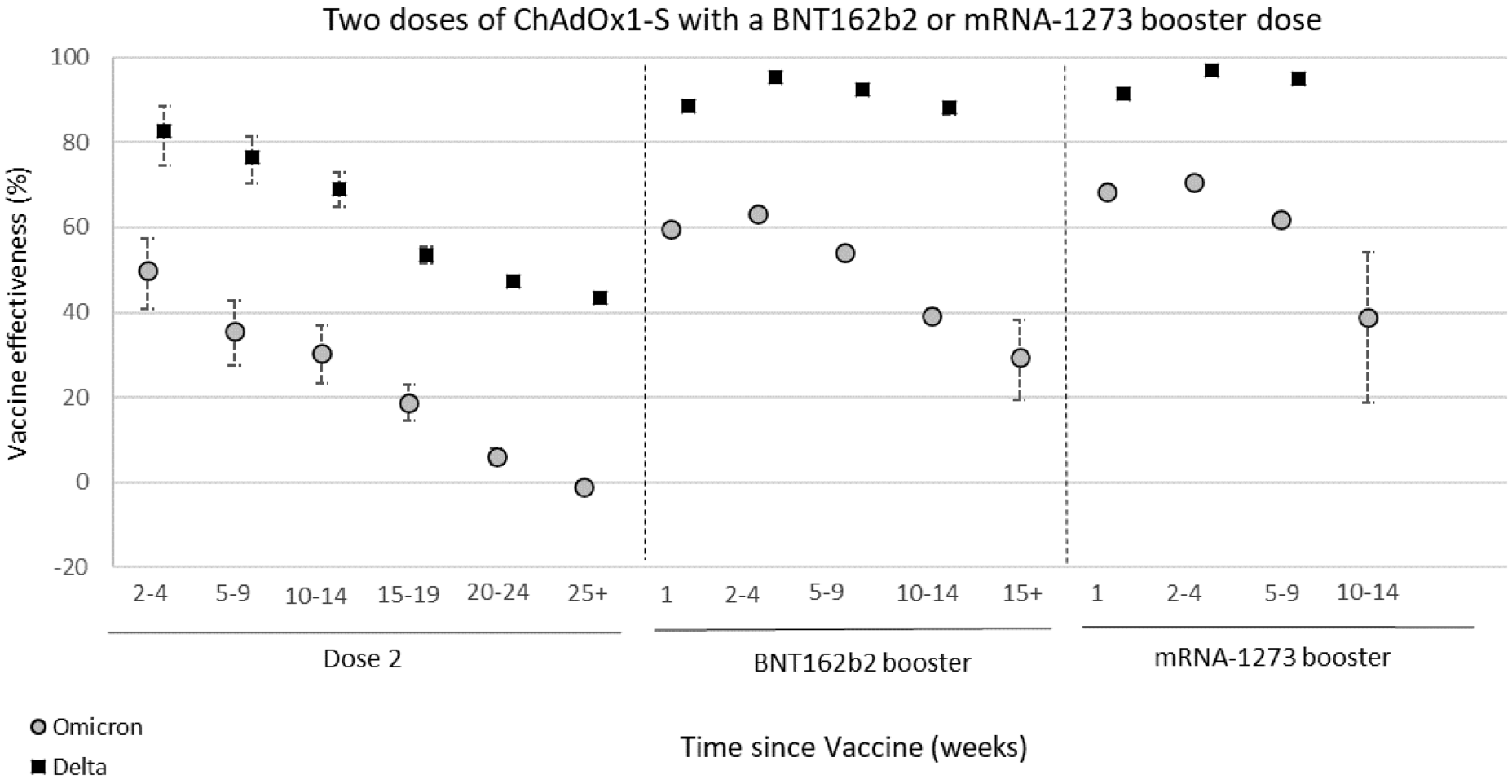
Post implementation real world vaccine effectiveness studies are needed to understand vaccine effectiveness against different outcomes (such as severe disease and onwards transmission), effectiveness in different subgroups of the population and against different variants as well as to understand the duration of protection.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. Where available we focus on data related to the Omicron variant which is currently dominant in the UK. The findings are also summarised in Table 2.

Effectiveness against symptomatic disease

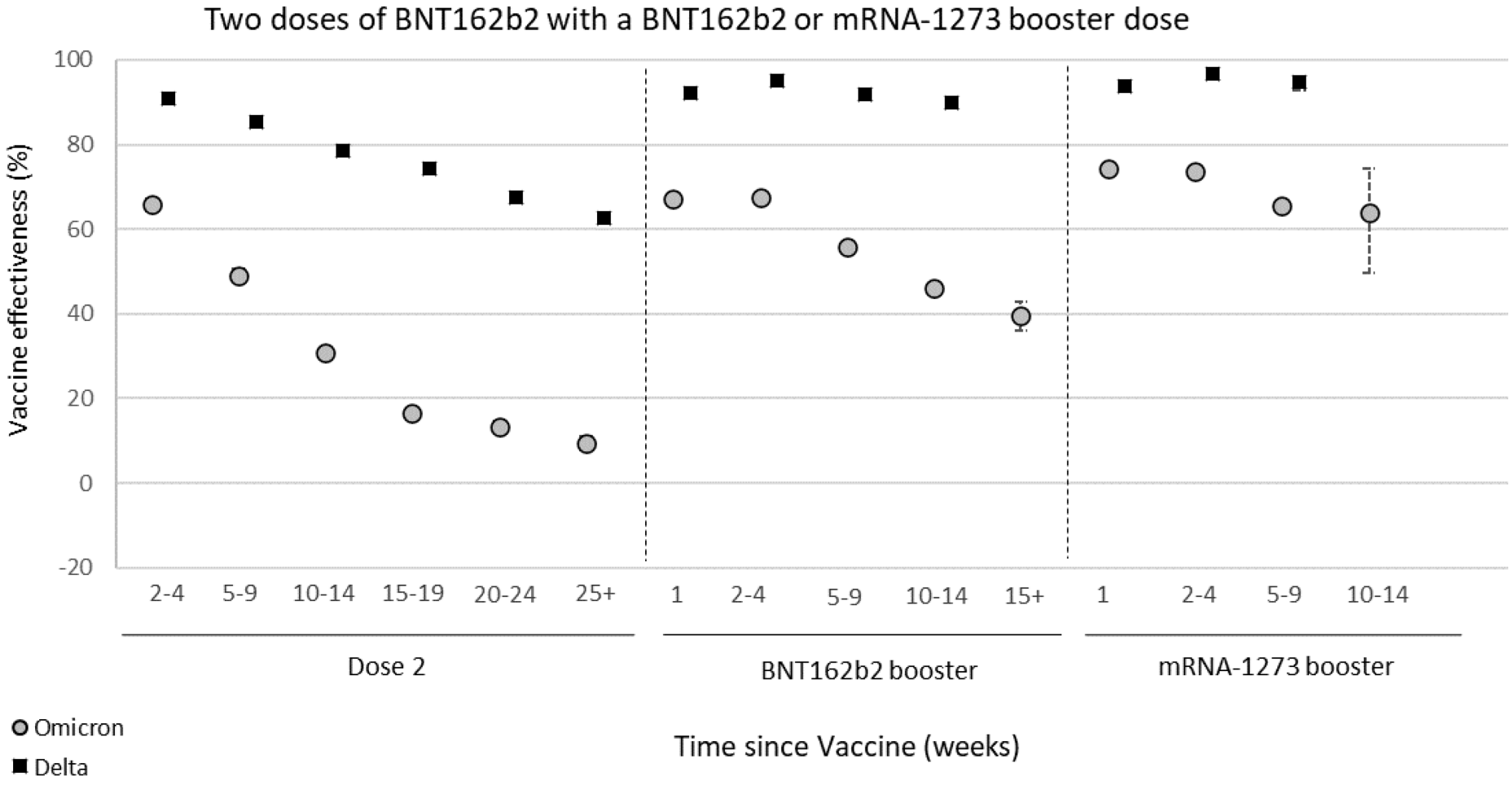
Vaccine effectiveness against symptomatic COVID-19 has been assessed in England based on community testing data linked to vaccination data from the National Immunisation Management System (NIMS), cohort studies such as the COVID Infection Survey and GP electronic health record data. After 2 doses of the AstraZeneca vaccine, vaccine effectiveness against the Omicron variant starts at 45 to 50% then drops to almost no effect from 20 weeks after the second dose. With 2 doses of Pfizer or Moderna effectiveness dropped from around 65 to 70% down to around 10% by 25 weeks after the second dose. Two to 4 weeks after a booster dose of either the Pfizer or Moderna vaccine, effectiveness ranges from around 60 to 75%, dropping to 25 to 40% from 15+ weeks after the booster. Vaccine effectiveness estimates for the booster dose are very similar, irrespective of the primary course received (3). Vaccine effectiveness is generally slightly higher in younger compared to older age groups.

Figure 1. Vaccine effectiveness against symptomatic disease by period after the second and booster doses for Delta (black squares) and Omicron (grey circles) for a) recipients of 2 doses of Astrazeneca (ChAdOx1-S) vaccine as the primary course and Pfizer (BNT162b2) or Moderna (mRNA-1273) as a booster; b) recipients of 2 doses of Pfizer vaccine as the primary course and Pfizer or Moderna as a booster, and c) 2 doses of Moderna as a primary course and Pfizer or Moderna as a booster

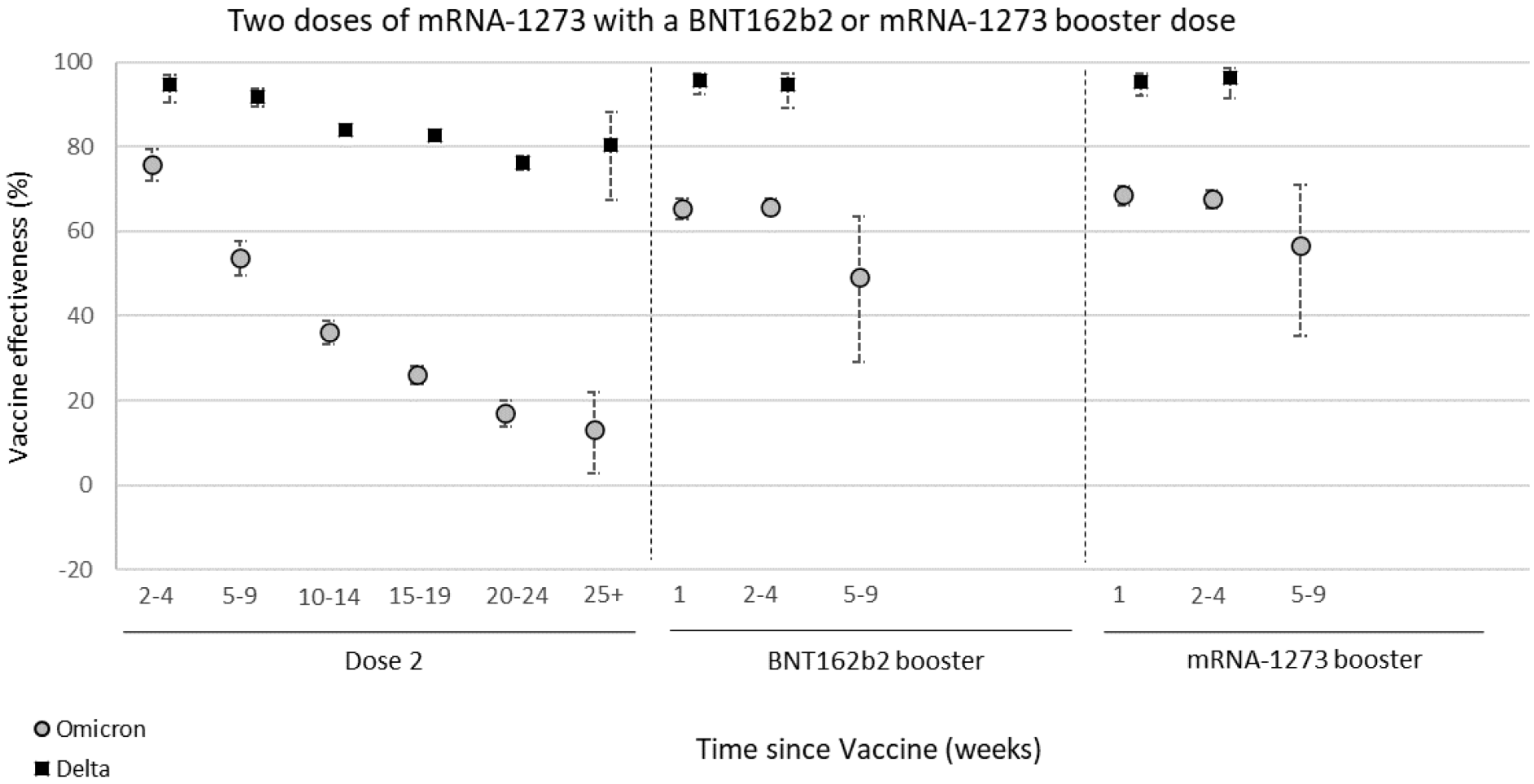
a)



b)


Two doses of BNT162b2 with a BNT162b2 or mRNA-1273 booster dose
Vaccine effectiveness (%)
100
80
60
40
20
0
-20
2-4
5-9
10-14
15-19
20-24
25+
1
2-4
5-9
10-14
15+
1
2-4
5-9
10-14
Dose 2
BNT162b2 booster
mRNA-1273 booster
Omicron
Delta
Time since Vaccine (weeks)

c)


Two doses of mRNA-1273 with a BNT162b2 or mRNA-1273 booster dose
Vaccine effectiveness (%)
100
80
60
40
20
0
-20
2-4
5-9
10-14
15-19
20-24
25+
1
2-4
5-9
1
2-4
5-9
Dose 2
BNT162b2 booster
mRNA-1273 booster
Omicron
Delta
Time since Vaccine (weeks)

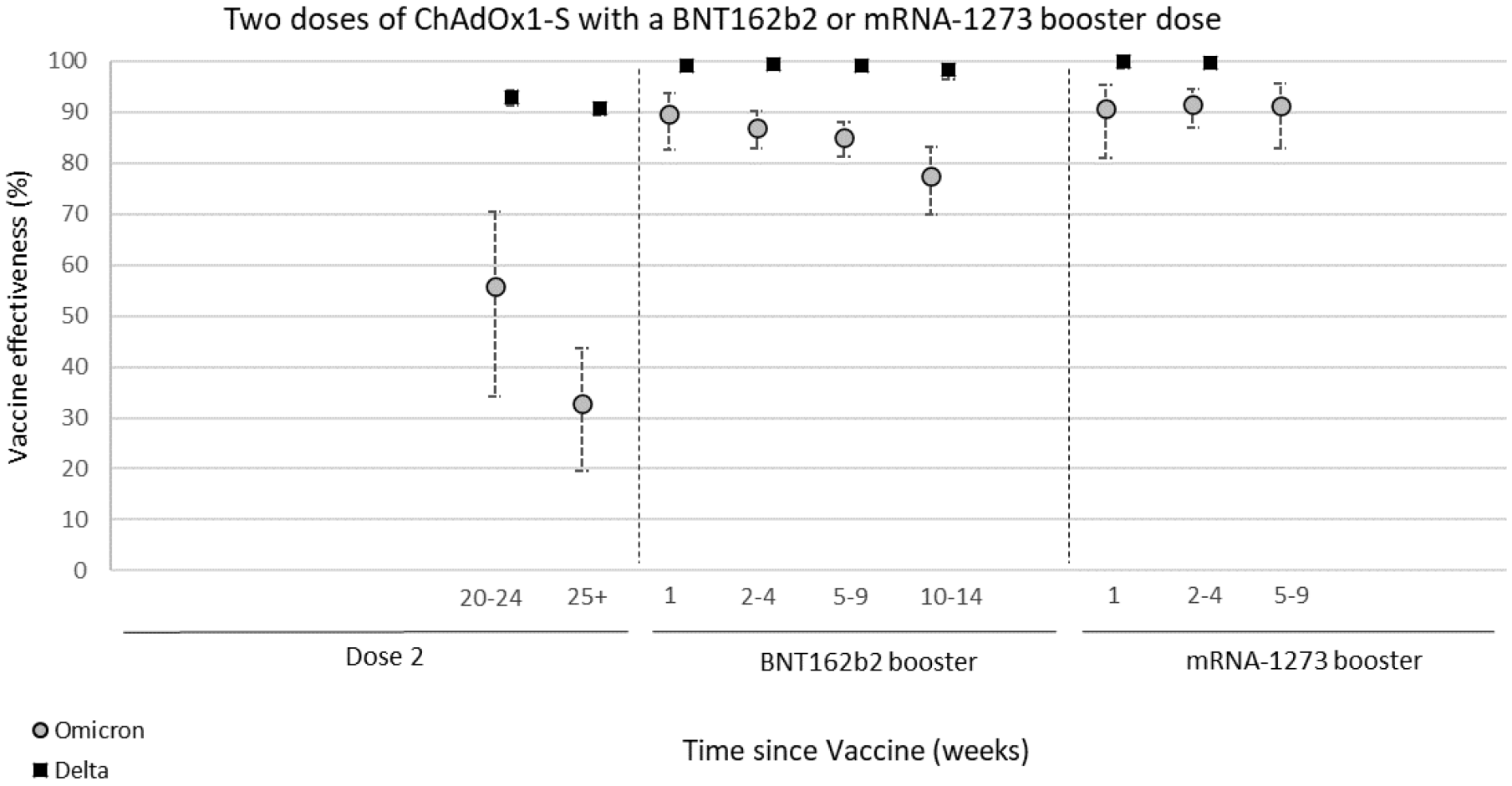
Data (based primarily on the Alpha and Delta variants) suggests that in most clinical risk groups, immune response to vaccination is maintained and high levels of VE are seen with both the Pfizer and AstraZeneca vaccines. Reduced antibody response and vaccine effectiveness were seen after 1 dose of vaccine among the immunosuppressed group, however, after a second dose the reduction in vaccine effectiveness is smaller (4). 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 (5).

