UK Health Security Agency

# COVID-19 vaccine surveillance report

## Week 5

2 February 2023

# Contents

# Executive summary

Rigorous clinical trials have been undertaken to understand the immune response, safety profile and efficacy of all coronavirus (COVID-19) vaccines approved for use in the UK 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).

Please note that this report is published monthly. The next report will be published on 2 March 2023.

This month's report contains updates on vaccine effectiveness, vaccine coverage, vaccine impact on the proportion of the population with antibodies to COVID-19 and vaccination status by the time of admission through SARI-Watch.

# Vaccine effectiveness

Large clinical trials were undertaken for each of the COVID-19 vaccines first approved in the UK. These found that they were highly efficacious at preventing symptomatic disease in the populations that were studied. The clinical trials were able to assess the efficacy of the vaccines against laboratory confirmed symptomatic disease caused by the strains circulating in 2020 and early 2021. They also assessed with lower power efficacy against more severe disease.

Post implementation real world vaccine effectiveness studies are needed to understand vaccine effectiveness against different outcomes (such as severe disease and onward 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 (or positivity among those tested) 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. Previous reports demonstrated high levels of effectiveness against Alpha and Delta variants, particularly for severe disease and death.

Please note that vaccine effectiveness data will be updated in this report as it becomes available.

## 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-19 Infection Survey and GP electronic health record data. After community testing for COVID-19 was reduced in April 2022, we were no longer able to assess vaccine effectiveness against symptomatic disease using these data but results from previous analyses are available in earlier iterations of this report. Evidence prior to April from community testing and in other studies since this time has shown that effectiveness of all COVID-19 vaccines, including after first booster doses, against symptomatic disease with Omicron BA.1 and subsequent sub-lineages of the Omicron variant is low (starting at about 50-60%) and wanes rapidly to near 0 by 6 months.

## Effectiveness against hospitalisation

Several studies have estimated vaccine effectiveness against hospitalisation, all of which indicate higher levels of protection against hospitalisation than symptomatic disease with all vaccines against the Alpha, Delta and Omicron variants (3 to 8). Given that Omicron generally causes milder disease than previous variants (9), in particular among younger individuals, an increasing proportion of individuals hospitalised with a positive COVID-19 test are likely to have COVID-19 as an incidental finding rather than the primary reason for admission (8).

We have previously found that using broader definitions of hospitalisation has given lower vaccine effectiveness estimates, reflecting outcome misclassification where cases are likely coincidentally positive whilst in hospital, without this being the primary reason for admission (and therefore these cases cannot be prevented by vaccination). We, therefore, use stricter definitions to define a COVID-19 hospitalisation. Here, a COVID-19 hospitalisation is defined as requiring at least 2 days stay in the hospital and a respiratory code in the primary diagnostic field. To estimate effectiveness against more severe disease we also estimate effectiveness for those requiring oxygen, mechanical ventilation or ICU (Table 1). There are likely still some incidental admissions in our data, in particular among younger adults. Using data from mid-July when BA.5 sub-lineage of Omicron has been dominant shows that protection against hospitalisation is maintained to a reasonable degree long term; VE after a second dose was 40.2% after 15 or more months and 52.3% at 12 to 14 months after a first booster dose (Table 1).

**Table 1. Vaccine effectiveness against hospitalisation in those aged 65 years and over**

| | | At least 2 days stay with a respiratory code in primary diagnosis field |
|---|---|---|
| | **Interval** | **VE** |
| Dose 2 | 2 weeks to 2 months | 70.3 (30.9 to 87.2) |
| | 3 to 5 months | 71.7 (50.5 to 83.8) |
| | 6 to 8 months | 57.6 (38.6 to 70.7) |
| | 9 to 11 months | 51.2 (31.2 to 65.4) |
| | 12 to 14 months | 35.5 (23.3 to 45.8) |
| | 15+ months | 40.2 (31.0 to 48.1) |
| Booster (third+ dose) | 2 weeks to 2 months | 78.1 (75.7 to 80.3) |
| | 3 to 5 months | 65.3 (61.7 to 68.6) |
| | 6 to 8 months | 53.6 (48.8 to 58.0) |
| | 9 to 11 months | 51.1 (45.7 to 56.0) |
| | 12 to 14 months | 52.3 (43.7 to 59.6) |
| | 15+ months | Insufficient data |

# Effectiveness of the spring 2022 booster

Spring boosters with either Pfizer BioNTech or a half dose (50µg) of Moderna were offered to those at risk and those aged 75 years and older from March 2022. VE was estimated against hospitalisation using a strict definition (at least 2 days stay with a respiratory code in the primary diagnosis field). VE was estimated against the Omicron variant, all sub-lineages (BA.1, BA.2, BA.4 and BA.5) combined since we have not found a big difference in VE between sub-lineages. Since very few individuals remained unvaccinated, VE of the fourth dose was estimated as compared to those who had a waned third dose (25 to 39 weeks past receiving

their third vaccine) (Table 2). The incremental VE for the fourth dose is therefore the level of protection that the fourth dose adds in addition to the remaining protection conferred by a third dose. These estimates, therefore, appear lower and are not directly comparable with estimates where VE is calculated relative to the unvaccinated. VE against hospitalisation was enhanced by a fourth dose; the incremental VE after 2 to 4 weeks was 58.8%. This waned to 10.8% at 20 or more weeks after receiving the fourth dose.

**Table 2. Vaccine effectiveness against hospitalisation for fourth doses, estimated using those 25 to 39 weeks post their third dose as the baseline group**

| Dose | Interval (weeks) | Vaccine effectiveness (95% CI) |
|---|---|---|
| 3 | 25 to 39 weeks | Baseline |
| 4 | 0 to 6 days | 46.5 (37.7 to 54.2) |
| | 7 to 13 days | 45.6 (36.4 to 53.4) |
| | 2 to 4 weeks | 58.8 (54.1 to 63.0) |
| | 5 to 9 weeks | 50.1 (45.6 to 54.2) |
| | 10 to 14 weeks | 35.9 (30.2 to 41.1) |
| | 15 to 19 weeks | 21.1 (11.6 to 29.5) |
| | 20+ weeks | 10.8 (-6.2 to 25.1) |

# Effectiveness of the autumn 2022 bivalent booster

Bivalent boosters with either Pfizer BioNTech (Original/Omicron BA.1 Comirnaty®) or a Moderna bivalent (Spikevax® bivalent Original/Omicron vaccine) targeting both the ancestral strain and Omicron BA.1 were offered to those in clinical risk groups and those aged 50 years and older from September 2022. VE of the bivalent boosters was estimated against hospitalisation in the period following 5 September 2022 against all Omicron sub-lineages in circulation at the time. Only individuals who had received at least 2 COVID-19 vaccines before 5 September 2022 and with the last of these doses at least 6 months prior to sample date were included in analysis.

The effectiveness measured is therefore incremental effectiveness on top of at least 6 months waned protection. The incremental protection conferred by the bivalent vaccines estimated relative to those with waned immunity was 43.1% for Pfizer after 2 weeks, and 57.8% for Moderna. Effectiveness remained high at 10 or more weeks after vaccination at 46.4% for the Pfizer booster and 47.5% for the Moderna booster (Table 3).

**Table 3. Vaccine effectiveness of the bivalent booster vaccines against hospitalisation in those aged 50 years and older (VE = vaccine effectiveness, CI = confidence intervals)**

| Vaccine Manufacturer | Interval after booster dose | Controls | Cases | VE (95% CI) |
|---|---|---|---|---|
| Pfizer | 2 to 4 weeks | 1,040 | 173 | 43.1 (32.3 to 52.3) |
| | 5 to 9 weeks | 1,476 | 185 | 50.8 (41.5 to 58.6) |
| | 10+ weeks | 214 | 32 | 46.4 (20.1 to 64.1) |
| Moderna | 2 to 4 weeks | 1,153 | 277 | 57.8 (51.2 to 63.5) |
| | 5 to 9 weeks | 2,841 | 432 | 50.5 (44.1 to 56.1) |
| | 10+ weeks | 1,893 | 265 | 47.5 (38.5 to 55.2) |

# Effectiveness against mortality (vaccines given prior to the autumn 2022 bivalent boosters)

Vaccine effectiveness against mortality with the Omicron variant (all sublineages using tests taken until 5 September 2022) has been estimated for those aged 65 years and older using a test-negative case control study design (all vaccines combined) (Table 4). At 40-plus weeks following the second dose, vaccine effectiveness was around 50%. At 2 or more weeks following third and fourth dose vaccination, effectiveness was boosted to 85.0% and 80.9%, respectively. At 40 or more weeks after a third dose VE waned to 56.9% while at 20 or more weeks after a fourth dose (spring 2022 booster) VE waned to 68.2%. This analysis is also likely to include some incidental deaths of individuals who died with COVID-19 as opposed to from COVID-19, and we suspect the true VE against mortality is likely higher than the estimates presented here.

**Table 4. Vaccine effectiveness against mortality in those aged 65 years and older (all vaccine brands combined) (VE = vaccine effectiveness, CI = confidence intervals)**

| Dose | Interval after dose (weeks) | VE (95% CI) |
|---|---|---|
| 2 | 40+ | 49.7 (41.5 to 56.7) |
| 3 | 2 to 4 | 85.0 (80.8 to 88.2) |
| 3 | 5 to 9 | 83.1 (80.3 to 85.5) |
| 3 | 10 to 14 | 79.5 (76.6 to 82.0) |
| 3 | 15 to 19 | 75.6 (72.3 to 78.6) |
| 3 | 20 to 24 | 68.8 (64.3 to 72.7) |
| 3 | 25 to 39 | 62.6 (57.4 to 67.2) |

| Dose | Interval after dose (weeks) | VE (95% CI) |
|---|---|---|
| 3 | 40+ | 56.9 (43.1 to 67.4) |
| 4 | 2 to 4 | 80.9 (76.8 to 84.3) |
| 4 | 5 to 9 | 79.5 (75.8 to 82.7) |
| 4 | 10 to 14 | 71.2 (66.2 to 75.5) |
| 4 | 15 to 19 | 68.2 (61.2 to 73.9) |
| 4 | 20+ | 68.2 (58.4 to 75.7) |

# 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 it 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 (10 to 13).

Generally, estimates are similar to or slightly lower than vaccine effectiveness estimates against symptomatic disease and there is evidence of a significant waning in protection against infection over time. Effectiveness against infection with the Omicron variant is low and wanes rapidly (Table 5).

# Effectiveness against transmission

As described above, several studies have provided evidence that vaccines provide some protection against infection. Uninfected individuals cannot transmit. Therefore, the vaccines also provide some protection against transmission. There may be an 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 (14 to 18) with past variants.

# Consensus vaccine effectiveness estimates

Table 5 summarises consensus estimates of relative vaccine effectiveness against BA.4 or BA.5 Omicron for a booster dose of COVID-19 vaccine compared to 6+ months since the last dose (at least 2 doses).

**Table 5. Consensus estimates of relative vaccine effectiveness against BA.4 or BA.5 Omicron for a booster dose of COVID-19 vaccine compared to 6+ months since the last dose (at least 2 doses)**

| Vaccine product of booster dose | Outcome | 0 to 1 month | 2 to 3 months | 4 to 6 months | 6+ months |
|---|---|---|---|---|---|
| **Monovalent*** | **All Infection**** | 30% (20 to 40%) | 20% (10 to 30%) | 10% (0 to 20%) | 0% (0 to 5%) |
| **Monovalent*** | **Symptomatic**** | 40% (30 to 50%) | 40% (30 to 50%) | 10% (0 to 20%) | Insufficient data |
| **Monovalent*** | **Hospitalisation** | 60% (55 to 65%) | 40% (30 to 50%) | 20% (15 to 25%) | 0% (0 to 5%) |
| **Monovalent*** | **Mortality** | Insufficient data | Insufficient data | Insufficient data | Insufficient data |
| **Bivalent*** | **All Infection**** | 30% (20 to 40%) | 20% (10 to 30%) | 10% (0 to 20%) | 0% (0 to 5%) |
| **Bivalent*** | **Symptomatic**** | 40% (30 to 50%) | 40% (30 to 50%) | 10% (0 to 20%) | Insufficient data |
| **Bivalent*** | **Hospitalisation** | 55% (40 to 65%) | 50% (40 to 60%) | Insufficient data | Insufficient data |
| **Bivalent*** | **Mortality** | Insufficient data | Insufficient data | Insufficient data | Insufficient data |

* Refers to either Pfizer or Moderna.
** Estimates were not stratified according to monovalent or bivalent.

| | |
|---|---|
| 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 moderate level of uncertainty |
| Low confidence | Little evidence is available, and results are inconclusive |

# Effectiveness against BQ.1

VE against hospitalisation for BQ.1 and BA.5 was estimated during a period of co-circulation (Table 6). This included the period from 5 September 2022 to 25 December 2022. Cases were classified as BA.5 (VOC-22APR-04) or BQ.1 (V-22OCT-01) based on sequencing information. VE was estimated for those who had received a bivalent booster vaccine as part of the autumn programme, as well as at least 2 previous doses at least 6 months previously, relative to those who were not boosted in the autumn but had at least 2 previous doses at least 6 months previously. Estimates are for those who received the booster 2 or more weeks ago. All vaccine manufacturers were combined in the analysis.

The effectiveness of the bivalent booster (manufacturers combined) against hospitalisation with BQ.1 was 52.1% as compared to 63.6% with BA.5, at 2 or more weeks after receiving the booster (Table 6). Although the effectiveness point estimate is lower for BQ.1 the confidence interval is fairly wide and overlaps the estimate for BA.5. Currently the number of BQ.1 cases in the analysis is too small to confidently assess differences in vaccine effectiveness between the 2 variants.

**Table 6. VE estimates against hospitalisation with BQ.1 and BA.5 for the bivalent boosters in those aged 50 years and older**

| Variant | Vaccine | Controls | Cases | VE (95% CI) |
|---|---|---|---|---|
| BQ.1 | Bivalent (any) | 8617 | 175 | 52.1 (40.2 to 61.6) |
| | Pfizer | 2730 | 49 | 54.1 (36.0 to 67.1) |
| | Moderna | 5887 | 126 | 51.0 (37.7 to 61.4) |
| BA.5 | Bivalent (any) | 8617 | 100 | 63.6 (53.8 to 71.3) |
| | Pfizer | 2730 | 25 | 53.7 (28.5 to 70) |
| | Moderna | 5887 | 75 | 65.8 (55.5 to 73.7) |

Estimates of earlier circulating Omicron sub-lineages (BA.4, BA.4.6 and BA.5) as compared to BA.2 are available in previous iterations of this report.

# Vaccine effectiveness publications

UKHSA and collaborators have published a significant amount of research into vaccine effectiveness, which is summarised on pages 4 to 14. The publications listed in Table 7 provide further results and details on the methods used.

**Table 7. UKHSA publications on the effectiveness of COVID-19 vaccination**

| Publication | Subject |
|---|---|
| Effectiveness of the COVID-19 vaccines against severe disease with Omicron sub-lineages BA.4 and BA.5 in England | The latest evidence shows that vaccine effectiveness against hospitalisation is similar for the BA.4/5 variants as it is for BA.2. In somebody who received their second dose around 6 months previously, a booster dose increases protection against hospitalisation by 50 to 60%. This is the most comprehensive analysis of vaccine effectiveness against hospitalisation for BA.4/5 undertaken to date. |
| Effectiveness of AstraZeneca COVID-19 booster vaccination against the Omicron and Delta variants | This study estimates the effectiveness of booster vaccination with AstraZeneca against symptomatic disease and hospitalisation in individuals who were not able to receive mRNA vaccines in the UK. |
| COVID-19 Vaccine Effectiveness against the Omicron BA.2 variant in England | This study estimates the effectiveness of booster vaccination against symptomatic disease caused by the BA.2 sub-lineage of the Omicron (B.1.1.529) variant. |
| Vaccine effectiveness against hospitalisation with the Omicron variant | This study estimates vaccine effectiveness against hospitalisation with the Omicron variant and investigates the impact of using different hospitalisation outcome definitions |
| Effectiveness of COVID-19 vaccines against hospitalisation with the Omicron variant in adults aged 75 years and older | This study reports on vaccine effectiveness against hospitalisation with the Omicron variant in adults aged 75 years and older. |
| 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. |
| Effectiveness of BNT162b2 COVID-19 booster vaccine against COVID-19 related symptoms and hospitalisation in England | This study provides real world evidence of significantly increased protection from the booster vaccine dose against symptomatic disease and hospitalisation irrespective of the primary course. |

| Publication | Subject |
|---|---|
| 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. |
| 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. |

| Publication | Subject |
|---|---|
| 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 the 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 UKHSA'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 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

By the end of week 4 2023 (week ending 29 January 2023), 64.7% (15,089,845 out of 23,326,643) of all people aged over 50 years old had been vaccinated with an Autumn booster dose since 1 September 2022. Vaccine uptake of those aged over 80 years old was 82.5% (2,457,234 out of 2,977,407). For further detail on the vaccine uptake and the current booster campaign, please the flu and COVID-19 weekly surveillance report weekly national influenza and COVID-19 surveillance report.

## 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 was reported after the first SARS-CoV-2 wave in England (19, 20) and Scotland (21, 22). It is not yet clear what impact the currently circulating Omicron strains may have had, although the disease is generally reported to be milder during the Omicron period with reduced risk of complications in pregnant women when compared to the Delta period (23 ,24). Omicron has also been associated with higher rates of infection in pregnant women when compared to Delta (24). Pregnant women who develop the severe disease have increased rates of admission to the 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 (25).

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 (26). 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 (26). 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 (27). The booster dose, made available to all individuals with severe immunosuppression from September 2021 and then extended to all eligible adults in England from 30 November 2021, is important to confer high levels of protection against Omicron strains (see report section Vaccine effectiveness). Pregnant women are included as one of the priority groups to be offered the Autumn 2022 COVID-19 booster dose.

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 due to reassuring global safety data (28).

There is evidence of high levels of protection against SARS-CoV-2 infection in pregnant women after COVID-19 vaccination (29 to 31) and evidence that vaccination induces higher antibody levels than after disease (31). 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 (32). 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 (33). Similar findings have been reported from Scotland with the report 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, 34). The researchers also found a higher 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 30,000 pregnant women to the end of March 2022 (21). In the USA data collected by the US Centre for Disease Control indicated that around 71% of pregnant people were fully vaccinated before or during pregnancy in week ending 20 August 2022 (35).

No safety concerns relating to COVID-19 vaccination of pregnant women have been found in published studies to date (35 to 39). The rate of vaccine side-effects appears to be similar in pregnant and non-pregnant populations (35). Studies from Norway, the USA and Scotland have found no association between COVID-19 vaccination and the risk of miscarriage (37 to 40).

This report presents data on vaccine coverage and outcomes for women delivering up to the end of June 2022 and updates the early data on COVID-19 vaccination in pregnant women published in the COVID-19 vaccine surveillance report – weeks 47 of 2021, 4, 8, 12, 16, 19 and 35 of 2022. Findings continue to be provisional and are not directly comparable between reports as data is updated through the complete time period under consideration. Vaccine coverage data for pregnant women will be updated in the March 2023 UKHSA COVID-19 vaccine surveillance report which will include data on women who delivered to end of October 2022.

## Vaccine coverage

COVID-19 vaccine coverage in women before they give birth has increased as more women have become eligible for vaccination. In November 2021, 48.7% of women giving birth had received at least one dose of vaccine before they delivered. This increased to 53.7% of women who gave birth in December 2021, to 65.9% of women by February 2022 and has stabilised at approximately 73% from May 2022. Of women who gave birth in December 2021, 43.4% had received 2 doses of the vaccine before they gave birth increasing to 57.9% of women giving birth in February 2022 and 67.3% of women who gave birth in June 2022 (see Table 8).

In the 18 month period between January 2021 and June 2022, a total of 755,030 women gave birth with linked records on vaccination status for 752,252 (99.6%) of them. Of all women who gave birth over this period, 258,639 (34.3%) were known to have received at least one dose of COVID-19 vaccine prior to delivery, 208,993 (27.7%) received at least 2 doses and 83,433 (11.1%) women had received at least 3 doses but not all would have been eligible during their pregnancy.

There were 121,726 women who received their first dose prior to pregnancy and went on to conceive and deliver by June 2022. There were 61,787 women who received at least one dose in the first trimester, 89,949 women received at least one dose in the second and 71,390 received at least one dose in the third trimester (women may be vaccinated in more than one trimester). In addition, 45,663 women were known to have received dose one before giving birth but without enough information to establish which trimester. Of these women, 26,401 were known to have received this dose in pregnancy, and 19,262 around the start of pregnancy.

Of all vaccinated women giving birth, 155,563 had received one or more doses of Pfizer vaccine only; 9,270 had one or more doses of only Moderna; 18,509 had one or more doses of only AstraZeneca. The remaining 75,297 vaccinated women with known vaccine manufacturer received a mixture of doses: 39,568 received a combination of Pfizer and Moderna and 35,693 received AstraZeneca with Pfizer or Moderna.

**Table 8. Overall vaccine coverage in women giving birth, by month of delivery[1]**

| Month | Women giving birth | One or more doses by time of delivery | 2 or more doses by time of delivery | Unvaccinated at delivery | Unvaccinated who went on to receive doses after pregnancy to 26 August 2022 |
|---|---|---|---|---|---|
| January 2021 | 41,949 | 18 (0.0%) | 1 (0.0%) | 41,774 (99.6%) | 32,271 (77.3%) |
| February 2021 | 40,093 | 83 (0.2%) | 0 (0.0%) | 39,882 (99.5%) | 30,833 (77.3%) |
| March 2021 | 44,589 | 296 (0.7%) | 25 (0.1%) | 44,173 (99.1%) | 33,931 (76.8%) |
| April 2021 | 42,467 | 493 (1.2%) | 93 (0.2%) | 41,825 (98.5%) | 31,850 (76.2%) |
| May 2021 | 43,964 | 1,261 (2.9%) | 309 (0.7%) | 42,542 (96.8%) | 31,625 (74.3%) |
| June 2021 | 43,723 | 4,369 (10.0%) | 656 (1.5%) | 39,219 (89.7%) | 27,832 (71.0%) |
| July 2021 | 47,393 | 7,717 (16.3%) | 2,203 (4.6%) | 39,497 (83.3%) | 26,493 (67.1%) |
| August 2021 | 46,149 | 10,486 (22.7%) | 6,129 (13.3%) | 35,488 (76.9%) | 22,208 (62.6%) |
| September 2021 | 46,710 | 15,101 (32.3%) | 10,519 (22.5%) | 31,433 (67.3%) | 17,992 (57.2%) |
| October 2021 | 46,196 | 19,211 (41.6%) | 14,655 (31.7%) | 26,801 (58.0%) | 13,689 (51.1%) |
| November 2021 | 42,917 | 20,896 (48.7%) | 16,482 (38.4%) | 21,860 (50.9%) | 8,864 (40.5%) |
| December 2021 | 41,578 | 22,372 (53.8%) | 18,048 (43.4%) | 19,033 (45.8%) | 5,634 (29.6%) |
| January 2022 | 39,331 | 23,449 (59.6%) | 19,971 (50.8%) | 15,739 (40.0%) | 2,776 (17.6%) |
| February 2022 | 36,348 | 23,938 (65.9%) | 21,043 (57.9%) | 12,254 (33.7%) | 1221 (10.0%) |
| March 2022 | 38,702 | 26,936 (69.6%) | 23,957 (61.9%) | 11,625 (30.0%) | 611 (5.3%) |
| April 2022 | 37,539 | 26,961 (71.8%) | 24,324 (64.8%) | 10,426 (27.8%) | 330 (3.2%) |
| May 2022 | 38,345 | 28,023 (73.1%) | 25,645 (66.9%) | 10,187 (26.6%) | 199 (2.0%) |
| June 2022 | 37,037 | 27,029 (73.0%) | 24,933 (67.3%) | 9,855 (26.6%) | 96 (1.0%) |

[1] 2,778 women could not be matched with a NIMS record. Their vaccine status is therefore unknown and they are excluded from these coverage figures.