Effectiveness against hospitalisation

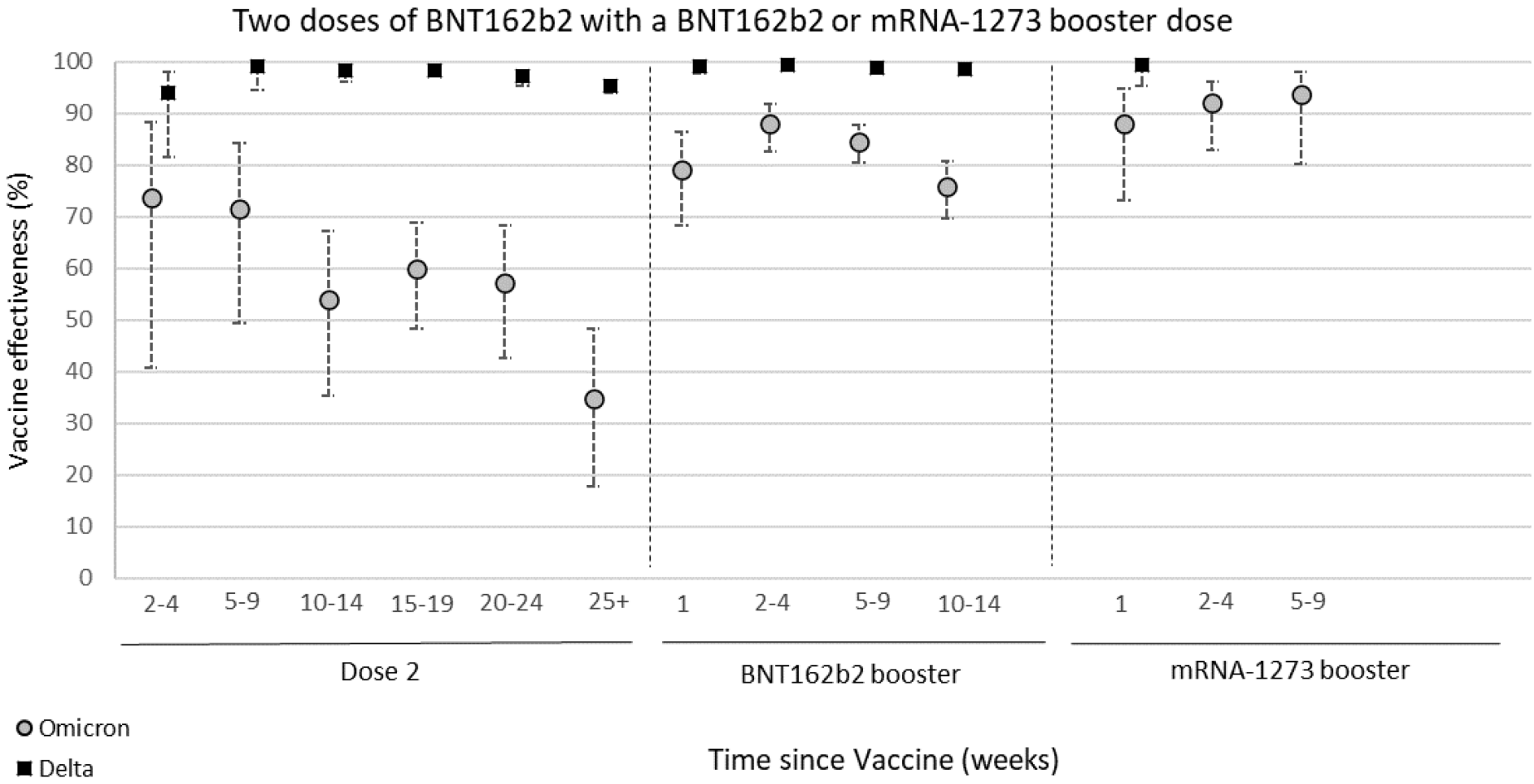
Several studies have estimated vaccine effectiveness against hospitalisation in older ages, all of which indicate higher levels of protection against hospitalisation with all vaccines against the Alpha and Delta variants (6, 7, 8, 9). Vaccine effectiveness against hospitalisation with the Omicron variant has been estimated using a test-negative case control study design (Figure 2). Two doses of either AstraZeneca (ChAdOx1-S) or Pfizer (BNT162b2) vaccines was associated with a vaccine effectiveness of approximately 25 to 35% against hospitalisation following infection with the Omicron variant, after 25+ weeks. After a Pfizer booster (after either primary vaccination course), vaccine effectiveness against hospitalisation started at around 90% dropping to around 75% after 10 to 14 weeks. After a Moderna booster (mRNA-1273) (after either primary vaccination course) vaccine effectiveness against hospitalisation was 90 to 95% up to 9 weeks after vaccination.

Figure 2. Vaccine effectiveness against hospitalisation by period after the second and booster doses for Delta (black squares) and Omicron (grey circles) for a) recipients of 2 doses of Astrazeneca (ChAdOx1-S) vaccine as the primary course and Pfizer (BNT162b2) or Moderna (mRNA-1273) as a booster; b) recipients of 2 doses of Pfizer vaccine as the primary course and Pfizer or Moderna as a booster

a)



b)


Two doses of BNT162b2 with a BNT162b2 or mRNA-1273 booster dose
Vaccine effectiveness (%)
100
90
80
70
60
50
40
30
20
10
0
2-4
5-9
10-14
15-19
20-24
25+
1
2-4
5-9
10-14
1
2-4
5-9
Dose 2
BNT162b2 booster
mRNA-1273 booster
Omicron
Delta
Time since Vaccine (weeks)

Effectiveness against mortality

High levels of protection (over 90%) are also seen against mortality with all 3 vaccines and against both the Alpha and Delta variants with relatively limited waning (6, 10, 11). Vaccine effectiveness against mortality with the Omicron variant has been estimated for those aged 50 years and older by combining the risk of becoming a symptomatic case with the risk of death among symptomatic cases in vaccinated (all vaccines combined) compared to unvaccinated individuals (Table 1). At 25-plus weeks following the second dose, vaccine effectiveness was around 60% while at 2 or more weeks following a booster vaccine effectiveness was 95% against mortality.

Table 1. Hazard ratios and vaccine effectiveness against mortality (all vaccine brands combined). OR = odds ratio, HR = hazards ratio, VE = vaccine effectiveness

Dose	Interval after dose	OR versus symptomatic disease	HR versus mortality	VE versus mortality
2	25+ weeks	0.93 (0.9 to 0.96)	0.45 (0.19 to 1.03)	59% (4 to 82)
3	2+ weeks	0.41 (0.39 to 0.42)	0.12 (0.06 to 0.24)	95% (90 to 98)

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 Alpha and Delta variants (12, 13, 14, 15). Generally estimates are similar to or slightly lower than vaccine effectiveness estimates against symptomatic disease and there is evidence of significant waning in protection against infection over time. Estimates for vaccine effectiveness against infection with the Omicron variant are not yet available.

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 also provide some protection against transmission. 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). Several studies have provided evidence of reduced risk of household transmission from vaccinated cases compared to unvaccinated cases (16, 17, 18, 19).

A summary of vaccine effectiveness evidence can be seen in Table 2.

Table 2. Summary of evidence on vaccine effectiveness against different outcomes (a) Omicron (b) Delta (all vaccines combined)

a)

	Dose 2			Dose 3		
	0 to 3 months	**4 to 6 months**	**Over 6 months**	**0 to 3 months**	**4 to 6 months**	**Over 6 months**
Infection	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Symptomatic disease	25 to 70%	5 to 30%	0 to 10%	50 to 75%	40 to 50%	Insufficient data
Hospitalisation	65 to 85%	55 to 65%	30 to 35%	80 to 95%	75 to 85%	Insufficient data
Mortality	Insufficient data	Insufficient data	40 to 70%	85 to 99%	Insufficient data	Insufficient data

b)

	Dose 2			Dose 3		
	0 to 3 months	**4 to 6 months**	**Over 6 months**	**0 to 3 months**	**4 to 6 months**	**Over 6 months**
Infection	65 to 80%	50 to 65%	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Symptomatic disease	65 to 90%	45 to 65%	40 to 60%	90 to 99%	90 to 95%	Insufficient data
Hospitalisation	95 to 99%	80 to 90%	70 to 85%	95 to 99%	Insufficient data	Insufficient data
Mortality	95 to 99%	90 to 95%	80 to 99%	95 to 99%	Insufficient data	Insufficient 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 against Omicron variant BA.2

The Omicron variant sub-lineage known as BA.2 was designated VUI-22JAN-01 on 19 January 2022. An increase in the number of sequences of the Omicron sub-lineage BA.2 was noted in the UK in the week starting the 3 January 2022. Vaccine effectiveness against symptomatic disease following BA.2 infection was analysed in a test-negative case control design, as compared to the Omicron BA.1 sub-lineage. Pillar 2 testing data from symptomatic cases tested between 27 December and 4 February were included. Analysis combined all vaccines (Table 3). Vaccine effectiveness against symptomatic disease was similar for BA.1 and BA.2 sub-lineages of Omicron. After 2 doses effectiveness was 10% (9 to 11%) and 18% (5 to 29%) respectively for BA.1 and BA.2, after 25+ weeks. This increased to 69% (68 to 69%) for BA.1 and 74% (69 to 77%) for BA.2 at 2 weeks following a booster vaccine before decreasing to 49% (48 to 50%) and 46% (37 to 53%) respectively after 10-plus weeks.

Table 3. Vaccine effectiveness against symptomatic disease (all vaccine brands combined) for BA.1 and BA.2. OR = odds ratio, VE = vaccine effectiveness.

Dose	Interval after dose	BA.1 (VE (95% CI))	BA.2 (VE (95% CI))
2	25 weeks and over	10% (9 to 11)	18% (5 to 29)
3	2 to 4 weeks	69% (68 to 69)	74% (69 to 77)
3	5 to 9 weeks	61% (61 to 62)	67% (62 to 71)
3	10+ weeks	49% (48 to 50)	46% (37 to 53)

Vaccine effectiveness publications

UKHSA and collaborators have published a significant amount of research into vaccine effectiveness, which is summarised on pages 4 to 15. The publications listed in table 4 provide further results and details on the methods used.

Table 4. UKHSA publications on the effectiveness of COVID-19 vaccination

Publication	Subject
Effectiveness of BNT162b2 and ChAdOx1 against SARS-CoV-2 household transmission: a prospective cohort study in England	This study reports on vaccine effectiveness against transmission of COVID-19 with the Alpha and Delta variants.
Effectiveness of 3 doses of COVID-19 vaccines against symptomatic COVID-19 and hospitalisation in adults aged 65 years and older	Updated analysis on the effectiveness of 3 doses of COVID-19 vaccines against symptomatic COVID-19 and hospitalisation in adults aged 65 years and older.

Publication	Subject
Effectiveness of BNT162b2 COVID-19 booster vaccine against COVID-19 related symptoms and hospitalization in England	This study provides real world evidence of significant increased protection from the booster vaccine dose against symptomatic disease and hospitalisation irrespective of the primary course.
Effectiveness of COVID-19 vaccines against the Omicron (B.1.1.529) variant of concern	This study reports on the vaccine effectiveness against symptomatic disease with 2 dose courses of BNT1622 and ChAdOx1-S as well as booster doses of BNT162b2 following a primary course of either BNT1622 or ChAdOx1-S.
Effectiveness of BNT162b2 (Comirnaty, Pfizer-BioNTech) COVID-19 booster vaccine against COVID-19 related symptoms in England: test negative case-control study	Results from the first UK real-world study by UKHSA show significantly increased protection against symptomatic disease from a booster dose of the Pfizer-BioNTech vaccine in those aged 50 years and older.
Duration of Protection against Mild and Severe Disease by COVID-19 Vaccines	This study reports on the vaccine effectiveness and duration of protection of Comirnaty, Vaxzevria and Spikevax against mild and severe COVID-19 in the UK.
Serological responses and vaccine effectiveness for extended COVID-19 vaccine schedules in England	This study investigates the impact of different dosing schedules on immune response and vaccine effectiveness.
Pfizer-BioNTech and Oxford AstraZeneca COVID-19 vaccine effectiveness and immune response among individuals in clinical risk groups	This study reports on the immune response and clinical effectiveness of COVID-19 vaccine among individuals in clinical risk groups. A supplementary appendix is also available to download.
Effectiveness of COVID-19 vaccines against hospital admission with the Delta (B.1.617.2) variant	This study reports on the effectiveness of COVID-19 vaccines on hospitalisation disease with the Delta variant. A supplementary appendix is also available to download.
Effectiveness of COVID-19 Vaccines against the B.1.617.2 (Delta) Variant	This study reports on the effectiveness of COVID-19 vaccines on symptomatic disease with the Delta variant.

Publication	Subject
Effectiveness of BNT162b2 mRNA and ChAdOx1 adenovirus vector COVID-19 vaccines on risk of hospitalisation among older adults in England: an observational study using surveillance data	A study using the SARI watch surveillance system of COVID-19 hospitalisations found high levels of protection against hospitalisation after both a single dose and 2 doses of COVID-19 vaccines.
Effectiveness of BNT162b2 mRNA vaccine and ChAdOx1 adenovirus vector vaccine on mortality following COVID-19	A study on deaths with COVID-19 indicates that COVID-19 vaccines offer high levels of protection against mortality.
Effect of Vaccination on Household Transmission of SARS-CoV-2 in England	Impact of vaccination on household transmission of SARS-COV-2 in England is an analysis to determine whether individuals who have received vaccine, but still become infected with SARS-COV-2 up to 60 days after the first dose, are less likely than unvaccinated cases to transmit to their unvaccinated household contacts.
Vaccine effectiveness of the first dose of ChAdOx1 nCoV-19 and BNT162b2 against SARS-CoV-2 infection in residents of Long-Term Care Facilities (VIVALDI study)	The VIVALDI study found evidence that COVID-19 vaccines were associated with a substantially reduced risk of infection in care home residents.
Effectiveness of BNT162b2 and ChAdOx1 nCoV-19 COVID-19 vaccination at preventing hospitalisations in people aged at least 80 years: a test-negative, case-control study	The Avon CAP study, conducted in 2 hospitals in Bristol, found evidence of high levels of protection against hospitalisation in 80+ year olds with a single dose of either vaccine.
COVID-19 vaccine coverage in health-care workers in England and effectiveness of BNT162b2 mRNA vaccine against infection (SIREN): a prospective, multicentre, cohort study	Early data from PHE's SIREN study shows a promising impact on infection in healthcare workers aged under 65. Healthcare workers in the study are tested for COVID-19 every 2 weeks – whether or not they have symptoms.
Effectiveness of the Pfizer-BioNTech and Oxford-AstraZeneca vaccines on COVID-19 related symptoms, hospital admissions, and mortality in older adults in England: test negative case-control study	Early data from routine COVID-19 testing in older adults shows that vaccines are effective at preventing COVID-19 disease and severe outcomes.
Impact of COVID-19 vaccination programme on seroprevalence in blood donors in England, 2021	Report on the Impact of COVID-19 vaccination programme on seroprevalence in blood donors in England, 2021.

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.