**Table 9. Vaccine coverage by ethnicity, for women giving birth April to June 2022 (latest 3 months)[2]**

| Ethnicity | Women giving birth in April to June 2022 | One or more doses by time of delivery | 2 or more doses by time of delivery | Unvaccinated at delivery | Unvaccinated who went on to receive doses after pregnancy to 25 August 2022 |
|---|---|---|---|---|---|
| Asian | 15,229 | 11,627 (76.3%) | 10,315 (67.7%) | 3,602 (23.7%) | 242 (6.7%) |
| Black | 5,909 | 2,999 (50.8%) | 2,496 (42.2%) | 2,910 (49.2%) | 72 (2.5%) |
| Mixed | 2,824 | 1,656 (58.6%) | 1,478 (52.3%) | 1,168 (41.4%) | 17 (1.5%) |
| Other | 4,843 | 3,062 (63.2%) | 2,717 (56.1%) | 1,781 (36.8%) | 35 (2.0%) |
| White | 79,459 | 59,868 (75.3%) | 55,333 (69.6%) | 19,591 (24.7%) | 235 (1.2%) |
| Unknown | 4,657 | 2,801 (60.1%) | 2,563 (55.0%) | 1,416 (30.4%) | 24 (1.7%) |

**Table 10. Vaccine coverage by quintile of deprivation of the small area in which the woman lived, for women giving birth April to June 2022 (latest 3 months)[3]**

| Quintile of deprivation | Women giving birth in April to June 2022 | One or more doses by time of delivery | 2 or more doses by time of delivery | Unvaccinated at delivery | Unvaccinated who went on to receive doses after pregnancy to 25 August 2022 |
|---|---|---|---|---|---|
| 1 – most deprived | 28,379 | 17,289 (60.9%) | 14,710 (51.8%) | 11,090 (39.1%) | 196 (1.8%) |
| 2 | 24,727 | 17,049 (68.9%) | 15,421 (62.4%) | 7,678 (31.1%) | 174 (2.3%) |
| 3 | 21,912 | 16,674 (76.1%) | 15,461 (70.6%) | 5,238 (23.9%) | 122 (2.3%) |
| 4 | 19,214 | 15,602 (81.2%) | 14,671 (76.4%) | 3,612 (18.8%) | 84 (2.3%) |
| 5 – least deprived | 16,919 | 14,516 (85.8%) | 13,837 (81.8%) | 2,403 (14.2%) | 47 (2.0%) |
| Unknown | 1,770 | 883 (49.9%) | 802 (45.3%) | 447 (25.3%) | 2 (0.4%) |

[2] 440 women could not be matched with a NIMS record. Their vaccine status is therefore unknown and they are excluded from these figures.
[3] 440 women could not be matched with a NIMS record. Their vaccine status is therefore unknown and they are excluded from these figures.

**Table 11. Vaccine coverage by age of mother, for women giving birth April to June 2022 (latest 3 months)[4]**

| Age | Women giving birth in April to June 2022 | One or more doses by time of delivery | 2 or more doses by time of delivery | Unvaccinated at delivery | Unvaccinated who went on to receive doses after pregnancy to 25 August 2022 |
|---|---|---|---|---|---|
| Under 20 | 2,062 | 808 (39.2%) | 532 (25.8%) | 1,254 (60.8%) | 19 (1.5%) |
| 20 to 24 | 11,957 | 6,741 (56.4%) | 5,451 (45.6%) | 5,216 (43.6%) | 88 (1.7%) |
| 25 to 29 | 27,373 | 18,177 (66.4%) | 16,046 (58.6%) | 9,196 (33.6%) | 206 (2.2%) |
| 30 to 34 | 38,891 | 30,144 (77.5%) | 28,110 (72.3%) | 8,747 (22.5%) | 179 (2.0%) |
| 35 to 39 | 25,193 | 20,486 (81.3%) | 19,407 (77.0%) | 4,707 (18.7%) | 109 (2.3%) |
| 40 and above | 7,002 | 5,657 (80.8%) | 5,356 (76.5%) | 1,345 (19.2%) | 24 (1.8%) |

[4] 440 women could not be matched with a NIMS record. Their vaccine status is therefore unknown and they are excluded from these figures. An additional 3 women of unknown age were unvaccinated at delivery and are excluded from Table 9.

In the most recent 3-month period (April to June 2022), there were 112,921 women whose vaccination record was linked and who gave birth, of whom 82,013 (72.6%) were vaccinated with at least one COVID-19 vaccine dose before they gave birth. There were differences in vaccine coverage by both ethnicity (Table 9) and by quintile of deprivation (Table 10). Overall, 50.8% of black women, 76.3% of Asian women and 75.3% of white women had received at least one dose of COVID-19 vaccine before they delivered, with a modest coverage increase in each of these groups of women compared to the 3 month period between December 2021 and February 2022 (coverage of 48.7%, 74.6% and 74.4% respectively). Of women who were unvaccinated when they gave birth in the most recent 3-month period, 2.1% went on to be vaccinated post-partum. This included 2.5% of Black women, 6.7% of Asian women and 1.2% of white women. In line with increased coverage before delivery, the proportions of unvaccinated women of these ethnicities who were immunised post-partum was lower than that previously reported.

Whilst increases in coverage were observed in all groups, women of black ethnicity and women living in the most deprived areas in England (in whom at least one dose coverage increased slightly from 59.3% to 60.9% in the most recent 3-month period) 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 10). Vaccine coverage at birth increased with increasing age group with uptake exceeding 80% for one dose and 75% for 2 doses in women aged 35 years or older (Table 11).

## Methods

Data on COVID-19 vaccination status together with details of each vaccine administered is recorded in a central data set called the 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 one 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 diagnostic codes were

[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.

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 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 diagnostic 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 1 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 28 September 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 28 September 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 8 to 10 was taken from the NIMS record. The analysis within this section was carried out on 28 September 2022. The latest HES data available was for June 2022, and all HES data since April 2021 is 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 2021 and June 2022, 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 2021 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 is also presented for women giving birth between 17 April 2021 and 30 June 2022 for comparison.

**Figure 1. Women giving birth January 2021 to June 2022 to live-born babies at term without low birthweight**

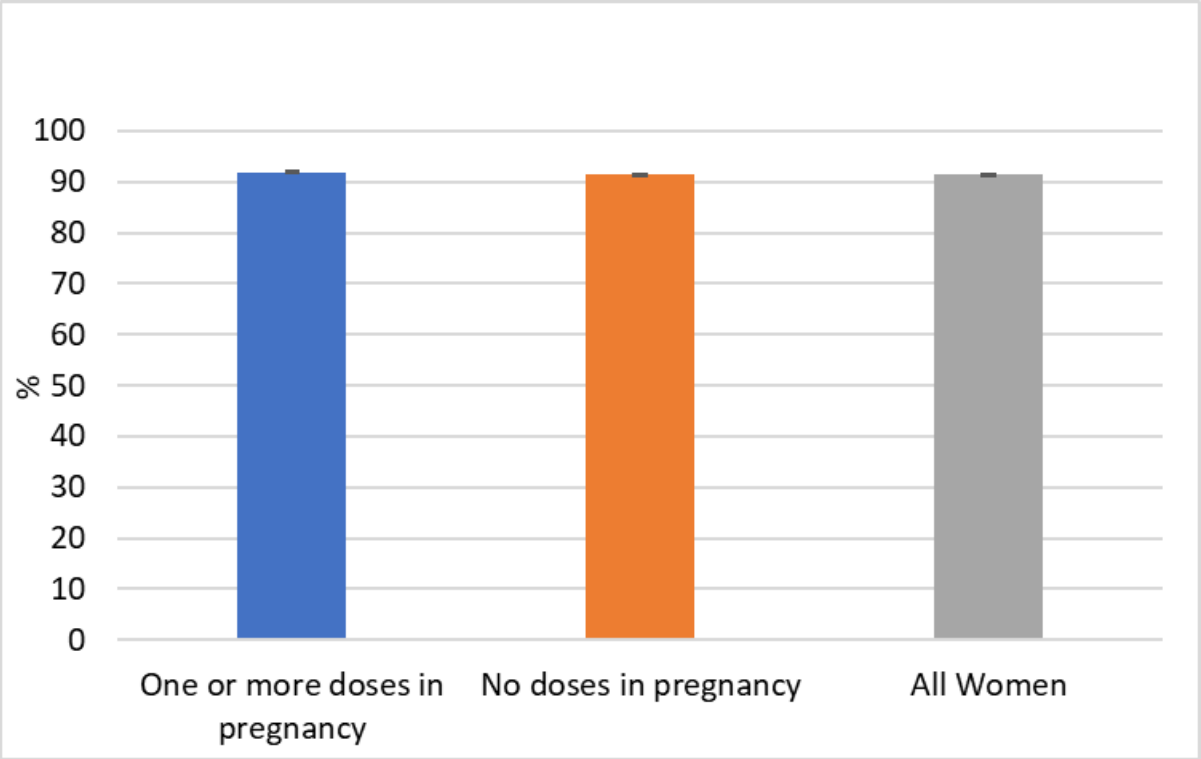



**Figure 2. Women giving birth January 2021 to June 2022 to live-born babies at term without low birthweight, by age**

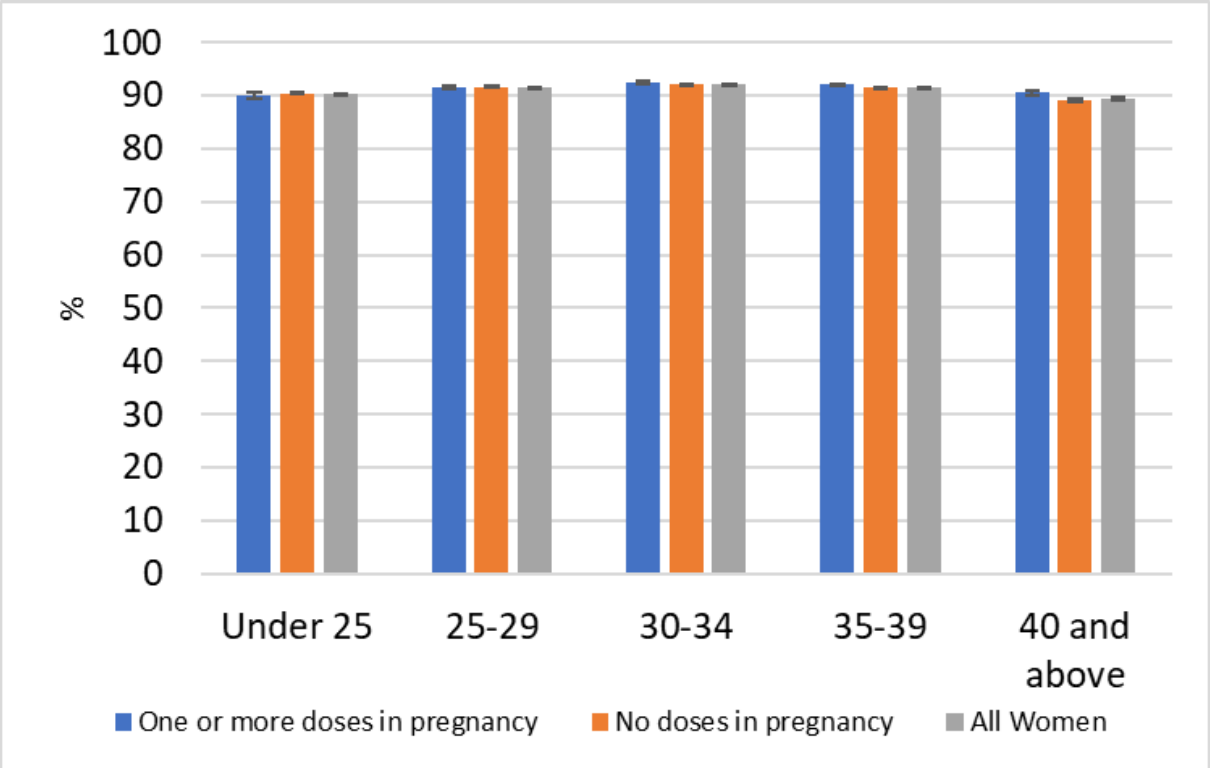


**Figure 3. Women giving birth April 2021 to June 2022 to live-born babies at term without low birthweight**

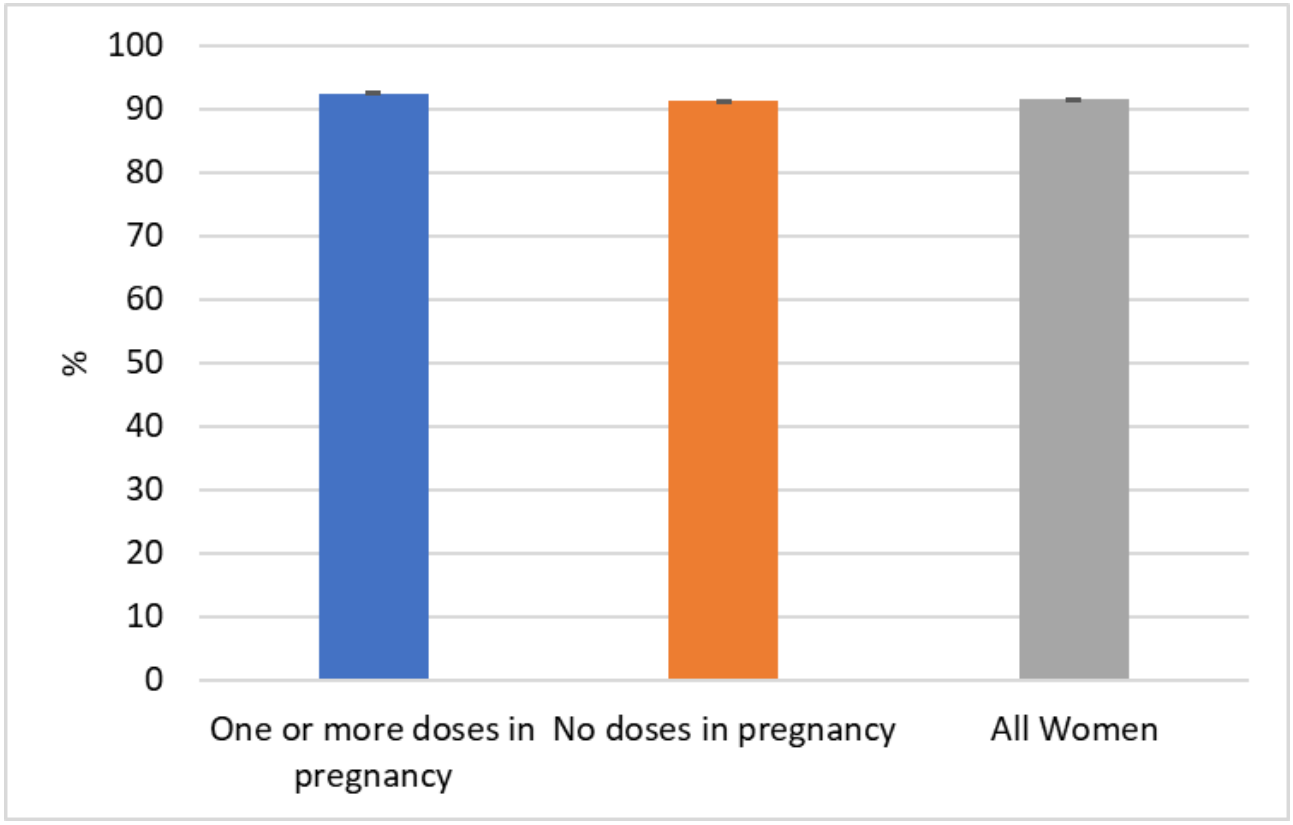



**Figure 4. Women giving birth April 2021 to June 2022 to live-born babies at term without low birthweight, by age group**