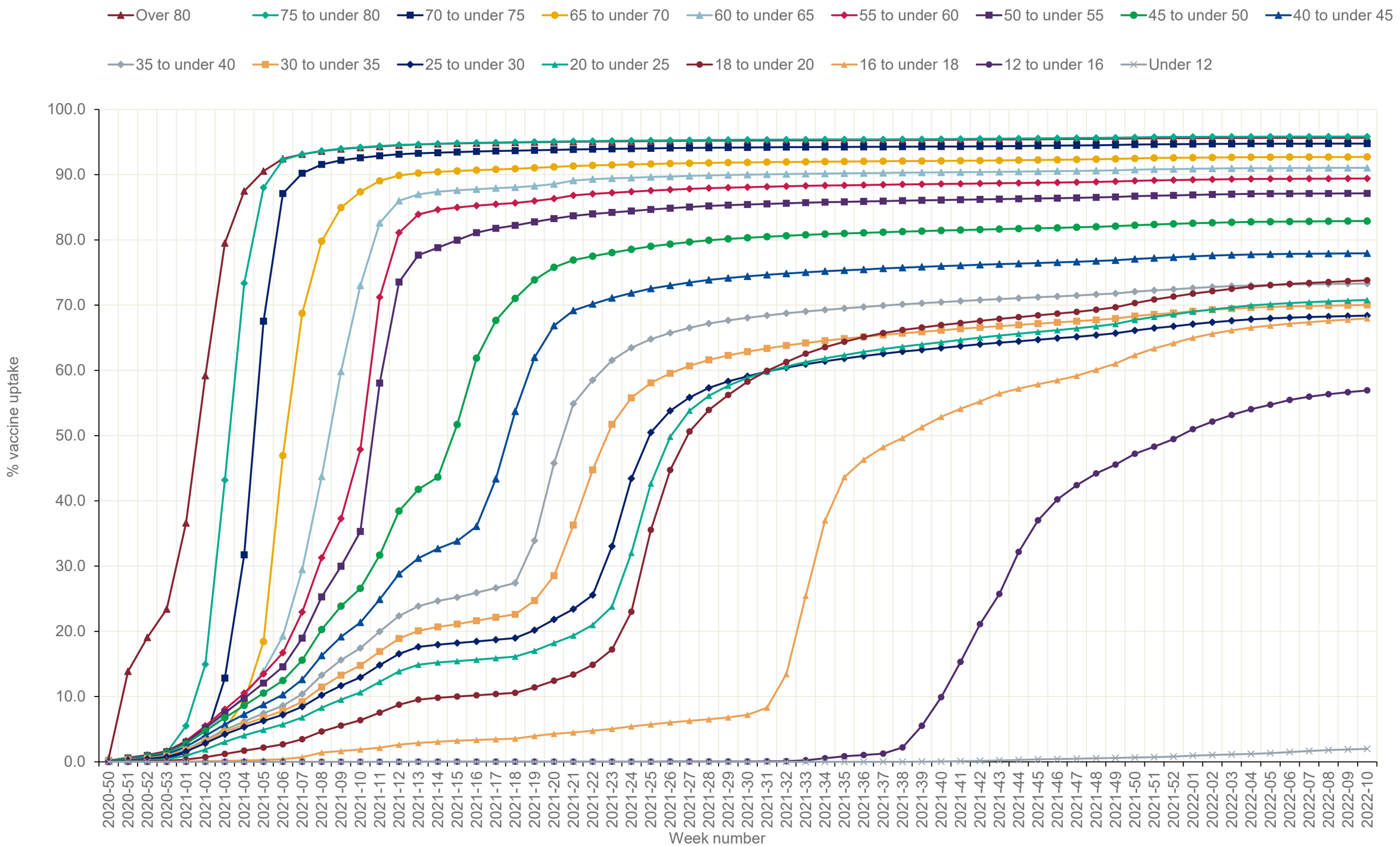
UKHSA and other government and academic partners monitor the impact of the of the vaccination programme on levels of COVID-19 antibodies in the population and different disease indicators, including hospitalisations and mortality. This is done through population-based testing and through modelling which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

Vaccine coverage

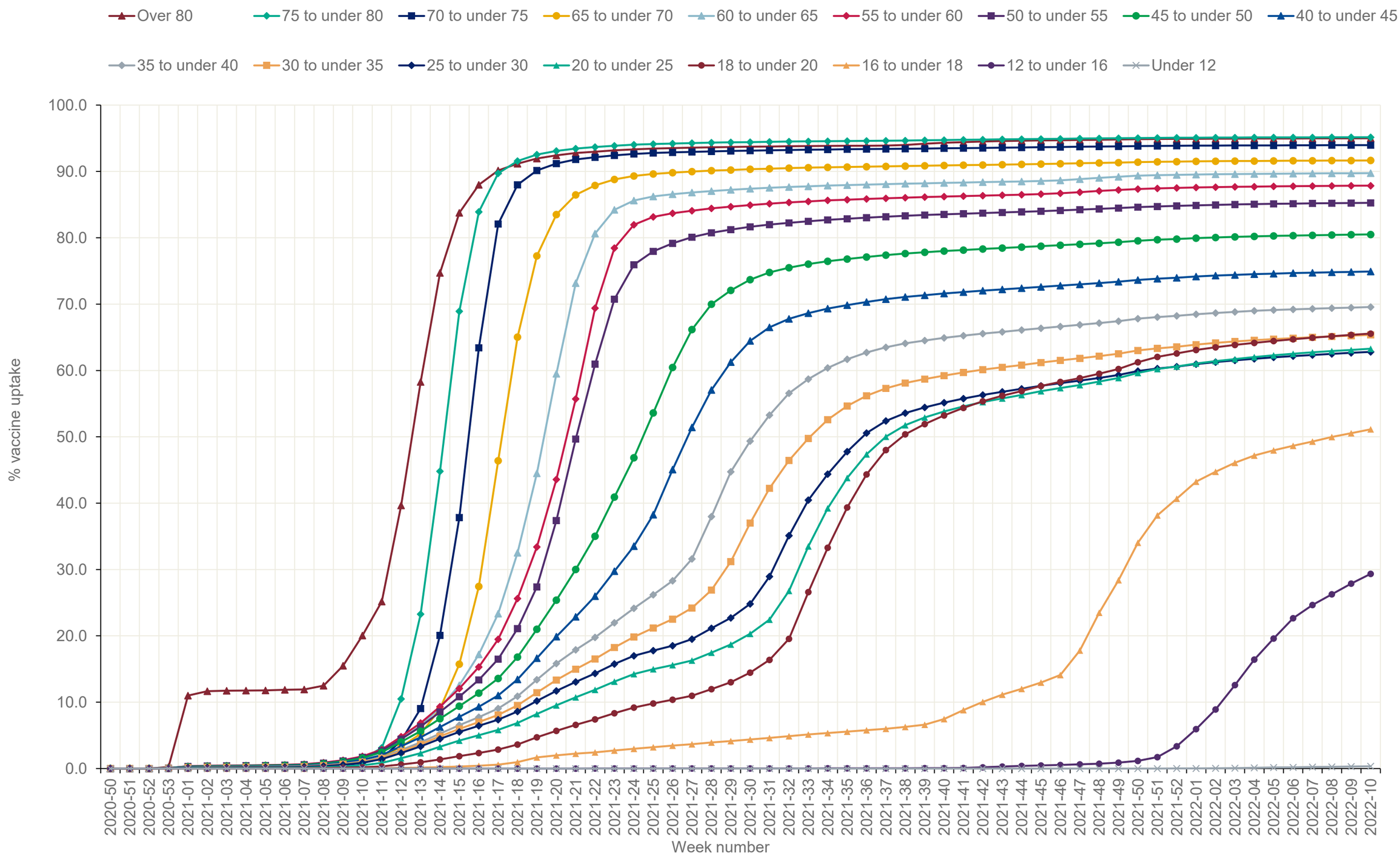
The data in this week's report covers the period from 8 December 2020 to 13 March 2022 (week 10) (Figure 3). It shows the provisional number and percentage of living people in England who have had received one, 2 or 3 doses of a COVID-19 vaccination by age group and week since the start of the programme. Further data on vaccine uptake by age in England can be found in the national flu and COVID-19 surveillance reports. Age is calculated as age on the 31 August 2021, that is, academic cohort for all ages.

Figure 3. 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
20 to under 25
18 to under 20
16 to under 18
12 to under 16
Under 12
% vaccine uptake
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
2020-50
2020-51
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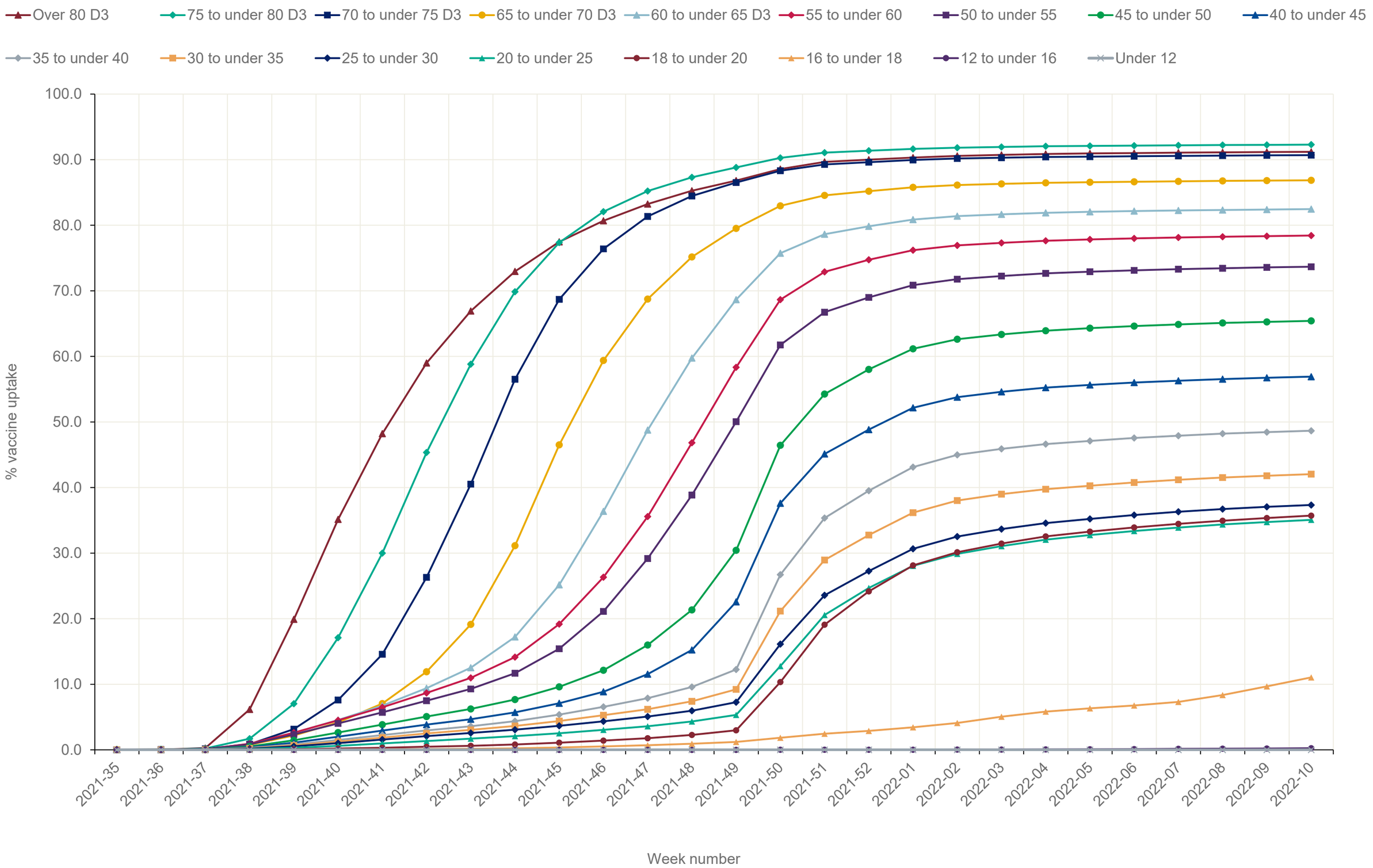
2022-10
Week number

c) Dose 3. Please note the data for this graph is shown from week 35 (week ending 5 September 2021)



Vaccination in immunosuppressed individuals

Provisional vaccine uptake data in living and resident people identified as immunosuppressed in England to the end of week 10 can be found in Table 5. This shows that vaccine uptake in the 526,181 people identified as immunosuppressed was 95.7% for at least dose 1, 94.3% for at least 2 doses and 87.6% for at least 3 doses. Additional data on vaccine uptake in people with at least 3 doses by age in England can be found in the National flu and COVID-19 surveillance reports.

Table 5. Vaccine uptake in people identified as immunosuppressed in England

Immuno-suppression	People in NIMs Cohort	Numbers vaccinated with at least 1 dose	Percentage vaccine uptake with at least 1 dose	Numbers vaccinated with at least 2 doses	Percentage vaccine uptake with at least 2 doses	Numbers vaccinated with at least 3 doses	Percentage vaccine uptake with at least 3 doses
England	526,181	503,296	95.7	496,390	94.3	461,012	87.6

Detailed information on the characterisation of the immunosuppressed group by NHS Digital is available.

Vaccination in pregnancy

Vaccination of pregnant women alongside their peers is recommended in the UK and other countries as an important way to protect pregnant women and their unborn children against COVID-19 disease. Vaccination of pregnant women is strongly recommended by the Royal College of Obstetricians and Gynaecologists and the Royal College of Midwives.

Increased severity of COVID-19 disease in pregnant and recently pregnant women has been reported after the first SARS-CoV-2 wave in England (20, 21) and in Scotland (22, 23). Pregnant women who develop severe disease have increased rates of admission to ICU, need for invasive ventilation and pre-term delivery. Data from the US Centers for Disease Control and Prevention (CDC) found that pregnant women were around 3 times more likely to be admitted to ICU and nearly 3 times more likely to require invasive ventilation compared to non-pregnant women with COVID-19 disease and 25% more likely to die (24).

From 16 April 2021, the Joint Committee on Vaccination and Immunisation (JCVI) advised that pregnant women be offered COVID-19 vaccines at the same time as people of the same age or risk group (25). Therefore, any pregnant women not in a high-risk group would likely have received their first dose from mid-April 2021 as part of the general adult population programme in those aged under 50 years. This was offered by decreasing age group (25). As part of the ongoing review of the programme, the JCVI met on 2 December 2021 and considered further data on severity of SARS-CoV-2 infection in pregnant women and their pregnancies together with data on vaccine safety; as a result pregnant women were added to the UK's priority COVID-19 vaccine list (26).

Prior to 16 April 2021, COVID-19 vaccine was delivered to priority groups, based on clinical risk and risk of exposure, and delivered in order of priority. On 22 December 2020, JCVI advised that vaccine could be offered to pregnant and breast-feeding women who were in these risk categories The Pfizer vaccine was rolled out from early December 2020, AstraZeneca vaccine was used from 4 January 2021 and the Moderna vaccine became available from April 2021. From 17 April 2021 pregnant women have been offered the Pfizer-BioNTech or Moderna (mRNA) vaccines where available for their first dose (27).

There is evidence of high levels of protection against SARS-CoV-2 infection in pregnant women after COVID-19 vaccination (28 to 30) and evidence that vaccination induces higher antibody levels than after disease (30). There is also evidence from a recent US study that 2-doses of mRNA COVID-19 vaccination during pregnancy might help prevent COVID-19 hospitalisations in young infants under 6 months of age (31). Between February and September 2021, 0.4% of 1,714 pregnant women with COVID-19 symptoms who required hospital treatment in the UK had received 2 doses of COVID-19 vaccine and, of 235 pregnant women who were admitted to intensive care with COVID-19 disease in that period, none had received 2 doses of vaccine (32). Similar findings have been reported from Scotland (23, 33) with the most recent study reporting that 90.9% (748 out of 823; 95% CI 88.7−92.7) of SARS-CoV-2 associated with hospital admission, 98% (102 out of 104; 95% CI 92.5−99.7) of SARS-CoV-2 associated with

critical care admission and all baby deaths, occurred in pregnant women who were unvaccinated at the time of their COVID-19 diagnosis (22). The researchers also found high extended perinatal mortality rate for women who gave birth within 28 days of a COVID-19 diagnosis compared to rates across the pandemic period and in women vaccinated and going on to give birth within 28 days.

COVID-19 vaccines used in the UK programme do not contain live SARS-CoV-2 virus and therefore cannot infect a pregnant woman or her unborn child with the virus. Whilst, as is commonly the case in trials of medicinal products, pregnant women were excluded from the original COVID-19 vaccine trials, there is accumulating experience and evidence of the safe and effective use of mRNA vaccines (such as the Pfizer-BioNTech or Moderna) in pregnant women. In Scotland COVID-19 vaccine had been administered to more than 25,000 pregnant women to the end of December 2021 (22) and over 4,500 women in Wales had received their first dose of vaccine before they gave birth (between 1 January 2021 and 30 November 2021) (34). In the USA more than 200,000 women have indicated they were pregnant at the time they received COVID-19 vaccination to 14 February 2022 (35).

No safety concerns relating to COVID-19 vaccination of pregnant women have been found in published studies to date (36 to 39). The rate of vaccine side-effects appears to be similar in pregnant and non-pregnant populations (36).

This report presents data on vaccine coverage and outcomes for women delivering up to the end of November 2021 and updates the early data on COVID-19 vaccination in pregnant women published in the COVID-19 vaccine surveillance report – weeks 47 of 2021 and 4 of 2022. Findings continue to be considered preliminary.

Vaccine coverage

COVID-19 vaccine coverage in women before they give birth has increased as more women have become eligible for vaccination. In August 2021, 22.5% of women giving birth had received at least one dose of vaccine. This increased to 32.1% of women who gave birth in September, 41.5% in October and 48.5% in November 2021. Of women who gave birth in November 2021, 38.2% had received 2 doses of the vaccine (see Table 6).

In the overall period between January and November 2021 a total of 483,677 women gave birth of whom 78,759 had received at least 1 dose of COVID-19 vaccine prior to delivery (50,359 of these women had received at least 2 doses and 941 women had received at least 3 doses). There were 4,780 women who had received their first dose prior to pregnancy and went on to conceive and deliver by November 2021. There were 8,353 women who were vaccinated in the first trimester, 28,468 in the second and 39,138 in the third trimester. In addition, 22,887 women were known to have received dose one before giving birth but without enough information to establish which trimester. Of these women, 18,686 were known to have received this dose in pregnancy, and 4,201 were around the start of pregnancy.

Of all vaccinated women giving birth, 50,162 had received one or more doses of only Pfizer vaccine; 3,206 one or more doses of only Moderna; 2,536 one or more doses of only AstraZeneca and the remaining 22,855 of vaccinated women received a mixture of doses: 16,362 received a combination of Pfizer and Moderna and 6,491 received AstraZeneca with Pfizer or Moderna.