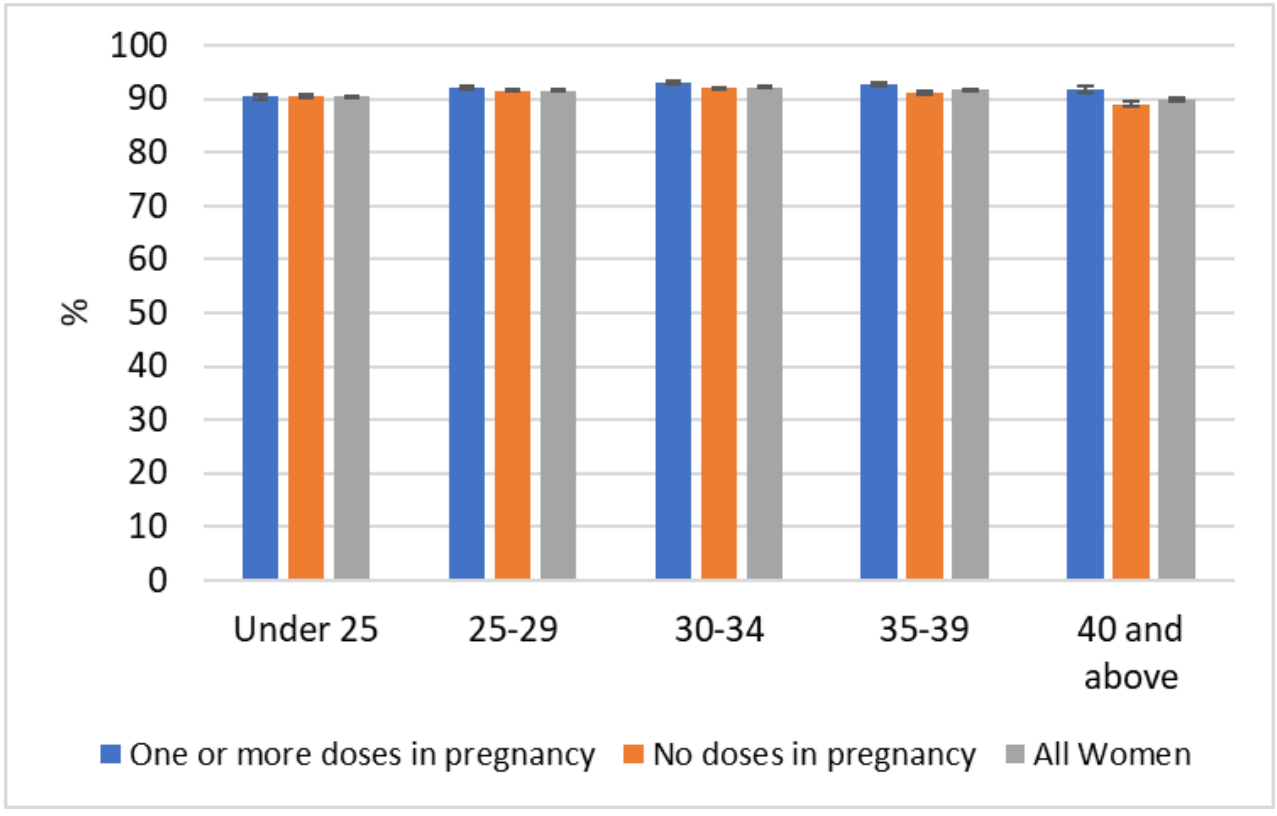


**Figure 5. Stillbirths experienced by women giving birth January 2021 to June 2022**

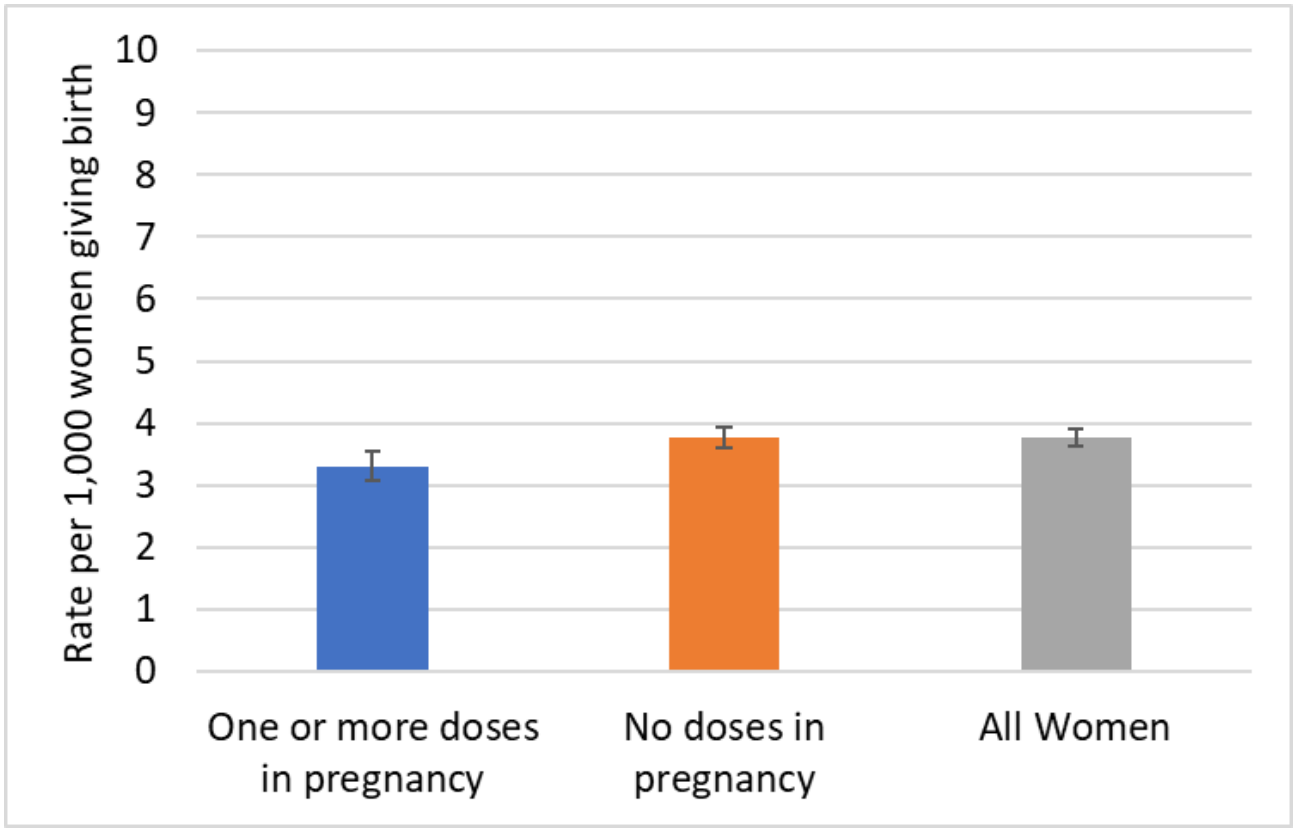



**Figure 6. Low birthweight experienced by women giving birth January 2021 to June 2022**

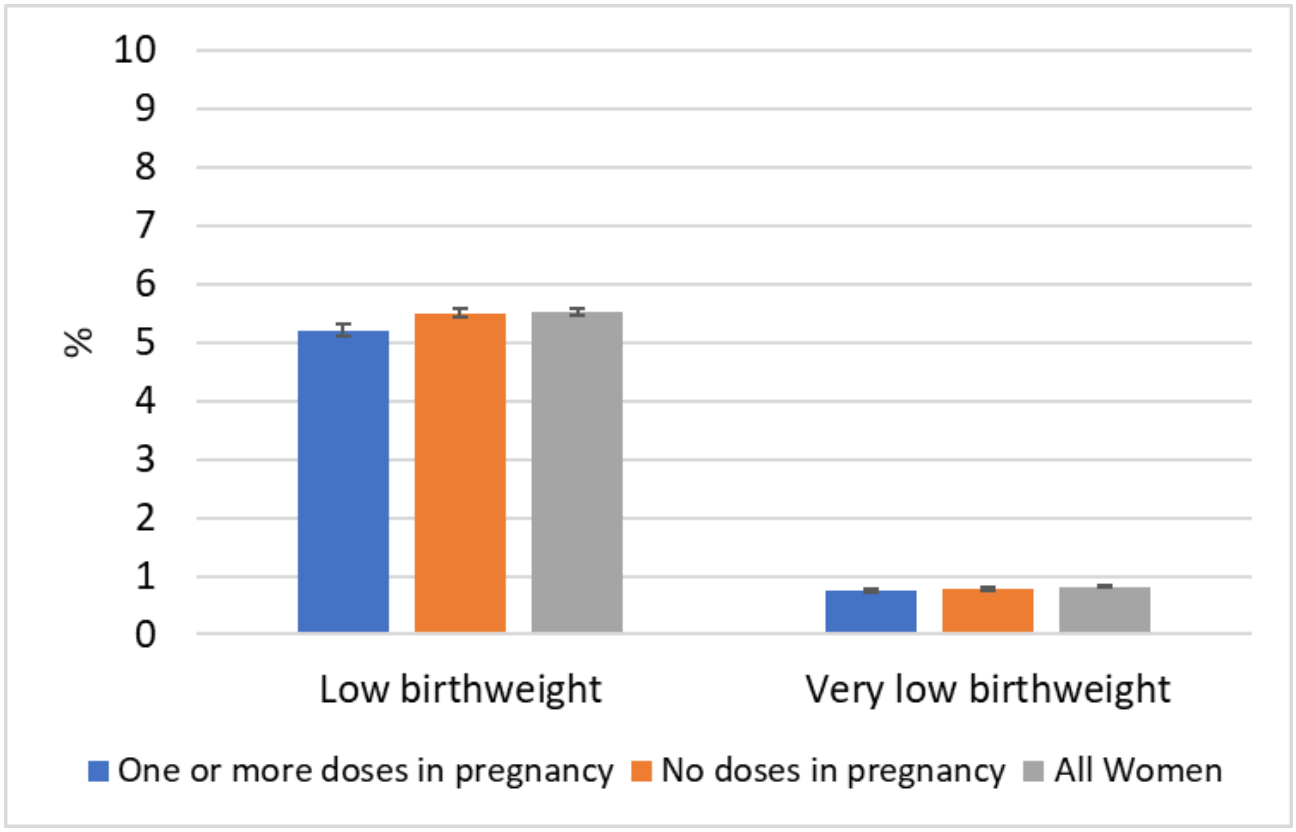
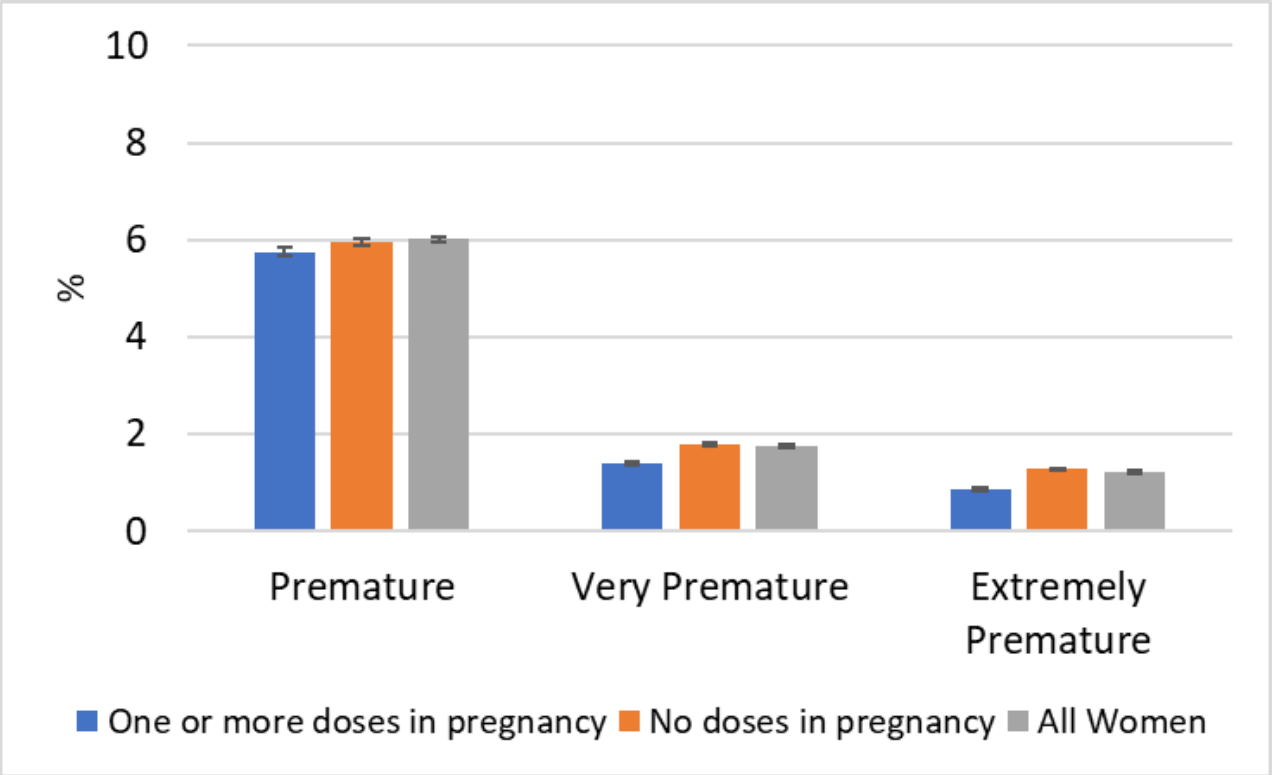


**Figure 7. Women giving birth prematurely January 2021 to June 2022**




The proportion of women giving birth between January 2021 and June 2022 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 91.8 to 92.0) is higher than the proportion in women who did not receive any doses in pregnancy (91.4% 95%CI 91.3 to 91.5) (Figure 1). These positive outcomes were similar across all age groups in vaccinated and unvaccinated women (Figure 2). 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 (92.5% 95%CI 92.4 to 92.6 compared with 91.3% 95%CI 91.2 to 91.4) (Figure 3). This difference was more apparent in those aged 30 years and older (Figure 4).

The stillbirth rate for women who gave birth having received one or more doses in pregnancy (3.30 per 1,000, 95%CI 3.07 to 3.56) was lower than the rate for those who had not received any doses in pregnancy (3.76 per 1,000, 95%CI 3.60 to 3.94) giving birth between January 2021 and June 2022 (Figure 5). In the same period, the proportion of women who had received one or more doses in pregnancy giving birth to babies with low birthweight (5.21%, 95%CI 5.11 to 5.30) was lower than those who had not received any doses in pregnancy (5.50%, 95%CI 5.44 to 5.57) (Figure 6). There was no statistically significant difference between the 0.76% (95%CI 0.72 to 0.79) of women who had received one or more doses in pregnancy and 0.78% (95%CI 0.75 to 0.80) of those who had not, who gave birth to a very low birthweight baby (Figure 6).

The proportion of women who received one or more doses in pregnancy having premature births was 5.76% (95%CI 5.66 to 5.86), compared with 5.95% (95%CI 5.88 to 6.02) in those who had not (Figure 7). The proportion of women with very premature births was 1.40% (95%CI 1.35 to 1.45) in those who received one or more dose in pregnancy, lower than the 1.79% (95%CI 1.75 to 1.83) with a very premature birth who had not been vaccinated during pregnancy. The proportion of women with extremely premature births was 0.86% (95%CI 0.82 to 0.90) in those who received one or more dose in pregnancy: lower than the 1.27% (95%CI 1.24 to 1.31) 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 2021 to June 2022 and that their rate of stillbirth was lower than that observed in women who were not vaccinated during pregnancy.

These findings continue to support the conclusions on vaccine safety from earlier COVID-19 vaccine surveillance reports from week 47 2021 onwards COVID-19 vaccine weekly surveillance reports (weeks 39 to 40, 2021 to 2022) and from analyses published by Public Health Scotland Outputs and information for the public – the University of Edinburgh.

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

## 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 28 September 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 one or more of the first 12 diagnoses was the following: Z37.1: Single stillbirth; Z37.3 Twins, one liveborn and one 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 2,499g (1,499g 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 is 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 (41). 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 pregnancies against severe COVID-19 disease. The JCVI has advised that women who are pregnant are considered to be in a clinical risk group within the COVID-19 vaccine programme. Unvaccinated women who become pregnant are strongly encouraged to come forward for vaccination. Women who are pregnant and have previously been vaccinated should be offered a booster dose this autumn (Joint Committee on Vaccination and Immunisation (JCVI) updated statement on the COVID-19 vaccination programme for autumn 2022).

COVID-19 vaccine coverage in pregnant women at delivery has increased as more women have become eligible for vaccination, stabilising from May 2022. 73.0% of women who gave birth in June 2022 had received one or more dose before their baby was born. In Scotland, 74% of the women delivering in March 2022 had received at least one dose of COVID-19 vaccine prior to delivery, with 65% having received at least 2 doses and 41% having received 3 doses (42). In Wales estimated coverage at time of delivery for 2,018 women with delivery dates

during July 2022 was 81% for at least one dose, 77% for at least 2 doses and 45% for at least one booster dose (data provided by Public Health Wales).

As in the previous report, however, coverage increased with decreasing levels of deprivation (with increasing affluence) and women of black ethnicity had the lowest vaccine coverage. Coverage also increased with increasing age group.

Whilst uptake improved between February and May 2022 as presented in the week 35 2022 report, across all groups, it appears to have now largely stabilised. Reported coverage continues to highlight inequalities consistent with those seen across the entire COVID-19 vaccination programme. Coverage of at least one dose increased from 5.5% in women of black ethnicity who delivered between June and August 2021 to 30.5% between November 2021 and January 2022 and to 50.8% between April and June 2022. The difference in coverage between black and white women was 24.5 percentage points in the most recent 3-month period (and 25.5 percentage points between black and Asian women), similar to the 25.7 percentage point difference reported between March and May 2022. In women living in the most deprived areas in England coverage increased from 25.5% to 38.9% to 60.9% in the same periods. A difference of 24.9 percentage points persists in those living between the most deprived and most affluent areas. Few women who were unvaccinated at delivery are still being vaccinated post-partum.

It is 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 as women who were not vaccinated in pregnancy, though the difference was very small. In addition, 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, without taking other factors into account.

The next update on COVID-19 vaccination in pregnancy will focus on the Autumn boost. This will be published in early 2023 to allow some time for women eligible for the vaccine in pregnancy to begin to deliver.

# Vaccination status in cases, deaths and hospitalisations

Data on the vaccination status of COVID-19 cases, and deaths and hospitalisations with COVID-19, was previously 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.

From 1 April 2022, the UK Government ended provision of 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 the week 14 report onwards this section of the report will no longer be published. For further context and previous data, please see previous vaccine surveillance reports and our blog post.

Vaccine effectiveness is measured in other ways as detailed in the vaccine effectiveness section of this report.

# 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 3 2023 are summarised. As of week 44 2020, approximately 250 samples from each geographic NHS region are tested each week.

The COVID-19 vaccination campaign began on 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. A second booster (spring booster) was introduced from 21 March 2022 for individuals aged 75 years and older, older residents in care homes and individuals with severe immunosuppression. The spring booster was offered 3 to 6 months after the last dose. An autumn booster was introduced from 7 September 2022 for individuals aged 50 years and over, those in care homes, individuals aged 5 years and over in clinical risk groups, frontline health and social care staff, those who care for vulnerable individuals and families of individuals with weakened immune systems, with those at highest risk being vaccinated first. The autumn booster is offered at least 3 months after the last dose.

Please note that this section will be updated monthly. This update was published on 2 February 2023.

## 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).

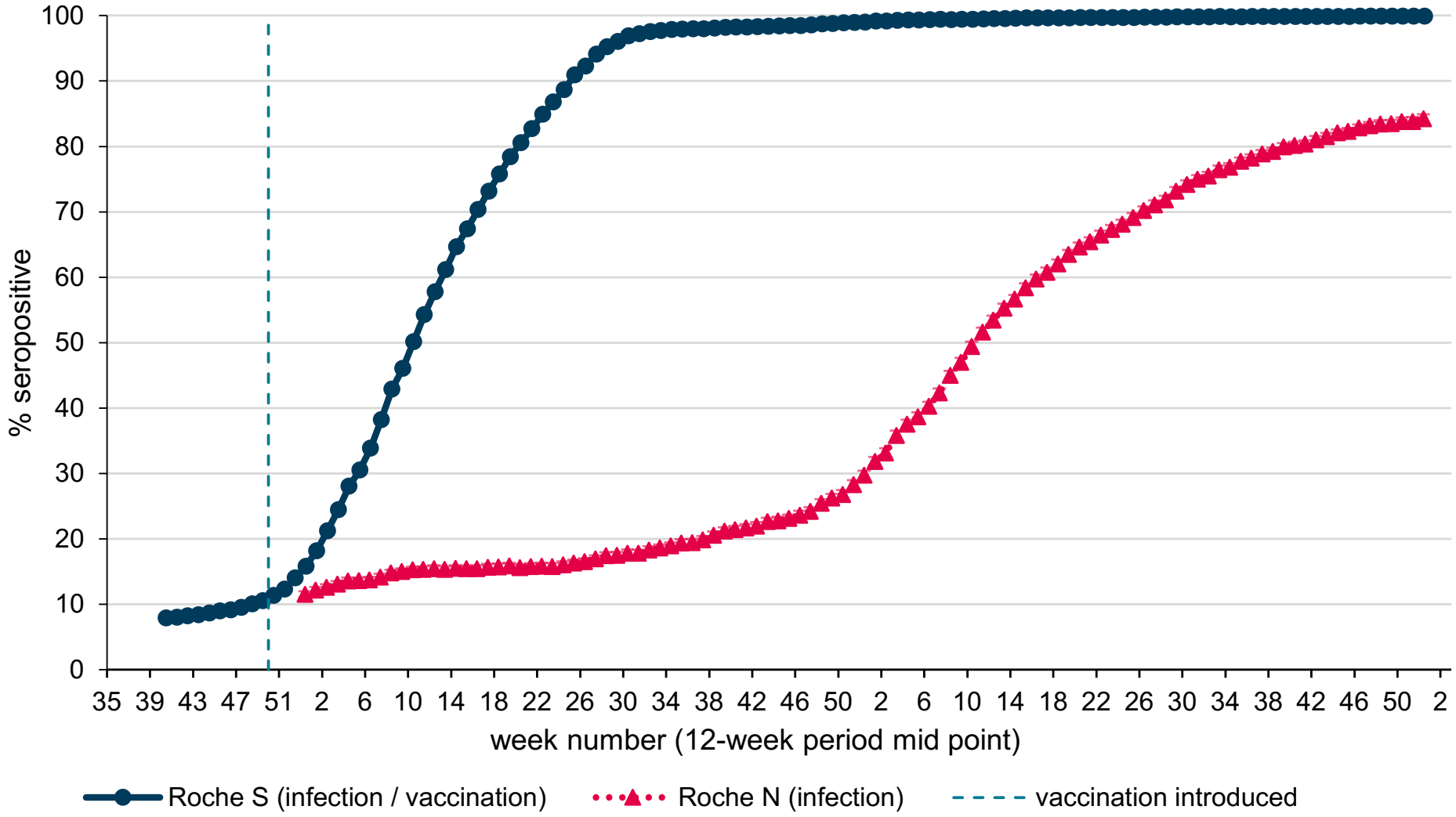
This report presents Roche N and Roche S seropositivity estimates on the same set of samples, using a 12-week rolling prevalence for national, age group and regional estimates. Seropositivity estimates are plotted using the mid-point of a 12-weekly rolling period that reduces to 8 weeks in the most recent 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 84.2 % (95% CI 83.5% to 84.9%) using the Roche N assay and 99.9% (95% CI 99.8% to 99.9%) using the Roche S assay for the period 21 November 2022 to 20 January 2023 (week 47 2022 to week 3 2023). 11,517 out of 13,651 were Roche N positive and 13,412 out of 13,427 samples were Roche S positive. This compares with 80.1% (95% CI 79.5% to 80.7%) Roche N seropositivity and 99.9% (95% CI 99.8% to 99.9%) Roche S seropositivity for the period of 30 August to 18 November 2022 (weeks 35 to 46 2022).