Table 6. Overall vaccine coverage in women giving birth, by month of delivery[1]

Month	Women giving birth	One or more doses by time of delivery	Two or more doses by time of delivery	Unvaccinated at delivery	Unvaccinated who went on to receive dose(s) after pregnancy to 18 February 2022
Jan-21	41,949	18 (0.0%)	1 (0.0%)	41,772 (99.6%)	31,908 (76.4%)
Feb-21	40,093	82 (0.2%)	0 (0.0%)	39,875 (99.5%)	30,492 (76.5%)
Mar-21	44,589	294 (0.7%)	25 (0.1%)	44,173 (99.1%)	33,509 (75.9%)
Apr-21	42,430	476 (1.1%)	89 (0.2%)	41,803 (98.5%)	31,244 (74.7%)
May-21	43,732	1,225 (2.8%)	298 (0.7%)	42,340 (96.8%)	30,775 (72.7%)
Jun-21	43,393	4,260 (9.8%)	630 (1.5%)	38,997 (89.9%)	26,960 (69.1%)
Jul-21	46,954	7,518 (16.0%)	2,149 (4.6%)	39,256 (83.6%)	25,556 (65.1%)
Aug-21	45,674	10,265 (22.5%)	5,988 (13.1%)	35,225 (77.1%)	21,279 (60.4%)
Sep-21	46,170	14,810 (32.1%)	10,304 (22.3%)	31,182 (67.5%)	16,955 (54.4%)
Oct-21	46,012	19,098 (41.5%)	14,560 (31.6%)	26,717 (58.1%)	12,742 (47.7%)
Nov-21	42,681	20,713 (48.5%)	16,315 (38.2%)	21,797 (51.1%)	7,820 (35.9%)

Table 7. Vaccine coverage by ethnicity, for women giving birth September to November 2021 (latest 3 months)[2]

	Women giving birth in September to November 2021	One or more doses by time of delivery	Two or more doses by time of delivery	Unvaccinated at delivery	Unvaccinated who went on to receive dose(s) after pregnancy to 18 February 2022
Asian	16,023	5,537 (34.6%)	3,943 (24.6%)	10,486 (65.4%)	5,723 (54.6%)

[1] 1,781 women could not be matched with a NIMS record; their vaccine status is therefore unknown, they are excluded from these figures.
[2] 546 women could not be matched with a NIMS record; their vaccine status is therefore unknown, they are excluded from these figures.

	Women giving birth in September to November 2021	One or more doses by time of delivery	Two or more doses by time of delivery	Unvaccinated at delivery	Unvaccinated who went on to receive dose(s) after pregnancy to 18 February 2022
Black	6,413	1,313 (20.5%)	838 (13.1%)	5,100 (79.5%)	1,683 (33.0%)
Other	2,863	857 (29.9%)	668 (23.3%)	2,006 (70.1%)	564 (28.1%)
Mixed	5,117	1,723 (33.7%)	1,345 (26.3%)	3,394 (66.3%)	1,321 (38.9%)
White	97,464	42,691 (43.8%)	32,484 (33.3%)	54,773 (56.2%)	26,463 (48.3%)
Unknown	6,983	2,500 (35.8%)	1,901 (27.2%)	3,937 (56.4%)	1,763 (44.8%)

Table 8. Vaccine coverage by quintile of deprivation of the small area in which the woman lived, for women giving birth September to November 2021 (latest 3 months)[3]

	Women giving birth in September to November 2021	One or more doses by time of delivery	Two or more doses by time of delivery	Unvaccinated at delivery	Unvaccinated who went on to receive dose(s) after pregnancy to 18 February 2022
1 - most deprived	31,780	8,105 (25.5%)	5,196 (16.3%)	23,675 (74.5%)	8,409 (35.5%)
2	29,071	10,161 (35.0%)	7,359 (25.3%)	18,910 (65.0%)	8,262 (43.7%)
3	26,110	11,304 (43.3%)	8,624 (33.0%)	14,806 (56.7%)	7,523 (50.8%)
4	24,470	12,194 (49.8%)	9,493 (38.8%)	12,276 (50.2%)	7,078 (57.7%)
5 - least deprived	22,085	12,596 (57.0%)	10,324 (46.7%)	9,489 (43.0%)	6,061 (63.9%)
Unknown	1,347	261 (19.4%)	183 (13.6%)	540 (40.1%)	184 (34.1%)

[3] 546 women could not be matched with a NIMS record; their vaccine status is therefore unknown, they are excluded from these figures.

Table 9. Vaccine coverage by age of mother, for women giving birth September to November 2021 (latest 3 months)[4]

Age	Women giving birth in September to November 2021	One or more doses by time of delivery	Two or more doses by time of delivery	Unvaccinated at delivery	Unvaccinated who went on to receive dose(s) after pregnancy to 18 February 2022
Under 20	2,610	331 (12.7%)	136 (5.2%)	2,279 (87.3%)	536 (23.5%)
20 to 24	15,027	3,110 (20.7%)	1,647 (11.0%)	11,917 (79.3%)	4,023 (33.8%)
25 to 29	34,326	10,489 (30.6%)	6,892 (20.1%)	23,837 (69.4%)	11,080 (46.5%)
30 to 34	47,863	22,247 (46.5%)	17,370 (36.3%)	25,616 (53.5%)	13,584 (53.0%)
35 to 39	27,688	14,825 (53.5%)	12,189 (44.0%)	12,863 (46.5%)	6,752 (52.5%)
40 and above	6,803	3,619 (53.2%)	2,945 (43.3%)	3,184 (46.8%)	1,542 (48.4%)

[4] 546 women could not be matched with a NIMS record; their vaccine status is therefore unknown, they are excluded from these figures.

In the most recent 3-month period, there were 134,863 women who gave birth of whom 54,621 (40.5%) were vaccinated. These women accounted for 69.4% of all vaccinated women giving birth since January. There were differences in vaccine coverage by both ethnicity (Table 7) and by quintile of deprivation (Table 8). Overall, 47% of women who were unvaccinated when they gave birth went on to be vaccinated post-partum. This included one third of Black women and more than half of Asian women, similar to the proportions of unvaccinated women of these ethnicities who were immunised post-partum between August and October 2021 (58.7% and 32.5% respectively). Whilst increases in coverage were observed in all groups, women of black ethnicity (in whom one dose coverage increased from 13.3% to 20.5%) and women living in the most deprived areas in England (in whom one dose coverage increased from 18.3% to 25.5%) continue to be least likely to have been vaccinated with one or 2 doses of COVID-19 vaccine before they gave birth. Coverage increased as levels of deprivation decreased (Table 8). Vaccine coverage increased with increasing age group to those aged 35 to 39 years in whom uptake was 53.5% for one dose and 44.0% for 2 doses (Table 9), with similar coverage in women who were aged 40 years or over when they gave birth.

Methods

Data on COVID-19 vaccination status together with details of each vaccine administered are recorded in a central data set called the National Immunisation Management Service (NIMS)[5]. In addition, NHS Digital manages the Hospital Episode Statistics (HES) data sets, containing information about hospital activity in England.

Records of women giving birth ('delivery records') in the months since 1 January 2021 were identified in HES. De-duplication of delivery records resulted in a data set of women who had given birth with 1 record per woman, identified by her NHS Number, and the latest 'delivery episode' associated with her. An 'earliest' and 'latest' likely pregnancy start date were assigned to each woman's record, using the known delivery date and further information from her record, where available:

1. Where a valid gestational age was recorded (GESTAT_1 between 24 and 42), the woman's earliest pregnancy start date was calculated by taking the number of weeks away from the delivery date, and then calculating an additional earlier week, to account for GESTAT_1 recording completed weeks of pregnancy. In a similar way, latest pregnancy start date was calculated by taking the number of weeks of GESTAT_1 away from the delivery date.
2. Where no valid GESTAT_1 was available, the first 12 diagnoses codes were examined to identify any with a code suggesting delivery at term (O60.2). In this case the gestational age at delivery was assumed to be between 37 and 42 completed weeks of pregnancy, and a similar method was used to establish earliest and latest pregnancy start dates.
3. Where no valid GESTAT_1 was available and there were no codes suggesting term

[5] NIMS Data controllers are NHSEI and NHSD. The NIMS IT software is commissioned by NHSEI via South Central West CSU and is provided by the System C and Graphnet Care Alliance.

delivery, the first 12 diagnoses codes were examined to identify any suggesting pre-term delivery (O60.1 or O60.3). In this case the gestational age at delivery was assumed to be between 24 and 36 completed weeks of pregnancy, and these values were used to establish earliest and latest pregnancy start dates.

4. In the absence of any additional information in the woman's record (or in conflicting cases where diagnoses codes suggesting both term and pre-term delivery appeared in the same record), the gestational age at delivery was assumed to be between 24 and 42 completed weeks of pregnancy, and these values were used to establish earliest and latest pregnancy start dates.

Earliest and latest dates for the start of each trimester were established in a similar way, using the windows of trimester 1: day 0 to day 97 (where day 0 is the earliest or latest pregnancy start date, as established using the method above), trimester 2: day 98 to day 195 and trimester 3: day 196 to delivery. Each woman's delivery record was linked to her record(s) in the NIMS using the NHS Number, establishing her vaccine status as either having had one or more doses before delivery (including any prior to becoming pregnant) or not having had any doses of the vaccine prior to delivery, using the NIMS vaccine records.

For each vaccine dose (this analysis considered doses one to 4) the woman was known to have received, the following information was ascertained:

Dose administered pre-pregnancy	Dose administered before the earliest pregnancy start date
Dose administered in pregnancy	Dose administered after the latest pregnancy start date and before the delivery date
Dose administered post-pregnancy	Dose administered on or after the delivery date based on NIMS records extracted on 18 February 2022
Dose in pregnancy: unknown	Dose administered around the start or pregnancy: after the earliest pregnancy start date and before the latest pregnancy start date
Unvaccinated	No vaccine records exist for the woman, based on NHS number

And the following information about trimester.

Dose administered pre-pregnancy	Dose administered before the earliest pregnancy start date
Dose administered in trimester 1	Dose administered after the latest pregnancy start date and before the earliest pregnancy start date +97 days
Dose administered in trimester 2	Dose administered after the latest pregnancy start date +98 days and before the earliest pregnancy start date +195 days

Dose administered in trimester 3	Dose administered after the latest pregnancy start date + 196 days and before the delivery date
Dose administered post-pregnancy	Dose administered on or after the delivery date based on NIMS records extracted on 18 February 2022
Dose in trimester unknown	Dose administered in the 'gap' between trimesters, because of inaccuracy in establishing pregnancy start date
Unvaccinated	No vaccine records exist for the woman, based on NHS number

The ethnicity, residence and age information used to generate Tables 7 to 9 was taken from the NIMS record. The analysis within this section was carried out on 18 February 2022. The latest HES data available were for November 2021, and HES data since April 2021 are considered provisional.

Pregnancy outcomes

The following figures present rates of women in England who:

1. Gave birth to one or more live-born babies at term without low birthweight; that is, they experienced none of the following adverse outcomes considered (outcomes 2 to 4), according to their delivery record.
2. Gave birth to a stillborn baby (based on recorded diagnoses).
3. Gave birth to a baby with low birthweight (less than 2,500g) or a very low birthweight (less than 1,500g). The babies with a very low birthweight are therefore a subset of the low birthweight babies.
4. Gave birth prematurely (less than 37 weeks gestation), very prematurely (less than 32 weeks gestation) and extremely prematurely (less than 28 weeks gestation). The very premature and extremely premature are therefore a subset of women who gave birth prematurely.

These analyses assess whether rates were different in women giving birth between January and November 2021, who received one or more COVID-19 vaccination doses during their pregnancy compared with those who did not (either because they were unvaccinated or had only received vaccine doses prior to pregnancy). The analyses do not take other factors that might affect these outcomes into account, such as age (except for outcome 1 above) and whether the woman was categorised as clinically at risk. However, women who gave birth on or after 17 April 2021 without the reported complications (outcome 1 above), were also reviewed with vaccinations given from 16 April onwards. This is a more homogenous group of pregnant women who were eligible for vaccination based solely on age and not because they were considered at high risk of exposure or severe disease. Therefore, data are also presented for women giving birth between 17 April and 30 November 2021 for comparison.

Figure 4. Women giving birth January to November 2021 to live-born babies at term without low birthweight

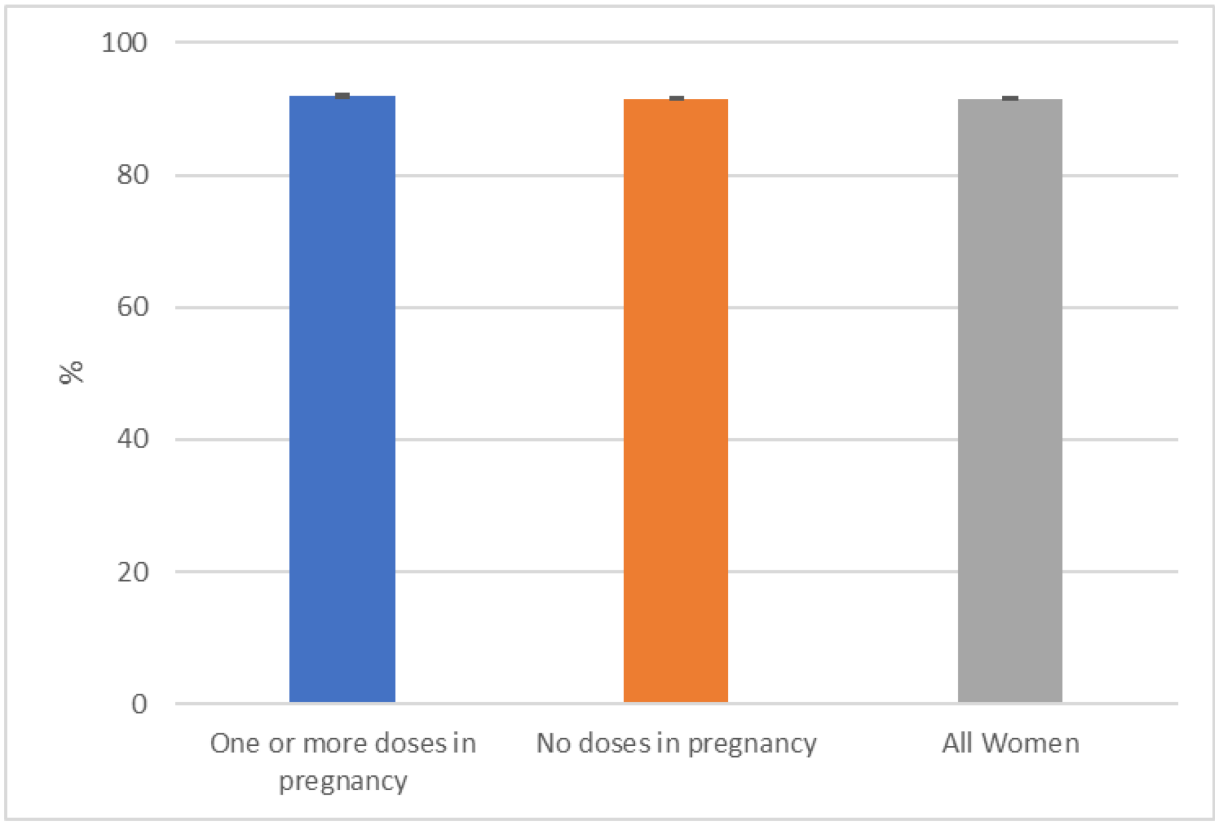


Figure 5. Women giving birth January to November 2021 to live-born babies at term without low birthweight, by age

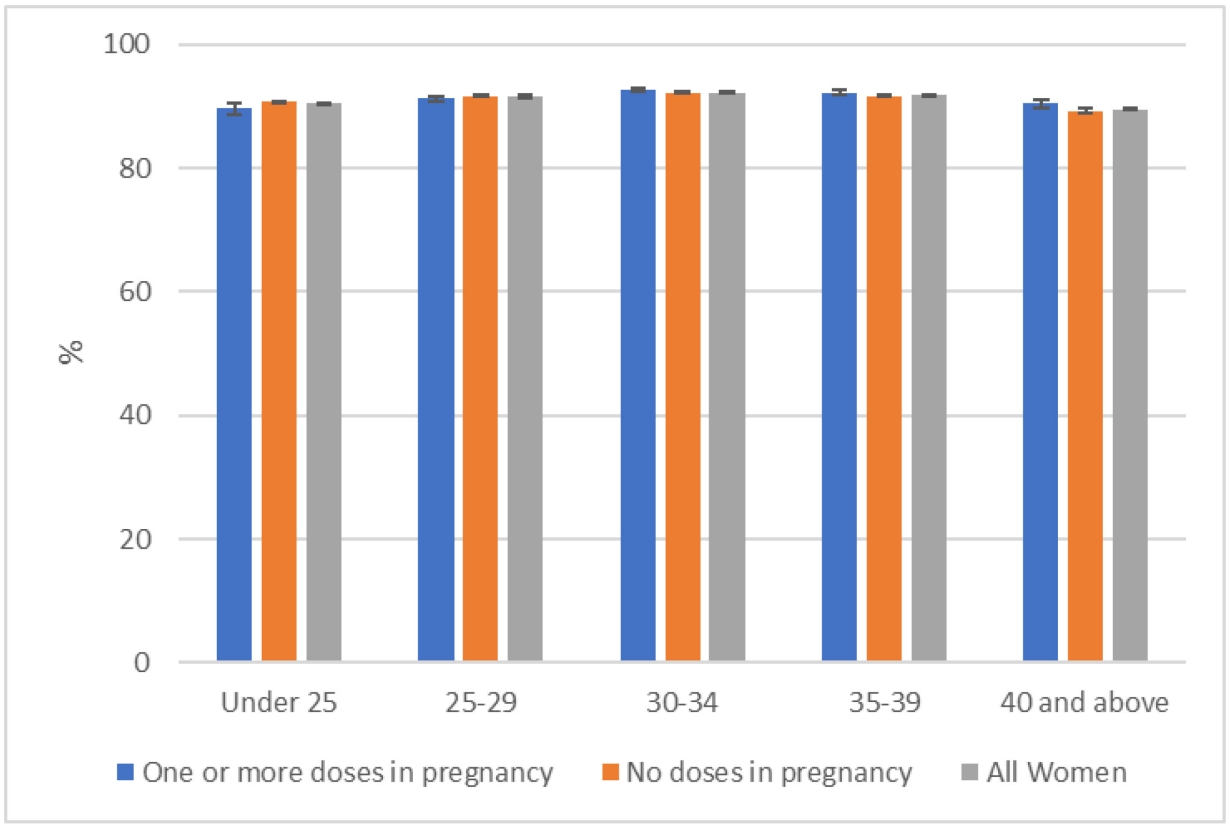


Figure 6. Women giving birth April to November 2021 to live-born babies at term without low birthweight

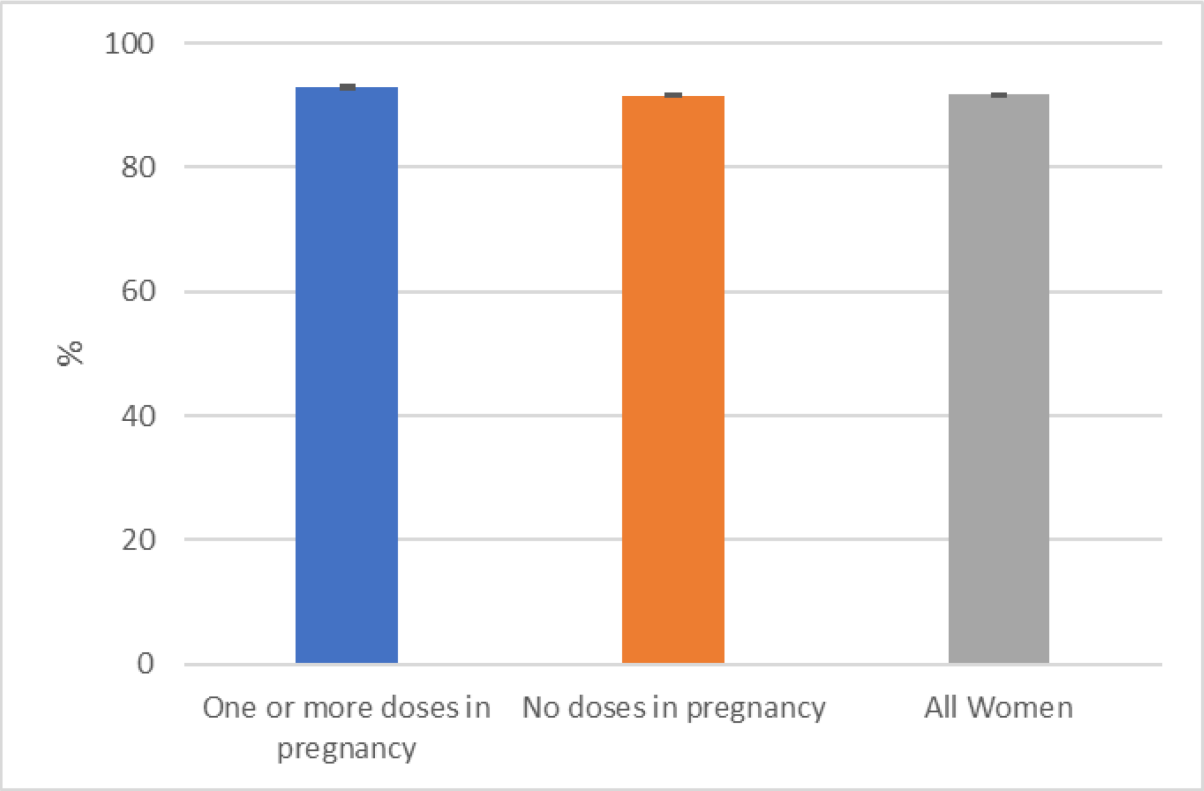


Figure 7. Women giving birth April to November 2021 to live-born babies at term without low birthweight, by age

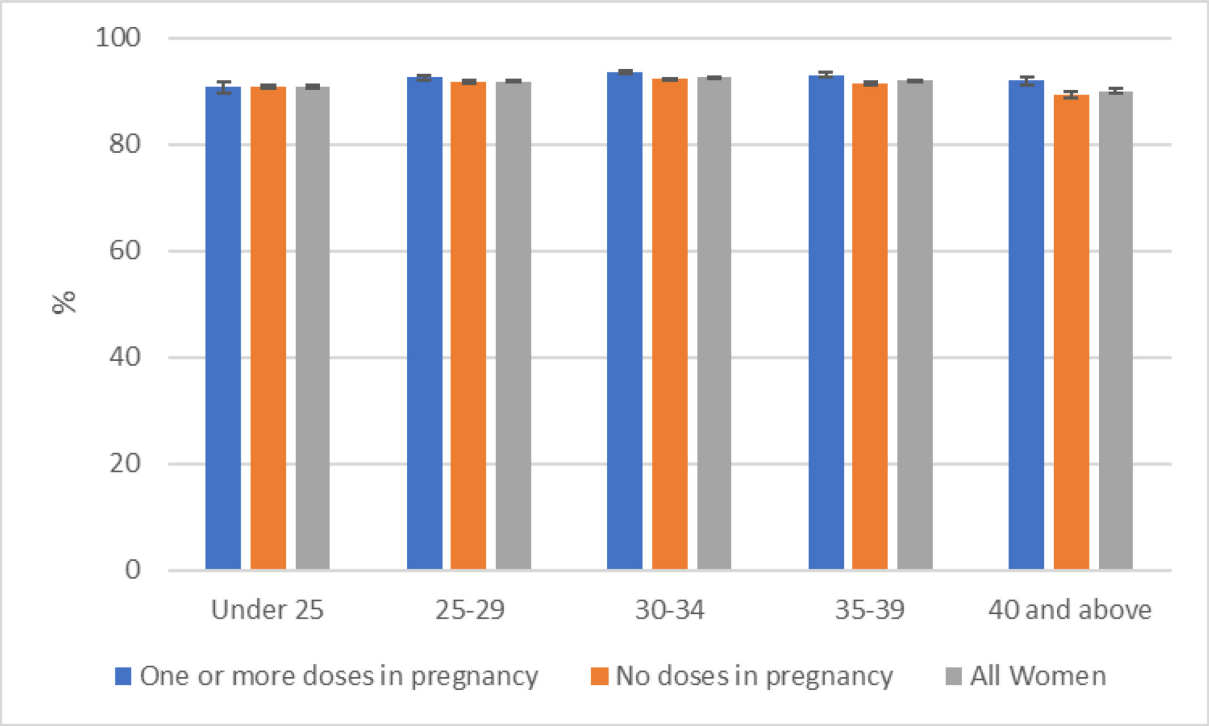


Figure 8. Stillbirths experienced by women giving birth January to November 2021

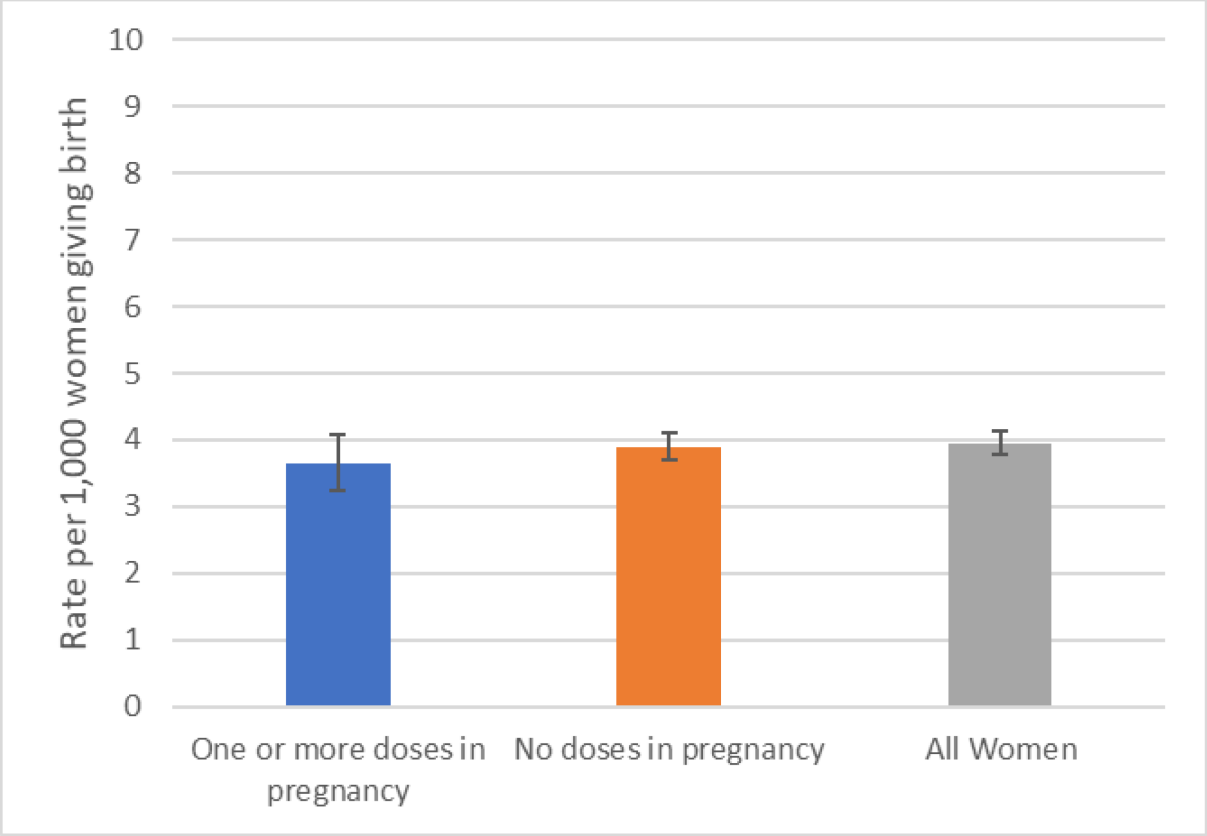


Figure 9. Low birthweight babies to women giving birth January to November 2021

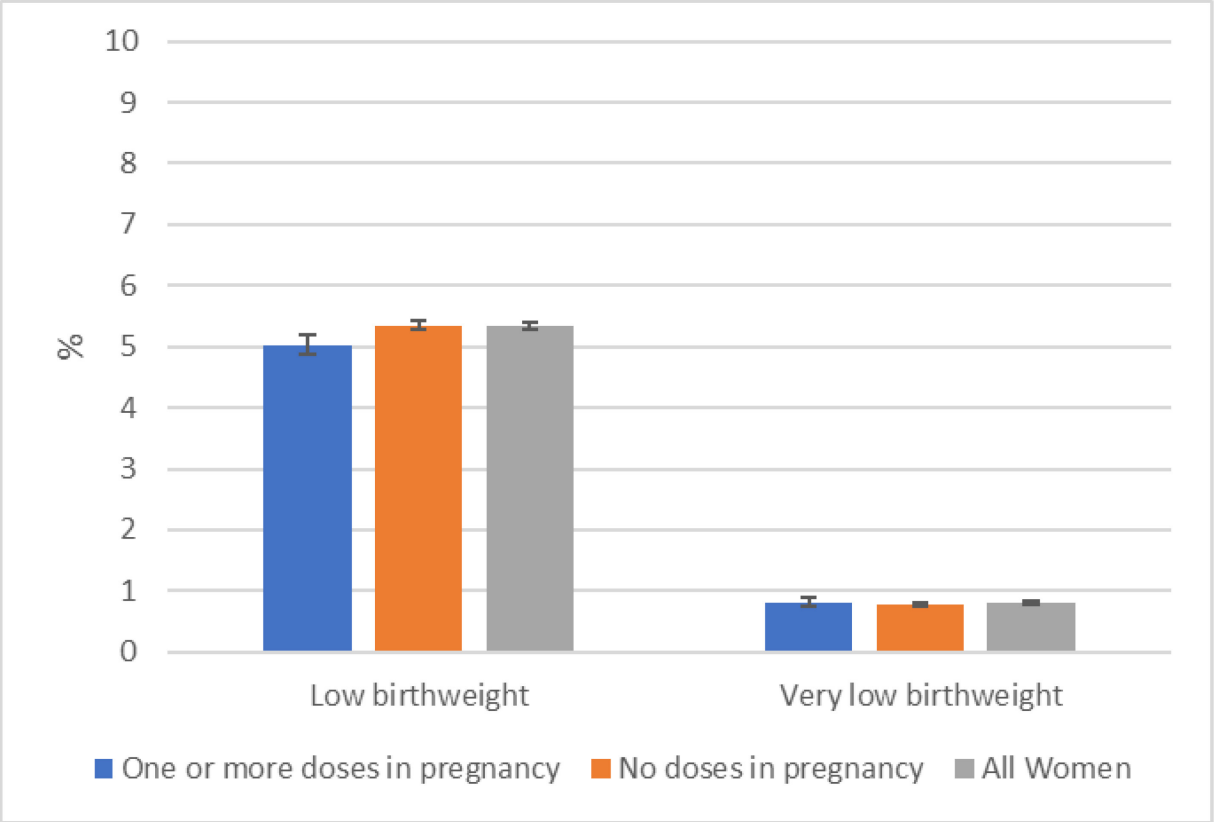
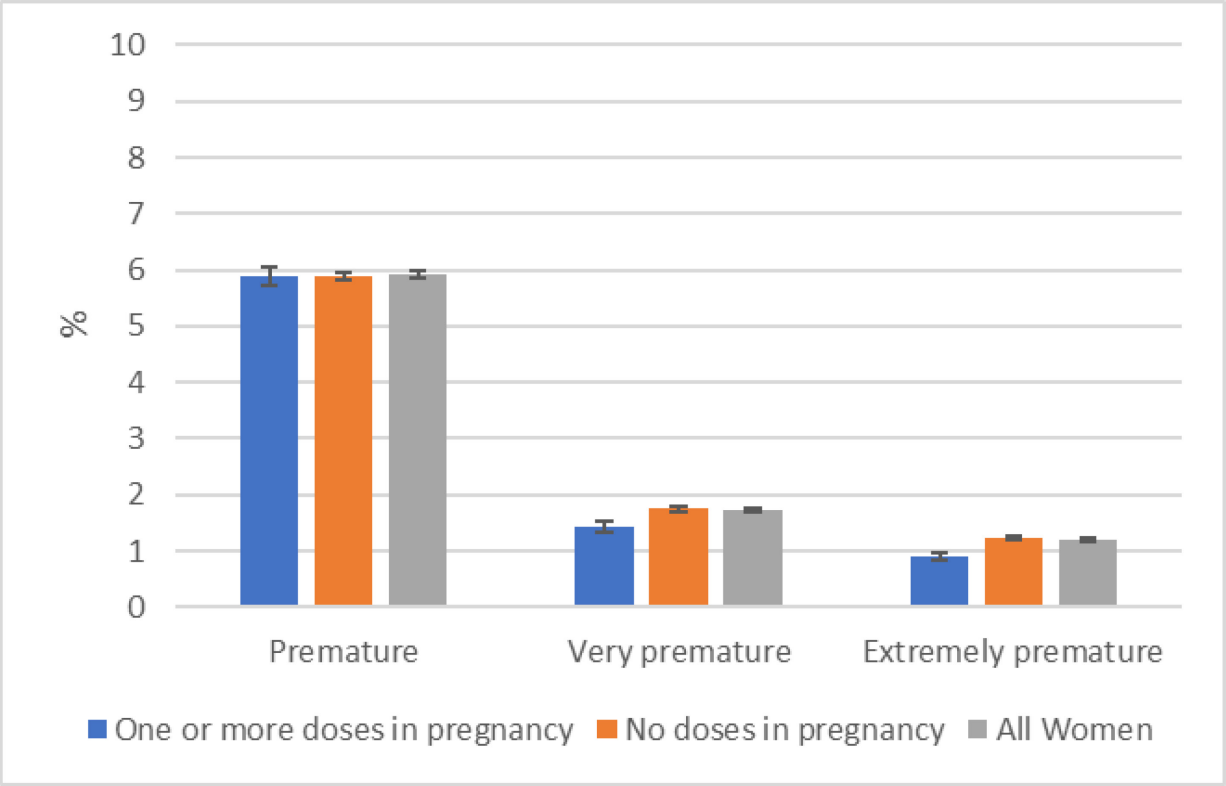


Figure 10. Women giving birth prematurely January to November 2021



The proportion of women giving birth between January and November 2021 to live-born babies at term without low birthweight (that is, with no specified adverse outcomes) having received one or more doses in pregnancy (91.9% 95%CI 91.7 to 92.1) is similar to the proportion in women who did not receive any doses in pregnancy (91.6% 95%CI 91.5 to 91.7) (Figure 4). These positive outcomes were similar across all age groups in vaccinated and unvaccinated women (Figure 5). For the more recent period (women vaccinated from 16 April and delivering from 17 April 2021), when all pregnant women were routinely offered vaccination on the basis of age, women who had received at least one dose of COVID-19 vaccine during their pregnancy were more likely to give birth without any of the reported adverse outcomes than women who had not been vaccinated in pregnancy (92.9% 95%CI 92.7 to 93.1 compared with 91.6% 95%CI 91.5 to 91.7) (Figure 6).This difference was more apparent in those aged 30 years and older (Figure 7).