Seropositivity (weighted by region, age group and sex) varies over time. Figure 8 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 8. 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 9).

**Figure 9. 12-weekly rolling SARS-CoV-2 antibody seroprevalence (% seropositive) in blood donors by region, using Roche N test; error bars show 95% confidence intervals**

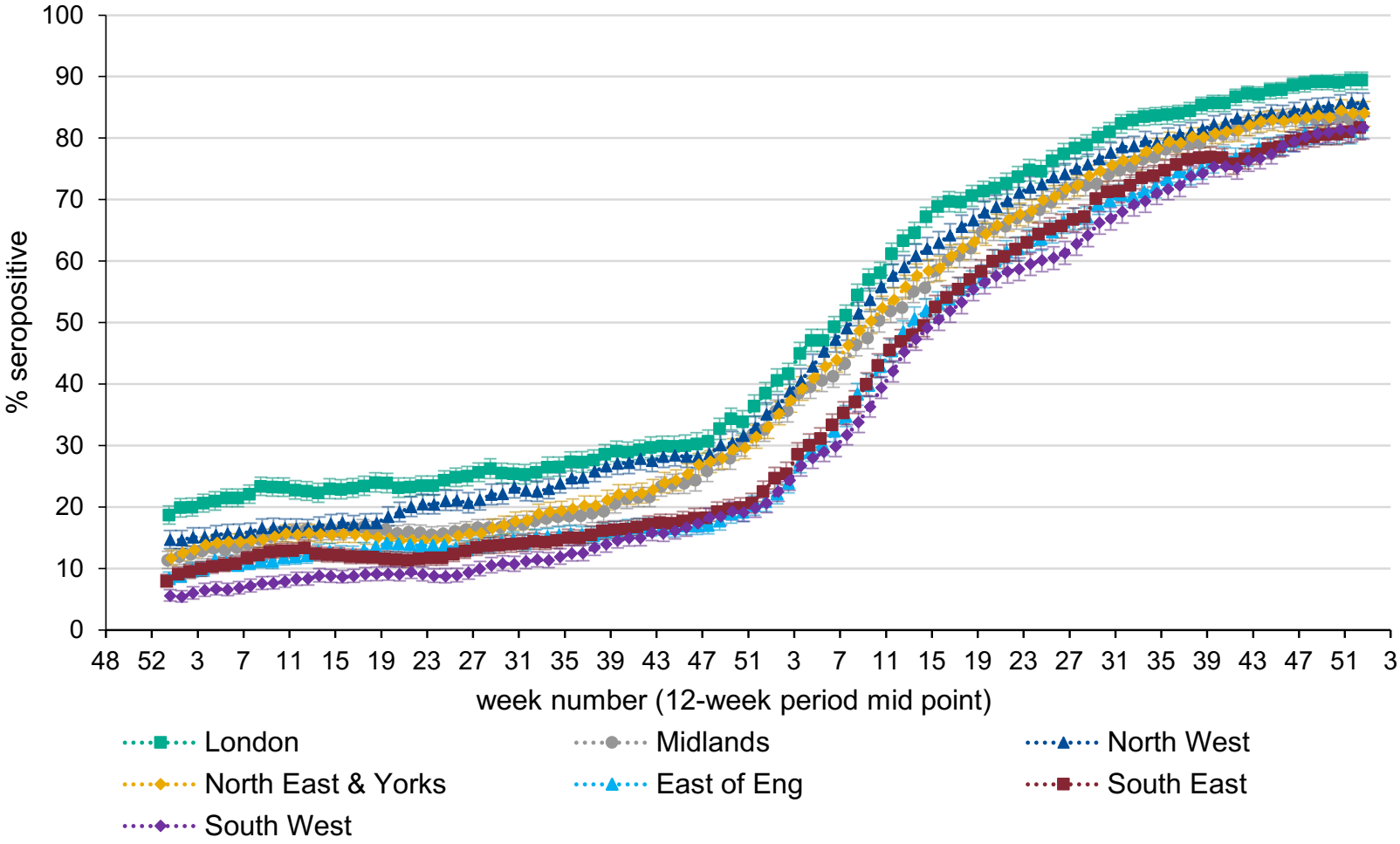


**Table 12. Roche N seropositivity (95% CI) estimates by NHS region**

| NHS region | Weeks 35 to 46 2022 | Weeks 47 2022 to 3 2023 |
|---|---|---|
| East of England | 77.0% (75.3% to 78.6%) | 82.1% (80.0% to 84.0%) |
| London | 85.7% (84.3% to 87.0%) | 89.4% (87.9% to 90.7%) |
| Midlands | 80.5% (78.9% to 82.0%) | 83.9% (81.9% to 85.6%) |
| North East and Yorkshire | 81.0% (79.4% to 82.6%) | 84.0% (81.9% to 86.0%) |
| North West | 82.5% (80.9% to 83.9%) | 85.6% (83.7% to 87.3%) |
| South East | 76.8% (75.2% to 78.3%) | 81.7% (79.8% to 83.5%) |
| South West | 75.4% (73.8% to 77.0%) | 81.8% (79.8% to 83.5%) |

Increases in Roche N seropositivity have recently been observed across all regions (Table 12) compared to the previous 12-week period with the largest increases in the South West and East of England regions

Seropositivity has consistently been lowest in the South West with the difference between other regions narrowing over time, whilst the highest seropositivity has consistently been observed in London, closely followed by the North West.

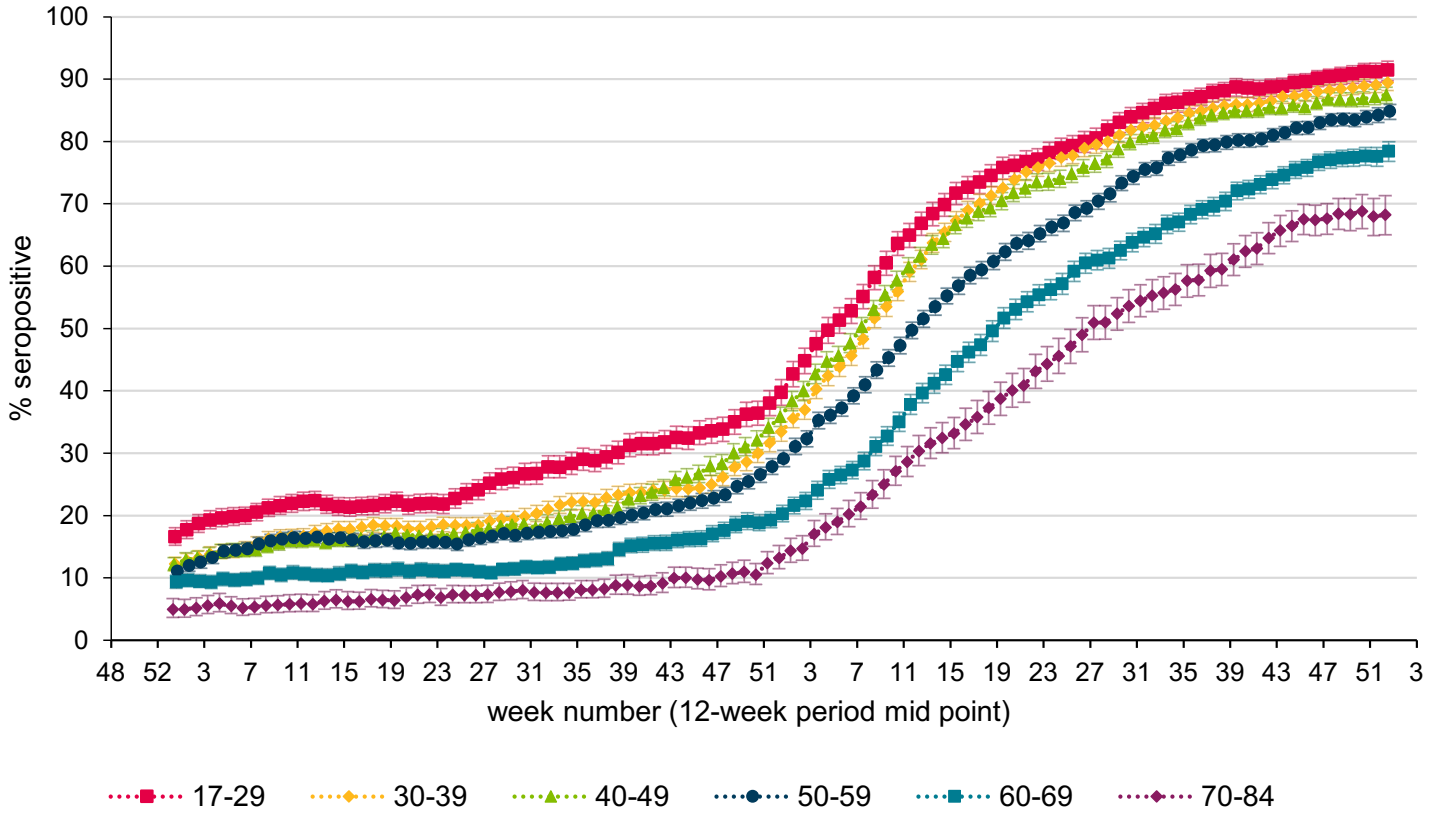
Overall COVID-19 case rates through Pillar 1 continued to decrease across all regions. Overall Pillar 1 positivity decreased compared to the previous week. (Weekly national Influenza and COVID-19 surveillance report week 4 2023).

Pillar 1 testing is undertaken by NHS hospitals and UKHSA labs for those with a clinical need and some health and social care workers. Testing recommendations have been updated and routine asymptomatic testing through NHS settings has been paused since the end of August 2022, which will have an impact on Pillar 1 case rates and positivity rates. Changes in testing practices is likely to influence a range of surveillance indicators highlighting the importance of maintaining the serosurveillance programme to provide consistent data on exposure to infection and vaccine impact in the population over time.

# Prevalence by age group

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

**Figure 10. 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 3) 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 13. Roche N seropositivity (95% CI) estimates by age group**

| Age group | Weeks 35 to 46 2022 | Weeks 47 2022 to 3 2023 |
|---|---|---|
| 17 to 29 | 88.6% (87.1% to 89.9%) | 91.4% (89.7% to 92.9%) |
| 30 to 39 | 85.9% (84.8% to 87.0%) | 89.5% (88.2% to 90.6%) |
| 40 to 49 | 84.9% (83.8% to 86.0%) | 87.5% (86.1% to 88.7%) |
| 50 to 59 | 80.2% (79.1% to 81.2%) | 84.8% (83.6% to 86.0%) |
| 60 to 69 | 72.4% (70.9% to 73.8%) | 78.4% (76.8% to 79.9%) |
| 70 to 84 | 62.4% (59.8% to 64.9%) | 68.2% (65.0% to 71.3%) |

Increases in N seropositivity have recently been observed across all age groups (Table 13) compared to the previous 12-week period. In the most recent period, the largest increase in seropositivity was observed in individuals aged 60 to 69 years and 70 to 84 years.

In England, Pillar 1 COVID-19 case rates for week 3 2023, continued to decrease across all age groups with the highest rates currently seen in individuals aged 70 years and older (Weekly national Influenza and COVID-19 surveillance report week 4 2023).

Roche S seropositivity in blood donors has plateaued and is now over 99% 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 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. The impact of the booster vaccination programmes 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 UKHSA surveillance since Autumn 2021 has found that over 99% 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 programmes.

Figure 11 shows monthly categorised Roche S levels in N-antibody negative individuals by age group over the past year. After high antibody levels following the rollout of the accelerated booster programme due to the emergence of the Omicron variant in late 2021, the decreasing profile of antibody levels among 17 to 69 year olds from February through to August shows signs of waning. From April 2022 the proportion of donors, aged 70 to 84 years, with very high antibody levels of 25,000+ au/ml increased following the introduction of the spring booster for ages 75 and older. Antibody levels in this older age group have remained consistent from May to September 2022. A further increase in highest antibody levels can be seen in October following the Autumn booster in those aged 40 to 84, with the highest increase seen in those aged 70 to 84. In November 2022 the proportion of donors aged 70 to 84 with very high antibody levels of 25,000+ au/ml remained high and the proportion of donors aged 50 to 69 years with very high antibody levels increased. In January 2023 the proportion of donors, aged 60 to 84 years, with very high antibody levels of 25,000+ au/ml decreased.

By the end of week 3 2023, 64.6% of all individuals aged 50 years and older had been vaccinated with an autumn booster dose (Weekly national Influenza and COVID-19 surveillance report week 4 2023).

Figure 12 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. The proportion of donors with very high antibody levels of 25,000+ au/ml remained stable during February and March 2022. Since April 2022 the proportion of donors with very high antibody levels of 25,000+ au/ml decreased across all age groups except for those aged 70 to 84 where increases were observed in April and May 2022; however decreases were observed between June and September 2022. Increases of the highest antibody levels are being seen across those aged 60 to 84 in October following rollout of the Autumn booster. In those aged 17 to 59 very little change has been observed between June and October 2022. In November 2022 increases in the proportion of donors with very high antibody levels of 25,000+ au/ml continued to be observed in donors aged 60 to 84 years and also in those aged 50 to 59 years. In January 2023 small decreases were seen in the proportion of donors, aged between 40 to 84 years, with very high antibody levels of 25,000+ au/ml.

Comparing Figure 11 with Figure 12, 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.

Whilst it is thought that there is no threshold antibody level that offers complete protection against infection, higher antibody levels are likely to be associated with lower probability of infection.

**Figure 11. Categorised Roche S antibody levels by age group and month in N negative samples, February 2022 to January 2023**

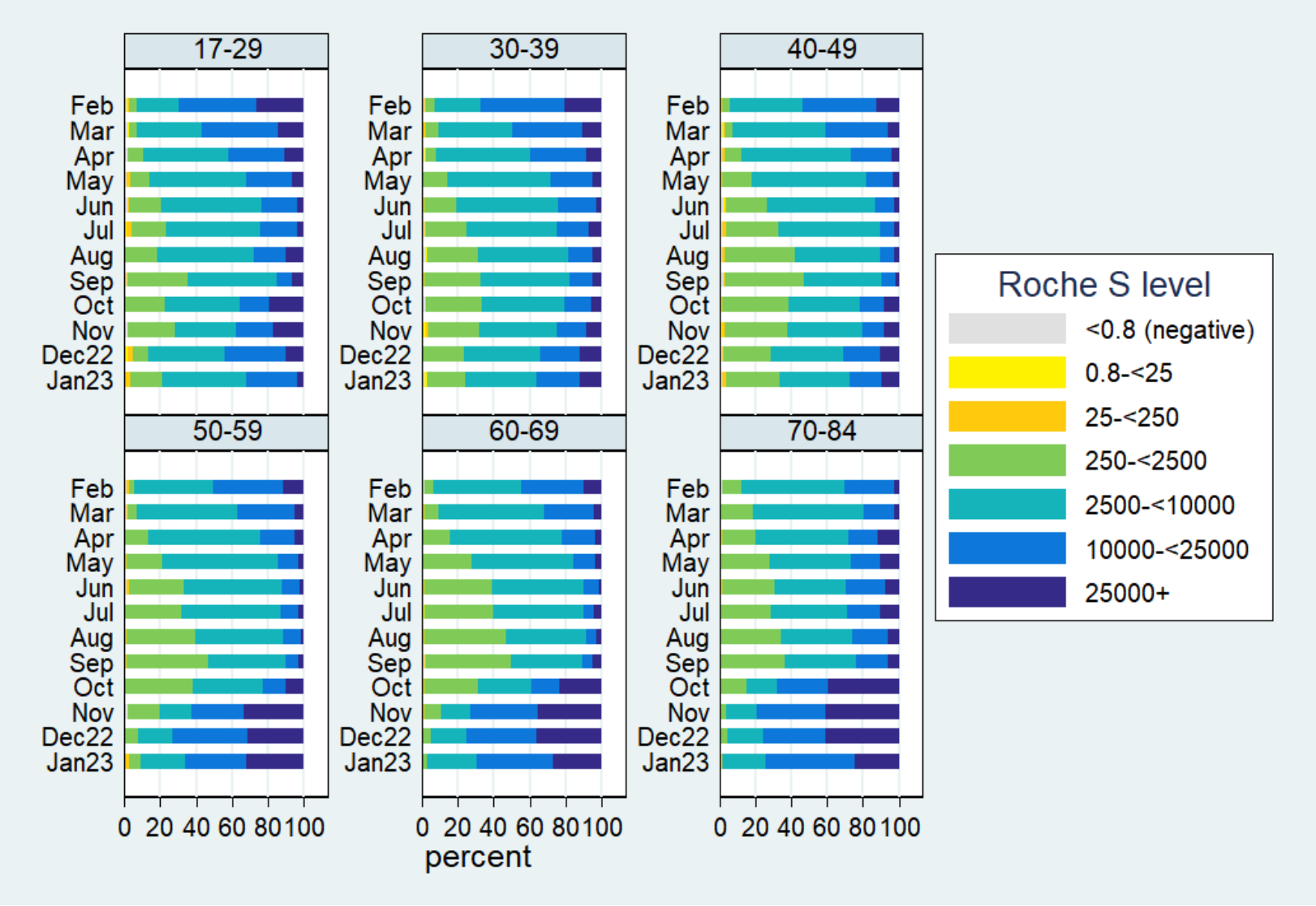
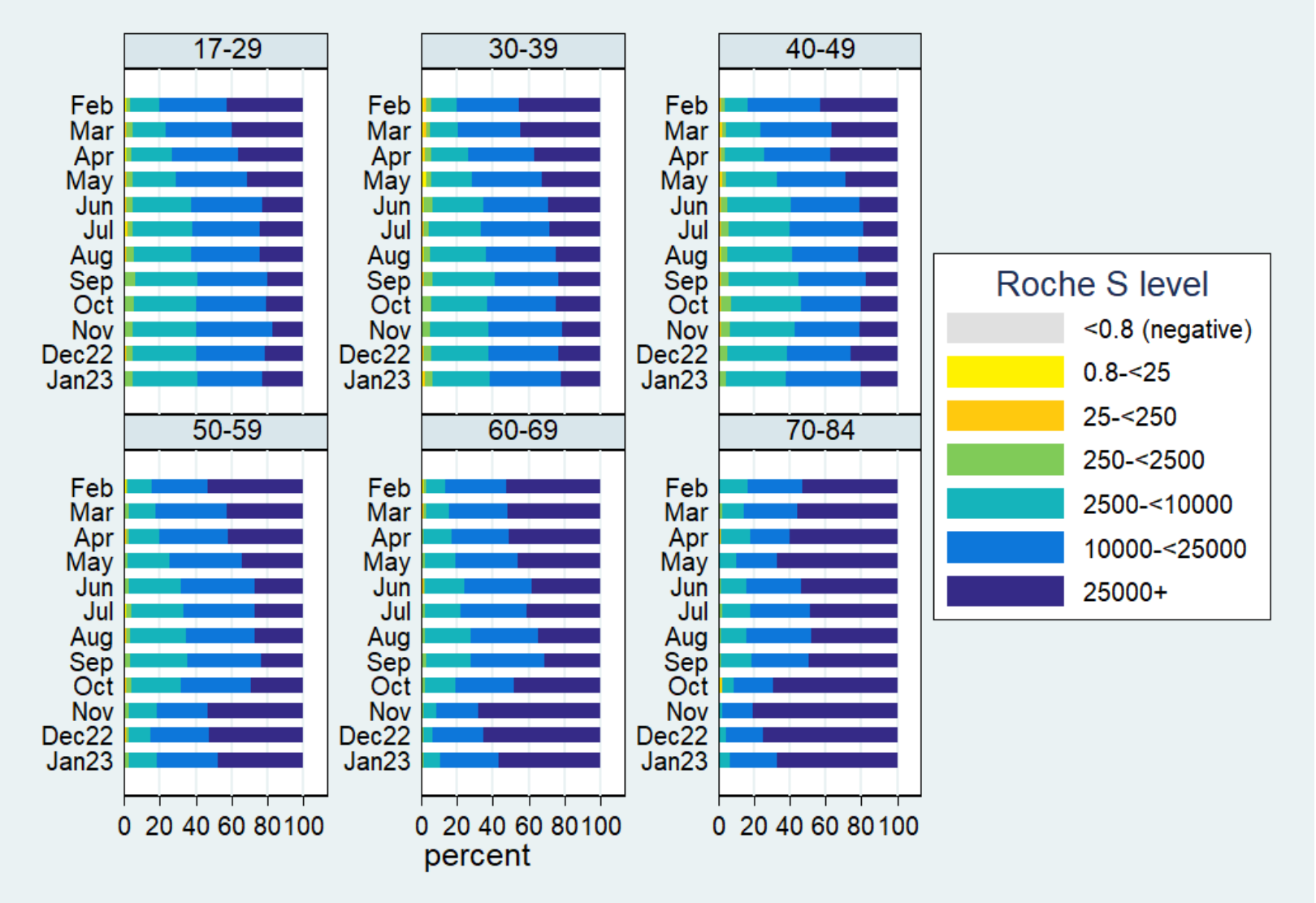


**Figure 12. Categorised Roche S antibody levels by age group and month in N positive samples, February 2022 to January 2023**



# SARI-Watch surveillance data

SARI-Watch is a national surveillance system in England that captures aggregate and individual data on laboratory confirmed COVID-19 hospitalisations (to all level of care) and ICU or HDU admissions. The individual level data is based on hospitalisations for laboratory confirmed COVID-19 submitted by a sentinel network of acute NHS trusts.

The analyses presented are based on individual level data from the sentinel collection in England. The analysis uses data from 1 September 2022 to 29 January 2023 inclusive submitted by 10 acute NHS trusts. 1 September was the official roll out of the Autumn 2022 booster campaign. The data was up to 29 January 2023 as this was last date of ISO week 4 2023. To obtain vaccine history for admitted persons, the SARI-Watch data was linked to the NIMS on 31 January 2023 using key personal identifiers. NIMS captures data on vaccination history of people in England. Data on vaccination history was used to group admissions into 4 categories. Please note that vaccination status on admission does not represent vaccine effectiveness against hospitalisation. Vaccination is highly protective against hospitalisation as VE studies show (see vaccine effectiveness section in this report) but does not completely eliminate the risk of being hospitalised. Hence those that get hospitalised even if vaccinated tend to be the vulnerable elderly population or those with significant underlying health issues. Other caveats are that London trusts are currently under-represented in sentinel data and the most recent data is typically subject to retrospective updates after submission.

## Vaccination status by time of admission by age group

Vaccination status on hospital admission was grouped into 4 categories:

- ‘Unvaccinated’ - no evidence of previous vaccination at the time of admission
- ‘D1’ comprising only 1 dose of the primary course by the time of admission
- ’D2’ comprising only 2 doses of the primary course by the time of admission
- ‘D3 comprising 3 doses or more by the time of admission. This includes 3 doses of primary course only or 2 doses of the primary course plus any or all of the boosters (either Autumn 2021, Spring 2022 or Autumn 2022 booster)

The unlinked group represents hospitalised cases that could not be matched to NIMS data either due to incorrect or missing personal identifiers. This accounted for <1% of data in the 1 September 2022 to 29 January 2023 period.