The stillbirth rate for women who gave birth having received one or more doses in pregnancy (3.63 per 1,000, 95%CI 3.23 to 4.09) was similar to the rate for those who had not received any doses in pregnancy (3.90 per 1,000, 95%CI 3.71 to 4.10) giving birth between January and November 2021 (Figure 8). In the same period, the proportion of women who had received one or more doses in pregnancy giving birth to babies with low birthweight (5.03%, 95%CI 4.87 to 5.19) was lower than those who had not received any doses in pregnancy (5.34%, 95%CI 5.28 to 5.41) (Figure 6). There was no statistically significant difference between the 0.81% (95%CI 0.75 to 0.88) of women who had received one or more doses in pregnancy and 0.77% (95%CI 0.74 to 0.80) of those who had not, who gave birth to a very low birthweight baby (Figure 9).

The proportion of women who received one or more doses in pregnancy having premature births was 5.87% (95%CI 5.71 to 6.04), compared with 5.88% (95%CI 5.81 to 5.96) in those who had not (Figure 10). The proportion of women with very premature births was 1.43% (95%CI 1.35 to 1.52) in those who received one or more dose in pregnancy, lower than the 1.75% (95%CI 1.71 to 1.79) with a very premature birth who had not been vaccinated during pregnancy. The proportion of women with extremely premature births was 0.89% (95%CI 0.83 to 0.96) in those who received one or more dose in pregnancy: lower than the 1.24% (95%CI 1.21 to 1.28) in those who had not.

Interpretation and limitations

The first women to be offered COVID-19 vaccine were those who were categorised as at risk of severe disease and women of older age who are at increased risk of the 3 adverse outcomes presented here (given the medical conditions that placed them in this category), together with healthcare professionals at higher risk of COVID-19 exposure. Women with underlying conditions that put them at very high risk of serious complications of COVID-19 will thus account for a relatively high proportion of early deliveries in women who had received one or more doses of the vaccine before 16 April 2021. It is therefore very reassuring that women who had received at least one dose of the vaccine in pregnancy were more likely to deliver live born babies at term without low birthweight and had no overall increased risk of any adverse outcome through January to November.

These findings support the conclusions on vaccine safety from COVID-19 vaccine surveillance report – week 47 (COVID-19 vaccine weekly surveillance reports (week 39 2021 to week 3 2022).

More detailed statistical analyses are planned (see COVID-19 vaccination in pregnancy surveillance protocol. The adverse pregnancy outcomes considered are routinely reported as official statistics annually by ONS, however HES data was used to monitor outcomes more quickly than ONS data allows. There are recognised limitations of the data sets including the level of completeness of the relevant fields.

Methods

The same methods as used to establish coverage figures were used to group records of deliveries into those who had received at least one dose of the vaccine during their pregnancy and those who had not. The definition of this second group includes any women who received dose(s) only prior to pregnancy and those who received their first dose after delivery, as well as those unvaccinated as of 18 February 2022. Outcomes are also presented by age at delivery, using the woman's date of birth as recorded in NIMS.

To identify deliveries where adverse outcomes were experienced; the following criteria were applied. The outcomes are related: for example, babies born prematurely are more likely to be born with low birthweight, and therefore a delivery may have more than one adverse outcome.

Stillbirths were identified as records where any 1 or more of the first 12 diagnoses was the following: Z37.1: Single stillbirth; Z37.3 Twins, 1 liveborn and 1 stillborn; Z37.4 Twins, both stillborn; Z37.6: Other multiple births, some liveborn; Z37.7: Other multiple births, all stillborn. Low birthweight and very low birthweight deliveries were identified as records where any of the first 4 babies born had a known birthweight between 500g and 2499g (1499g or lower for very low birthweight).

Premature deliveries were identified as records where the gestational length was less than 37 weeks (less than 32 weeks for very premature, and less than 28 weeks for extremely premature).

Low birthweight is by convention presented as a percentage of all deliveries with known birthweights, and prematurity usually presented as a percentage of all deliveries with known gestational length. However here they are presented as percentages of all deliveries, to reduce the chance of significant findings arising from a change in the overall success of recording these fields during the pandemic. Figures will therefore differ from official statistics and should be considered for surveillance purposes only.

Confidence intervals were calculated using the Wilson Score method (40). A confidence interval is a range of values that is used to quantify the imprecision in the estimate of a particular indicator. Specifically, it quantifies the imprecision that results from random variation in the measurement of the indicator. A wider confidence interval shows that the indicator value presented is likely to be a less precise estimate of the true underlying value.

Main findings

COVID-19 vaccination is the safest and most effective way for women to protect themselves and their babies against severe COVID-19 disease.

COVID-19 vaccine coverage in pregnant women at delivery has increased as more women have become eligible for vaccination reaching 48.5% for women who gave birth in November 2021 having had one or more dose before their baby was born. This is in line with coverage reported across the UK with 56% of women in Scotland (22) and 57.7% in Wales (34) delivering in December 2021 who had received any dose and their first dose of COVID-19 vaccine respectively prior to delivery.

As in the previous report, however, coverage increased with decreasing levels of deprivation and women of black ethnicity had the lowest vaccine coverage. Coverage increased with increasing age group to 35 to 39 years.

Whilst coverage has improved since the October coverage presented in the week 4 report, across all groups it continues to highlight inequalities consistent with those seen across the entire COVID-19 vaccination programme. The percentage point differences between the groups

with highest and lowest coverage were greater than those in the January report. However, coverage of at least one dose has increased from 5.5% in women of black ethnicity who delivered between June and August 2021 to 20.5% of these women delivering between September and November 2021. In women living in the most deprived areas in England coverage increased from 7.8% to 25.5% in the same period. In addition, 33% of Black women and 35.5% of women living in the most deprived areas who are unvaccinated go on to be vaccinated post-partum.

It is very reassuring that women who had received at least one dose of the vaccine in pregnancy were as likely to deliver live born babies at term without low birthweight as women who were not vaccinated in pregnancy.

The group of women who were most likely to be immunised on the basis of their age group alone (vaccinated from 16 April 2021 and giving birth from 17 April 2021) were significantly more likely to deliver live born babies at term without low birthweight than women giving birth in the same period who were not vaccinated in pregnancy.

The specific outcomes that were considered (stillbirth, low birthweight and premature delivery) were similar or lower in women who were vaccinated whilst pregnant compared to women who were not vaccinated during their pregnancy.

Vaccination status in cases, deaths and hospitalisations

From 1 April 2022, the UK Government will no longer provide free universal COVID-19 testing for the general public in England, as set out in the plan for living with COVID-19. Such changes in testing policies affect the ability to robustly monitor COVID-19 cases by vaccination status, therefore, from early April onwards this section of the report will not be updated. Updates to vaccine effectiveness data will continue to be published elsewhere in this report.

Please note that from 31 January 2022, UKHSA moved all COVID-19 case reporting in England to use a new episode-based definition which includes possible reinfections. Each infection episode is counted separately if there are at least 91 days between positive test results. Each infection episode begins with the earliest positive specimen date. Further information can be found on the UK COVID-19 dashboard.

Vaccination status of COVID-19 cases, deaths and hospitalisations by week of specimen date over the past 4 weeks up to week 10 (up to 13 March 2022) are shown in tables 10 to 12.

This data is published to help understand the implications of the pandemic to the NHS, for example understanding workloads in hospitals, and to help understand where to prioritise vaccination delivery. **This raw data should not be used to estimate vaccine effectiveness.** We have published a blog post to accompany this section of the vaccine surveillance report.

Methods

COVID-19 cases and deaths identified through routine collection from the Second Generation Surveillance System (SGSS) and from UKHSA EpiCell's deaths data, as described in the technical summary, 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 Data Set (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 this data twice weekly. Data from ECDS is 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 reports 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, this 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 specimen date for a COVID-19 case. Deaths include those who died (a) within 28 days of the most recent episode of infection or (b) within 60 days of the episode specimen date or more than 60 days after the episode 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 at the mid-point of the reporting period from NIMS.

Results

The rate of a positive COVID-19 test varies by age and vaccination status. 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 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 data

This data should be considered in the context of the vaccination status of the population groups shown in the rest of 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 **from** COVID-19.

The vaccination status of cases, inpatients and deaths should not be used to assess vaccine effectiveness because of differences in risk, behaviour and testing in the vaccinated and unvaccinated populations. The case rates in the vaccinated and unvaccinated populations are crude rates that do not take into account underlying statistical biases in the data. There are likely to be systematic differences between vaccinated and unvaccinated populations, for example:

- testing behaviour is likely to be different between people with different vaccination status, resulting in differences in the chances of being identified as a case
- many of those who were at the head of the queue for vaccination are those at higher risk from COVID-19 due to their age, their occupation, their family circumstances or because of underlying health issues
- people who are fully vaccinated and people who are unvaccinated may behave differently, particularly with regard to social interactions and therefore may have differing levels of exposure to COVID-19
- people who have never been vaccinated are more likely to have caught COVID-19 in the weeks or months before the period of the cases covered in the report. This gives them some natural immunity to the virus which may have contributed to a lower case rate in the past few weeks

These biases become more evident as more people are vaccinated and the differences between the vaccinated and unvaccinated population become systematically different in ways that are not accounted for without undertaken formal analysis of vaccine effectiveness. Vaccine effectiveness has been formally estimated from a number of different sources and is described on pages 4 to 15 in this report.

Denominator

The potential sources of denominator data are either the National Immunisation Management Service (NIMS) or the Office for National Statistics (ONS) mid-year population estimates. Each source has its strengths and limitations which have been described in detail on the NHS website and GOV.Wales.

NIMS may over-estimate denominators in some age groups, for example because people are registered with the NHS but may have moved abroad. However, as it is a dynamic register, such patients, once identified by the NHS, are able to be removed from the denominator. On the other hand, ONS data uses population estimates based on the 2011 census and other sources of data. When using ONS, vaccine coverage exceeds 100% of the population in some age groups, which would in turn lead to a negative denominator when calculating the size of the unvaccinated population.

UKHSA uses NIMS throughout its COVID-19 surveillance reports including in the calculation rates of COVID-19 infection, hospitalisation and deaths by vaccination status because it is a dynamic database of named individuals, where the numerator and the denominator come from the same source and there is a record of each individual's vaccination status. Additionally, NIMS contains key sociodemographic variables for those who are targeted and then receive the vaccine, providing a rich and consistently coded data source for evaluation of the vaccine programme. Large scale efforts to contact people in the register will result in the identification of people who may be overcounted, thus affording opportunities to improve accuracy in a dynamic fashion that feeds immediately into vaccine uptake statistics and informs local vaccination efforts.

Sources of further information

UKHSA has published a blog post to accompany this section of the report.

The Office of the Statistics Regulator has published a blog post.

UKHSA has published a significant amount of research into vaccine effectiveness which is summarised on pages 4 to 15 of this report.

ONS has published research into the risk of testing positive for COVID-19 by vaccination status, impact of Delta on viral burden and vaccine effectiveness (4), and the risk of death by vaccination status.

Table 10. COVID-19 cases by vaccination status between week 7 2022 and week 10 2022
Please note that corresponding rates by vaccination status can be found in Table 13.

Cases reported by specimen date between week 7 2022 (w/e 20 February 2022) and week 10 2022 (w/e 13 March 2022)	Total	Unlinked*	Not vaccinated	Received one dose (1 to 20 days before specimen date)	Received one dose, ≥21 days before specimen date	Second dose ≥14 days before specimen date[1]	Third dose ≥14 days before specimen date[1]
	[This data should be interpreted with caution. See information below in footnote about the correct interpretation of these figures]						
Under 18	153,208	6,626	112,192	1,292	15,994	15,958	1,146
18 to 29	155,025	11,145	21,016	318	7,661	37,147	77,738
30 to 39	184,909	9,497	20,107	163	5,051	32,287	117,804
40 to 49	162,218	6,602	10,536	57	2,433	18,719	123,871
50 to 59	146,438	5,554	5,119	21	1,256	9,754	124,734
60 to 69	97,323	3,309	2,011	19	545	3,556	87,883
70 to 79	59,919	2,013	919	9	274	1,391	55,313
80 or over	36,126	2,865	664	4	228	1,726	30,639

* Individuals whose NHS numbers were unavailable to link to the NIMS.
[1] 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 11. 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 7 2022 and week 10 2022

Please note that corresponding rates by vaccination status can be found in Table 13.

Cases presenting to emergency care (within 28 days of a positive test) resulting in overnight inpatient admission, by specimen date between week 7 2022 (w/e 20 February 2022) and week 10 2022 (w/e 13 March 2022)	Total	Unlinked*	Not vaccinated	Received one dose (1 to 20 days before specimen date)	Received one dose, ≥21 days before specimen date	Second dose ≥14 days before specimen date[1]	Third dose ≥14 days before specimen date[1]
	[This data should be interpreted with caution. See information below in footnote about the correct interpretation of these figures]						
Under 18	658	14	575	7	44	15	3
18 to 29	464	6	146	1	34	130	147
30 to 39	436	1	132	0	33	93	177
40 to 49	409	5	87	0	28	81	208
50 to 59	601	2	110	0	29	114	346
60 to 69	720	1	87	0	24	113	495
70 to 79	1,202	1	109	1	14	112	965
80 or over	2,083	1	103	0	26	179	1,774

* Individuals whose NHS numbers were unavailable to link to the NIMS.

[1] 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 12. 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 7 2022 and week 10 2022

Please note that corresponding rates by vaccination status can be found in Table 13.

(a)

Death within 28 days of positive COVID-19 test by date of death between week 7 2022 (w/e 20 February 2022) and week 10 2022 (w/e 13 March 2022)	Total**	Unlinked*	Not vaccinated	Received one dose (1 to 20 days before specimen date)	Received one dose, ≥21 days before specimen date	Second dose ≥14 days before specimen date[1]	Third dose ≥14 days before specimen date[1]
	[This data should be interpreted with caution. See information below in footnote about the correct interpretation of these figures]						
Under 18	2	0	1	0	1	0	0
18 to 29	5	0	1	0	1	2	1
30 to 39	16	0	10	0	0	3	3
40 to 49	34	2	9	1	3	12	7
50 to 59	100	1	25	0	5	24	45
60 to 69	177	0	33	0	7	37	100
70 to 79	503	5	56	0	11	84	347
80 or over	1,584	3	102	0	29	220	1,230

* 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.

[1] 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.

(b)

Death within 60 days of positive COVID-19 test by date of death between week 7 2022 (w/e 20 February 2022) and week 10 2022 (w/e 13 March 2022)	Total**	Unlinked*	Not vaccinated	Received one dose (1 to 20 days before specimen date)	Received one dose, ≥21 days before specimen date	Second dose ≥14 days before specimen date[1]	Third dose ≥14 days before specimen date[1]
	[This data should be interpreted with caution. See information below in footnote about the correct interpretation of these figures]						
Under 18	2	0	1	0	1	0	0
18 to 29	17	0	6	0	2	7	2
30 to 39	34	0	14	0	2	10	8
40 to 49	88	2	16	1	6	29	34
50 to 59	232	1	41	0	9	72	109
60 to 69	431	1	59	0	17	105	249
70 to 79	1076	6	96	0	29	185	760
80 or over	3,217	3	168	1	55	465	2,525

* 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.
[1] 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 13. Unadjusted rates of COVID-19 infection, hospitalisation and death in vaccinated and unvaccinated populations.
Please note that the following table should be read in conjunction with pages 37 to 40 of this report, and the footnotes provided on page 45.

	Cases reported by specimen date between week 7 2022 (w/e 20 February 2022) and week 10 2022 (w/e 13 March 2022)		Cases presenting to emergency care (within 28 days of a positive test) resulting in overnight inpatient admission, by specimen date between week 7 2022 (w/e 20 February 2022) and week 10 2022 (w/e 13 March 2022)		Death within 28 days of positive COVID-19 test by date of death between week 7 2022 (w/e 20 February 2022) and week 10 2022 (w/e 13 March 2022)		Death within 60 days of positive COVID-19 test by date of death between week 7 2022 (w/e 20 February 2022) and week 10 2022 (w/e 13 March 2022)	
	[see information on population bases and unadjusted rates in footnotes 1 and 2 below this table]							
	Unadjusted rates among persons vaccinated with at least 3 doses (per 100,000)	Unadjusted rates among persons not vaccinated (per 100,000)[1,2]	Unadjusted rates among persons vaccinated with at least 3 doses (per 100,000)	Unadjusted rates among persons not vaccinated (per 100,000)[2]	Unadjusted rates among persons vaccinated with at least 3 doses (per 100,000)	Unadjusted rates among persons not vaccinated (per 100,000)[2]	Unadjusted rates among persons vaccinated with at least 3 doses (per 100,000)	Unadjusted rates among persons not vaccinated (per 100,000)[2]
Under 18	949.6	1,110.7	2.5	5.7	0.0	0.0	0.0	0.0
18 to 29	2,191.7	701.9	4.1	4.9	0.0	0.0	0.1	0.2
30 to 39	2,780.4	747.8	4.2	4.9	0.1	0.4	0.2	0.5
40 to 49	2,481.6	651.7	4.2	5.4	0.1	0.6	0.7	1.0
50 to 59	1,964.8	520.2	5.5	11.2	0.7	2.5	1.7	4.2
60 to 69	1,622.2	382.2	9.1	16.5	1.8	6.3	4.6	11.2
70 to 79	1,214.3	386.1	21.2	45.8	7.6	23.5	16.7	40.3
80 or over	1,223.9	556.3	70.9	86.3	49.1	85.5	100.9	140.7

[1] Comparing case rates among vaccinated and unvaccinated populations should not be used to estimate vaccine effectiveness against COVID-19 infection. Vaccine effectiveness has been formally estimated from a number of different sources and is summarised on pages 4 to 15 in this report.

The rates are calculated per 100,000 in people who have received either 3 doses of a COVID-19 vaccine or in people who have not received a COVID-19 vaccine. These figures are updated each week as the number of unvaccinated individuals and individuals vaccinated with 3 doses in the population changes.

The case rates in the vaccinated and unvaccinated populations are unadjusted crude rates that do not take into account underlying statistical biases in the data and there are likely to be systematic differences between these 2 population groups. For example:

- testing behaviour is likely to be different between people with different vaccination status, resulting in differences in the chances of being identified as a case
- many of those who were at the head of the queue for vaccination are those at higher risk from COVID-19 due to their age, their occupation, their family circumstances or because of underlying health issues
- people who are fully vaccinated and people who are unvaccinated may behave differently, particularly with regard to social interactions and therefore may have differing levels of exposure to COVID-19
- people who have never been vaccinated are more likely to have caught COVID-19 in the weeks or months before the period of the cases covered in the report. This gives them some natural immunity to the virus which may have contributed to a lower case rate in the past few weeks

[2] Case rates are calculated using NIMS, a database of named individuals from which the numerator and the denominator come from the same source and there is a record of each individuals vaccination status. Further information on the use of NIMS as the source of denominator data is presented on page 39 of this report.

Unadjusted case rates among persons not vaccinated have been formatted in grey to further emphasise the caution to be employed when interpreting this data.

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

Seroprevalence

The results from testing samples provided by healthy adult blood donors aged 17 years and older, supplied by the NHS Blood and Transplant (NHS BT collection) between weeks 35 2020 and week 8 of 2022 are summarised. As of week 44 of 2020, approximately 250 samples from each geographic NHS region are tested each week.

The COVID-19 vaccination campaign began on the 8 December 2020 (week 50) with a phased roll out by age and risk group. From the beginning of September 2021, a third dose was offered to individuals with severe immunosuppression. A booster dose was introduced from 16 September 2021 for individuals aged 50 years and over, frontline health and social care staff, individuals aged 16 to 49 with certain underlying health conditions and household contacts of immunosuppressed individuals. Eligibility for booster doses was extended to individuals aged 40 years and over from 22 November and from December to those aged 18 to 39 in a phased rollout by age group. Booster doses are generally given at least 6 months after the second dose, although the minimum interval was reduced to at least 3 months from the second or third dose in an effort to accelerate the roll out with the emergence of the Omicron variant.

Please note that this section will be updated monthly. Last update was published on 10 March 2022.

Seroprevalence in blood donors aged 17 years and older

The results presented here are based on testing samples with Roche nucleoprotein (N) and Roche spike (S) antibody assays.

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 seropositivity for the Roche N assay reflect the effect of natural infection. Increases in seropositivity as measured by S antibody reflect both infection and vaccination. Antibody responses to both targets reflect infection or vaccination occurring at least 2 to 3 weeks previously given the time taken to generate a COVID-19 antibody response. Currently donors are asked to defer donations for at least 48 hours post vaccination (previously 7 days), and for at least 10 full days after a positive COVID-19 test as well as 7 days following resolution of any symptoms (previously 28 days, changes were implemented during January 2022).

This report presents Roche N and Roche S seropositivity estimates on the same set of samples, using a 12-week rolling prevalence for national, age group and regional estimates. Seropositivity estimates are plotted using the mid-point of a 12-weekly rolling period that reduces to 8 weeks in the most recent weeks to allow for a more representative current

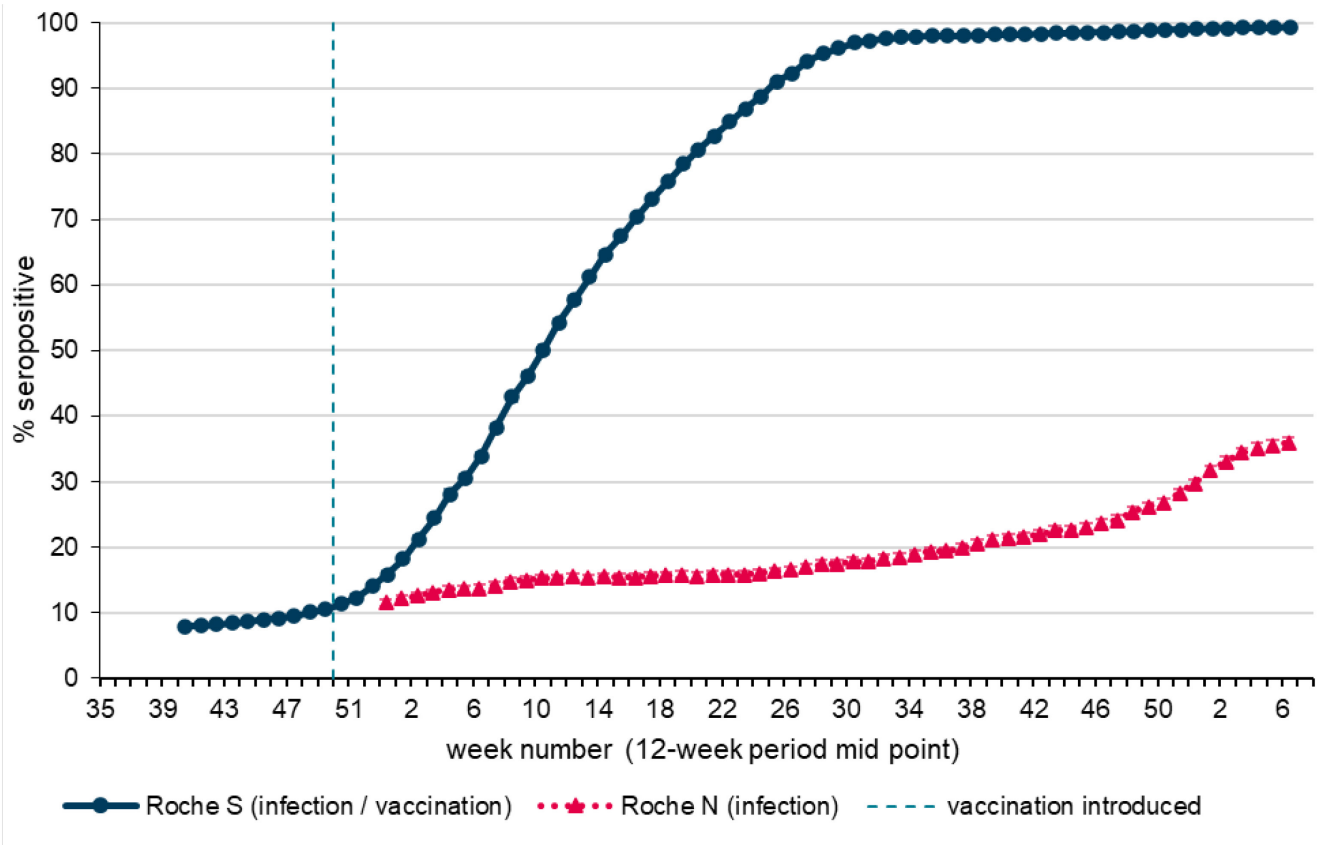
estimate of seropositivity. However, this also means the data will reflect seroprevalence several weeks previously. Seroprevalence estimates reported are based on seropositivity which are unadjusted for the sensitivity and specificity of the assays used.

National prevalence

Overall population weighted (by age group, sex and NHS region) antibody prevalence among blood donors aged 17 years and older in England was 36.0% (95% CI 35.1% - 36.8%) using the Roche N assay and 99.3% (95% CI 99.1% - 99.5%) using the Roche S assay for the period 4 January to 27 February (weeks 1 2022 to 8 2022). 5,325 out of 14,989 were Roche N positive and 14,904 out of 14,996 samples were Roche S positive. This compares with 23.6% (95% CI 22.9% - 24.2%) Roche N seropositivity and 98.5% (95% CI 98.3% - 98.7%) Roche S seropositivity for the period of 11 October to 31 December 2021 (weeks 41 to 52 2021).

Seropositivity (weighted by region, age group and sex) varies over time. Figure 11 shows the overall 12-weekly rolling proportion seropositive over time for the Roche N and Roche S assays. Seropositivity estimates are plotted weekly using the mid-point of a rolling 12-weekly period.

Figure 11. Overall 12-weekly rolling SARS-CoV-2 antibody seroprevalence (% seropositive) in blood donors



Regional prevalence of infection over time

Seropositivity (weighted by age group and sex) using the Roche N assay which detects infection only, varies by region (Figure 12).

Figure 12. 12-weekly rolling SARS-CoV-2 antibody seroprevalence (% seropositive) in blood donors by region, using Roche N test; error bars show 95% confidence intervals.

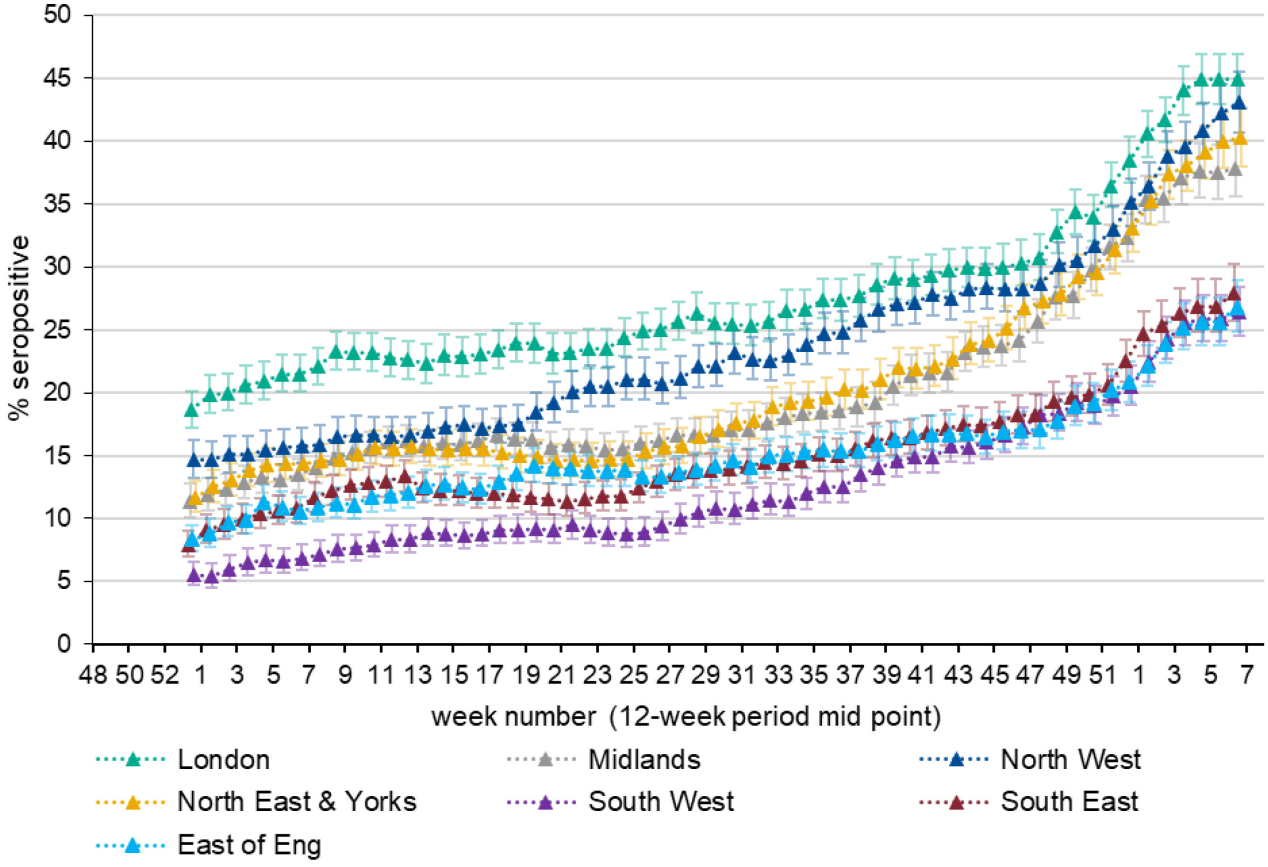


Table 14. Roche N seropositivity (95%CI) estimates by NHS region

NHS region	Weeks 41 to 52 2021	Weeks 1 to 8 2022
East of England	17.0% (15.6% - 18.5%)	26.8% (24.8% - 28.9%)
London	30.3% (28.5% - 32.1%)	44.9% (42.9% - 46.9%)
Midlands	24.2% (22.5% - 26.0%)	37.8% (35.6% - 40.0%)
North East and Yorkshire	26.8% (25.0% - 28.6%)	40.3% (38.0% - 42.6%)
North West	28.2% (26.5% - 30.1%)	43.1% (40.7% - 45.5%)
South East	18.2% (16.7% - 19.8%)	27.9% (25.7% - 30.2%)
South West	17.3% (15.9% - 18.8%)	26.4% (24.5% - 28.4%)

Increases in Roche N seropositivity have recently been observed across all regions (Table 14) compared to the previous 12-week period with the most notable increases in London, Midlands,

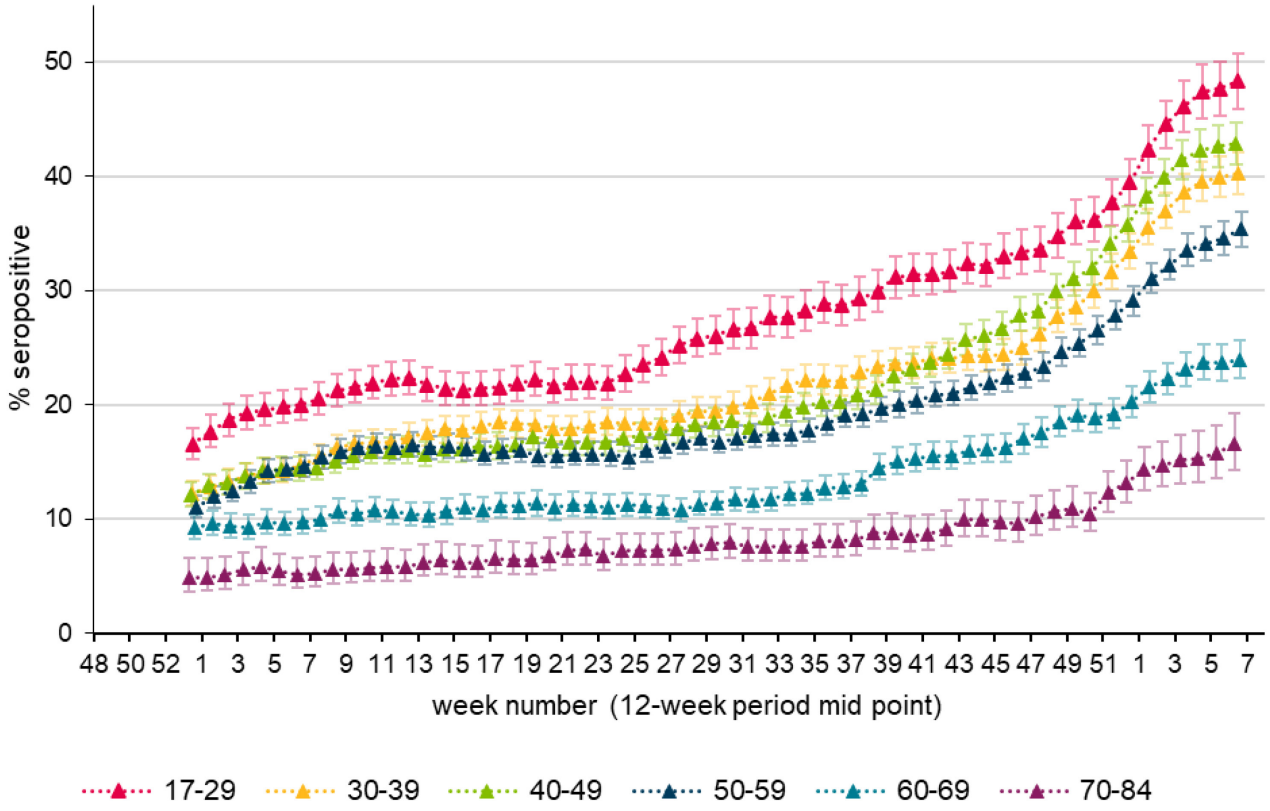
North West and North East and Yorkshire regions. These increases are beginning to slow across all regions and plateauing of Roche N seropositivity can be seen in London in most recent weeks. This earlier plateauing in London is likely due to it being the first region to see large increases in case rates due the Omicron wave and peaking before other regions as well as already having the highest Roche N seropositivity.

Whilst seropositivity has consistently been lowest in the South West, recent increases have resulted in the region now having similar levels as observed in the East of England. With the emergence of the Omicron variant considerable increases in COVID-19 case rates in England have been observed across all regions which are now continuing to fall across all regions. (Weekly national Influenza and COVID-19 surveillance report week 8). Since it takes approximately 2 to 3 weeks to develop an antibody response following infection, recent rises in seroprevalence will likely reflect infection during the peak of the Omicron wave up to the end of January 2022.

Prevalence by age group

Seropositivity estimates by age group using the Roche N assay are presented below.

Figure 13. Population weighted 12-weekly rolling SARS-CoV-2 antibody seroprevalence (% seropositive) in blood donors from the Roche N assay by age group



Based on testing samples using the Roche N assay (Figure 13) as a marker of infection, the highest seropositivity continues to be observed in those aged 17 to 29 and the lowest in those aged 70 to 84.

Table 15. Roche N seropositivity (95%CI) estimates by age group

Age group	Weeks 41 to 52 2021	Weeks 1 to 8 2022
17 to 29	33.4% (31.4% - 35.4%)	48.4% (45.9% - 50.8%)
30 to 39	25.0% (23.6% - 26.4%)	40.2% (38.4% - 42.1%)
40 to 49	27.9% (26.4% - 29.4%)	42.9% (41.1% - 44.8%)
50 to 59	22.7% (21.6% - 24.0%)	35.4% (33.9% - 37.0%)
60 to 69	17.0% (15.8% - 18.4%)	24.0% (22.3% - 25.6%)
70 to 84	9.6% (8.1% - 11.5%)	16.6% (14.3% - 19.2%)

Increases in Roche N seropositivity have recently been observed across all age groups (Table 15) compared to the previous 12-week period. In the most recent period, the largest increase in seropositivity was observed in the 3 youngest age groups. In England, COVID-19 case rates for weeks 4 2021 to week 8 2022, have decreased across most adult age groups with the highest rates currently seen in individuals aged 30 to 39 followed by 40 to 49 years old (Weekly national Influenza and COVID-19 surveillance report week 8).

Roche S seropositivity in blood donors has plateaued and is now over 96% across all age groups.

Seropositivity estimates for S antibody in blood donors are likely to be higher than would be expected in the general population and this probably reflects the fact that donors are more likely to be vaccinated. Seropositivity estimates for N antibody will underestimate the proportion of the population previously infected due to (i) waning of the N antibody response over time and (ii) observations from UK Health Security Agency (UKHSA) surveillance data that N antibody levels are lower in individuals who acquire infection following 2 doses of vaccination. These lower N antibody responses in individuals with breakthrough infections (post-vaccination) compared to primary infection likely reflect the shorter and milder infections in these patients. Patients with breakthrough infections do have significant increases in S antibody levels consistent with boosting of their antibody levels.

Vaccination has made an important contribution to the overall Roche S increases observed since the roll out of the vaccination programme, initially amongst individuals aged 50 years and above who were prioritised for vaccination as part of the phase 1 programme and subsequently in younger adults as part of phase 2 of the vaccination programme. The impact of the booster vaccination programme can be assessed by monitoring Roche S antibody levels across the population over time.

Roche S levels by age group and month

The Roche S assay that the UK Health Security Agency (UKHSA) uses for serological surveillance is fully quantitative, meaning that it measures the level of antibodies in a blood sample; an antibody level above 0.8 au/ml (approximately 1 IU/ml using the WHO standard) is deemed positive. The PHE/ UKHSA surveillance over the past few months has found that over 98% of the population of blood donors test positive for S-antibodies, which may have resulted from either COVID-19 infection or vaccination. With such high seropositivity, it is important to look at population antibody levels in order to assess the impact of the vaccination booster programme. In the previous report, groupings of antibody level ranges were updated to better illustrate changes over time.

Figure 14 shows monthly categorised Roche S levels in N-antibody negative individuals by age group over the past year. In the 3 oldest age groups, the impact of first vaccine dose, then second vaccine dose, can be seen from March through June 2021, as the profile of population antibody levels increases. Then from June through September the profile of antibody levels in these cohorts gradually decreases, consistent with waning. During October there was a small increase in percentage of donors with very high antibody levels of 10,000+ au/ml for the 50 to 84 age group, following the initiation of the booster programme. In November the proportion of donors with very high antibody levels of 10,000+ au/ml increased further particularly in those aged 70 to 84 years. In December large increases were observed in the proportion of donors aged 50 to 69 with very high antibody levels of 10,000+ au/ml. By January 2022 large increases were also observed in younger age groups as the booster programme was accelerated due to the emergence of the Omicron variant, however the slightly decreasing profile of antibody levels among all age groups in February shows signs of waning. Given the evidence of waning, those most at risk are being offered a booster vaccine in the Spring.

Figure 15 shows categorised Roche S levels in N-antibody positive individuals, those likely to have experienced past infection. Pre-vaccination antibody levels will be influenced by time since infection, variant and severity of infection, as well as individual factors such as underlying health conditions and age. In November more than half of donors aged 70 to 84 years had very high antibody levels of 25,000+ au/ml. By January 2022 increases in the proportion of donors with very high antibody levels of 25,000+ AU/ml were observed across all age groups. Comparing Figure 14 with Figure 15, the overall higher profile of antibody levels in those who have experienced past infection is evident; both vaccination post infection and breakthrough infection following vaccination are expected to boost existing antibody levels.

Researchers across the globe are working to better understand what antibody levels mean in terms of protection against COVID-19. Current thinking is that there is no threshold antibody level that offers complete protection against infection, but instead that higher antibody levels are likely to be associated with lower probability of infection.

Figure 14. Categorised Roche S antibody levels by age group and month in N negative samples, March 2021 to February 2022

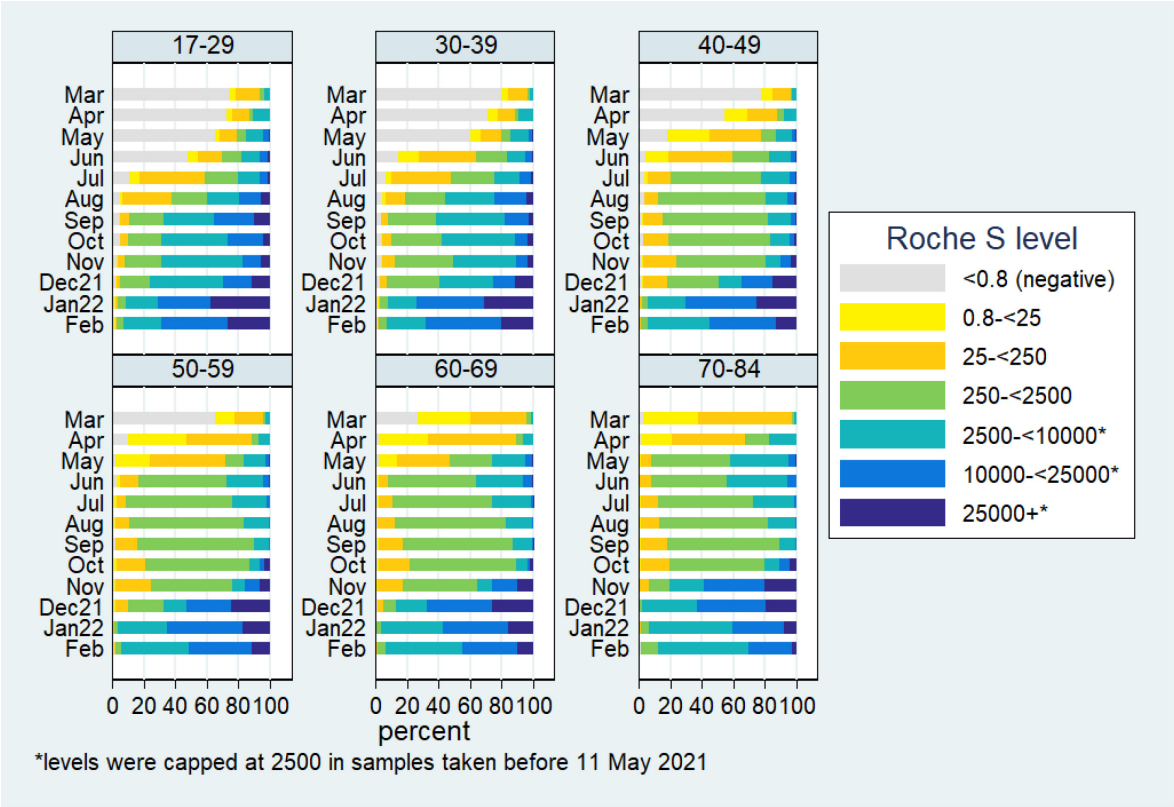
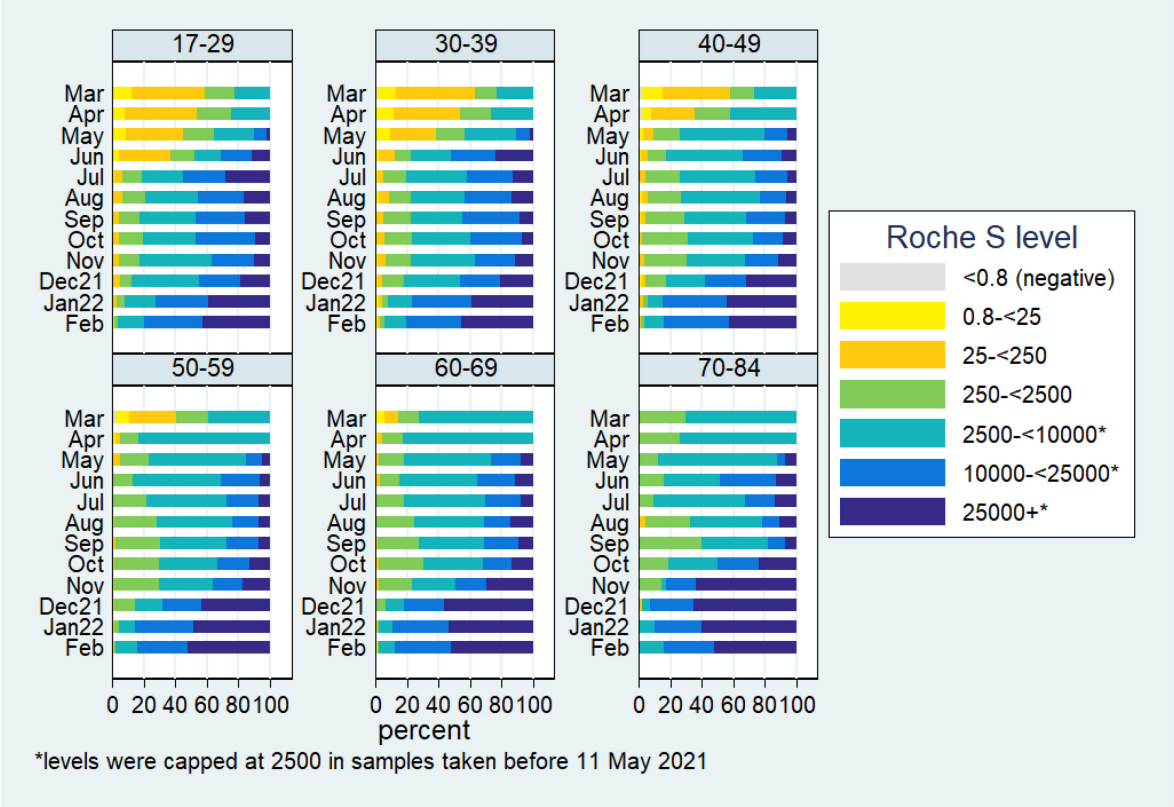


Figure 15. Categorised Roche S antibody levels by age group and month in N positive samples, March 2021 to February 2022



Direct impact on hospitalisations

The analysis estimates the number of hospitalisations averted by booster vaccinations in the period since 13 December 2021 when Omicron infections started to become more dominant. The booster vaccination programme was accelerated and expanded to all adults aged 18 years and over from November 2021 in response to a rapid increase in Omicron infections.

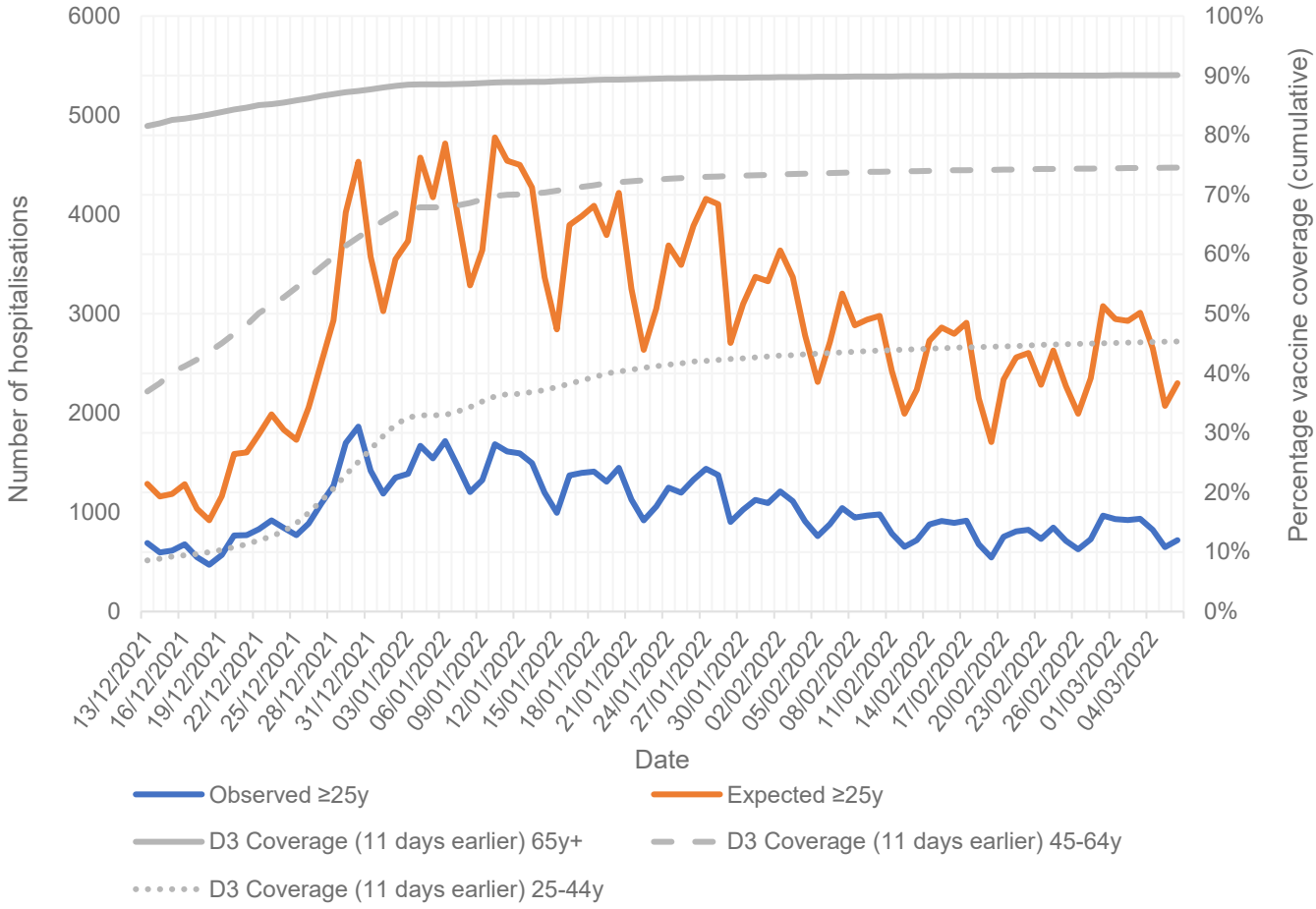
The number of hospitalisations averted is estimated by incorporating vaccine effectiveness against hospitalisation, vaccine coverage and observed hospitalisations. The focus of the calculation in this model is hospitalisations averted in the Omicron period given the coverage of booster vaccinations. This allows us to model the expected number of hospitalisations in the absence of the booster vaccination programme. The most recent estimates for vaccine effectiveness against hospitalisations are used: 85% from the booster against Omicron in the period 5-9 weeks post booster and 35% for the second dose for the period 25+ weeks after that dose. This gives a relative effectiveness (rVE) of the booster compared to 2 doses of 1-(1-0.85)/(1-0.35) = 77%. The expected cases in the absence of boosting is calculated as $O_{0/1}$+ [$O_{2/boost}$ / (1- (booster cover/(booster cover + 2 dose cover))*rVE)], where $O_{0/1}$ is observed hospitalised cases with 0 or 1 doses and $O_{2/boost}$ is observed cases with 2 doses or more (note that these observed totals are in fact estimated using information from the subset of SARI-Watch cases where this information is ascertained, with weekly proportions with each dose number applied to the daily overall hospitalisation numbers). The daily expected cases are calculated per age group and summed for an overall total in the period. The overall total per age group is summed to provide the all age total across the period. This is the same for the observed calculation.

Based on the direct effect of the booster vaccination and booster vaccine coverage rates, UKHSA estimates that around 157,300 hospitalisations have been prevented in those aged 25 years and over in England from 13 December 2021 to 6 March 2022 inclusive. The total number averted by age group is approximately 129,400 in those aged 65 years and over, 21,500 in those aged 45 to 64 years and 6,400 in those aged 25 to 44 years as a result of the booster vaccination programme (Figure 16). All those aged 25 to 64 years in this analysis are inclusive of healthy and at-risk individuals.

Several caveats are necessary to consider. The indirect effect of protection from infection and onwards transmission is not considered. Any indirect effects are likely to be small given the low and rapidly waning vaccine effectiveness against mild disease or infection observed with the Omicron variant. Finally, the vaccine effectiveness estimates used in this model are based on all age estimates. Work is being done to further assess VE against different hospitalisation end points and how this differs by age which could lead to changes in these impact estimates.

Please note this analysis will be updated every 2 weeks. The next update will be in the report for week 12 2022.

Figure 16. Estimated number of hospitalisations averted by booster vaccinations since 13 December 2021



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