Table 12 shows vaccination status by the time of admission and age group among admitted cases from 1 September 2022 to 29 January 2023 inclusive (n = 4,951 admissions).

Those aged 75 years or more had the lowest proportion that were unvaccinated by the time of admission at 3.5% in this period. The highest proportion that were unvaccinated by time of admission was in <40y at 55.0% (Table 14).

Those in the category '≥3 doses' by time of admission accounted for 91.9% of admitted cases aged 75 years or more (Table 14). This compares with 24.1% in those aged <40 years.

**Table 14. Vaccination status at time of admission by age group for admissions from 1 September 2022 to 29 January 2023, sentinel data, England**

| Age group | | Unvaccinated | 1 dose (primary) | 2 doses (primary) | ≥3 doses | Unlinked | Total |
|---|---|---|---|---|---|---|---|
| Under 40 | Number | 251 | 19 | 70 | 110 | 6 | 456 |
| | % | 55 | 4.2 | 15.4 | 24.1 | 1.3 | |
| 40 to 49 | Number | 27 | 8 | 30 | 94 | 1 | 160 |
| | % | 16.9 | 5 | 18.8 | 58.8 | 0.6 | |
| 50 to 64 | Number | 58 | 19 | 51 | 420 | 2 | 550 |
| | % | 10.6 | 3.5 | 9.3 | 76.4 | 0.4 | |
| 65 to 74 | Number | 59 | 15 | 48 | 676 | 6 | 804 |
| | % | 7.3 | 1.9 | 6 | 84.1 | 0.7 | |
| Over 75 | Number | 104 | 22 | 104 | 2741 | 10 | 2981 |
| | % | 3.5 | 0.7 | 3.5 | 91.9 | 0.3 | |

# Rate of hospitalisation for COVID-19 in vaccinated people by time since vaccination (any dose) and age group

Using linked sentinel data, admissions from 2 to 29 January 2023 inclusive were analysed as this represented the first 4 weeks in 2023 (ISO weeks 1 to 4). This period will match the ISO week system used in the mandatory aggregate collection (ISO weeks 1 to 4 2023, used in second step of the calculation - see next paragraph). In this time period 10 sentinel acute NHS trusts contributed data. Time since last vaccination at the time of admission was calculated based on time in days between the last vaccination and hospital admission date. The last vaccination is irrespective of any dose whether from the primary or the booster schedule. The interval for each admitted case was grouped into <6 months, 6 to under 9 months, 9 to under 12 months and 12 months and over since last vaccination. Each month comprises 30 days. The proportion falling in each interval was calculated per age group.

The proportion by time since last vaccination and age group obtained from sentinel data was then applied to the corresponding age group for cases from the aggregate collection. Cases

from the aggregate collection was used as this is a mandatory surveillance system based on wider national reporting. The mandatory surveillance is based on weekly data (based on ISO week system from Monday to Sunday). The first 4 weeks of 2023 were used from the aggregate data (ISO weeks 1 to 4). Due to mean 71% trust coverage in the period of study (2 to 29 January 2023 inclusive) in the aggregate collection, a corrective factor was applied to the second step of the calculation (the second step is where the proportions by age group and time since vaccination from sentinel data are applied to the cases from the aggregate collection in same age group. The corrective factor would approximate the true total cases if there was 100% coverage.

To estimate rates of hospitalisation among vaccinated people by time since last vaccination and age group, the NIMS denominator is needed. Using NIMS data, the time since last vaccination in days was calculated from vaccination date (any dose) capped to 29 January 2023. The time in days was grouped in the same intervals described. The same age/time since vaccination groups are used for SARI-Watch and NIMS, with the former being the numerator and latter being the denominator. The rate of hospitalisation is calculated for each age/time since last vaccination group, expressed as hospitalised cases in the study period (2 to 29 January 2023) per 100,000 vaccinated people in England.

Figure 13 shows that the highest hospitalisation rates were in those aged 75 years and over for every time since last vaccination interval compared to corresponding intervals in other age groups. Also, for people aged 50 years or more, the lowest rate of hospitalisation was in those who were vaccinated in the 6 months prior to hospitalisation.

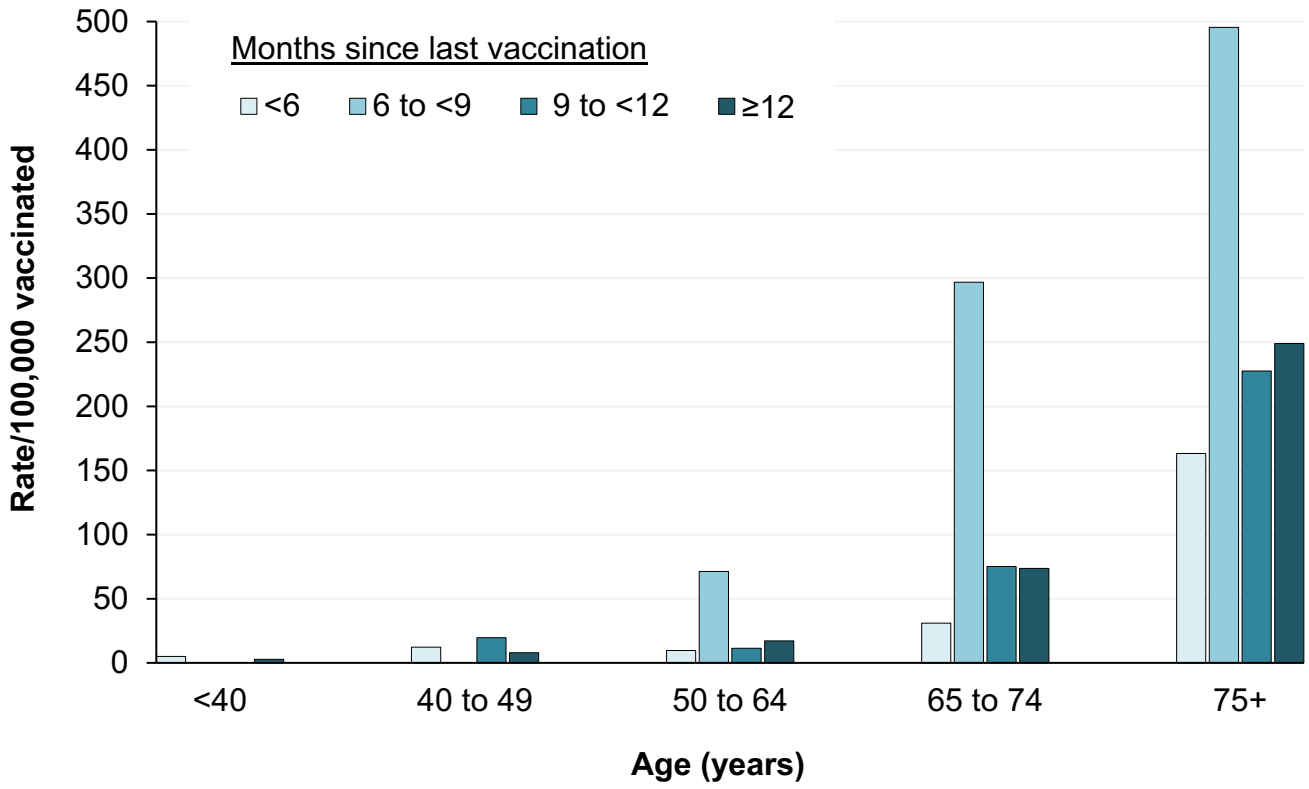
For example, among people aged 75 years or more, the lowest hospitalisation rate was in the shortest interval of <6 months (163.3 out of 100,000). This interval coincided with 2 Omicron waves (in October and December 2022) although hospitalisations were also deceasing since late December 2022 based on data from the mandatory surveillance system. Recency of vaccination pulled the rate downwards; the NIMS data shows that nationally 83.1% (4,491,008 out of 5,403,291) of people aged 75 years or more had their last vaccination within 6 months of 29 January 2023. The hospitalisation rate in this age group peaked at 495.5 out of 100,000 for those whose last vaccination was between 6 months to less than 9 months prior to hospital admission. The increase for intervals 6 months or more is partly due to these periods coinciding with Omicron cycles. There have been 5 Omicron cycles in 2022 alone, with the impact on hospitalisations usually highest in those aged 75 years or more. Although the rate dropped in subsequent intervals (last vaccination 9 months or more prior to admission) these were higher than the rate for the shortest interval.

The rates in younger age groups were much lower and declined with age reflecting progressively lower risk of hospitalisation. For those aged 50 to 64 years 65 to 74 years, the rates by time since last vaccination had a broadly similar pattern to the one for 75 years and over. The rate in the 65 to 74 year age group was lowest in the shortest interval of <6 months (30.9 out of 100,000). This is reflected in population level vaccination coverage where 75.7% (4,369,295 out of 5,770,398) of people in this age group had their last vaccination (any dose)

within 6 months of 29 January 2023. The rate peaked in the interval 6 to <9 months to 296.8 out of 100,000 (coinciding with Omicron wave in July 2022 due to BA.4 and BA.5 sublineages) before dropping in subsequent intervals. For both age groups, the rates for longer intervals exceeded the rate for the shortest interval.

The rates in <40 years and 40 to 49 years requires careful interpretation as the time since last vaccination percentages derived from linked data were based on small volumes for the period under study. For people aged <40 years for example, the rate was highest in the <6 months interval (5.0 out of 100,000). It is possible that the clinical risk factors that make younger adults eligible for the Autumn 2022 booster vaccination may also make them more pre-disposed to hospital admissions than the general age-matched population. For example, patients with immunosuppression in whom the vaccine may be less effective. The combined effect of these factors may have elevated the risk in the shortest interval.

**Figure 13. Estimated rate of hospitalisation for COVID-19 per 100,000 vaccinated people by time since last vaccination (any dose) and age group, admissions from 2 to 29 January 2023 inclusive (ISO weeks 1 to 4 2023), England**



# References


1. PHE. COVID-19: vaccine surveillance strategy 2021
2. Medicines and Healthcare Products Regulatory Agency. 'Coronavirus vaccine – weekly summary of Yellow Card reporting 2021'
3. Kirsebom F, Andrews N, Sachdeva R, Stowe J, Ramsay M, Lopez Bernal J. 'Effectiveness of ChAdOx1-S COVID-19 booster vaccination against the Omicron and Delta variants in England'
4. Lopez Bernal J, Andrews N, Gower C, Robertson C, Stowe J, Tessier E and others. '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' British Medical Journal 2021: volume 373, page 1,088
5. Vasileiou E, Simpson CR, Robertson C, Shi T, Kerr S, Agrawal U and others. 'Effectiveness of first dose of COVID-19 vaccines against hospital admissions in Scotland: national prospective cohort study of 5.4 million people' 2021
6. Hyams C, Marlow R, Maseko Z, King J, Ward L, Fox K and others. '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' Lancet Infectious Diseases 2021
7. Ismail SA, Vilaplana TG, Elgohari S, Stowe J, Tessier E, Andrews N and others. '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' Public Health England Preprints 2021
8. Stowe J, Andrews N, Kirsebom F and others. Effectiveness of COVID-19 vaccines against Omicron and Delta hospitalisation, a test negative case-control study Nature Communications 2022: volume 13, article 5,736. 10.1038/s41467-022-33378-7
9. Nyberg T, Ferguson NM, Nash SG, Webster HH, Flaxman S, Andrews N, Hinsley W, Bernal JL, Kall M, Bhatt S, Blomquist P, Zaidi A, Volz E, Aziz NA, Harman K, Funk S, Abbott S, COVID-19 Genomics UK (COG-UK) consortium, Hope R, Charlett A, Chand M, Ghani AC, Seaman SR, Dabrera G, De Angelis D, Presanis AM, Thelwall S. Comparative analysis of the risks of hospitalisation and death associated with SARS-CoV-2 Omicron (B.1.1.529) and Delta (B.1.617.2) variants in England: a cohort study. Lancet 2022: volume 399, issue 103,32, pages 1,303-1,312. 10.1016/S0140-6736(22)00462-7
10. Pritchard E, Matthews PC, Stoesser N, Eyre DW, Gethings O, Vihta K-D and others. 'Impact of vaccination on SARS-CoV-2 cases in the community: a population-based study using the UK's COVID-19 Infection Survey' medRxiv 2021: 2021.04.22.21255913
11. Hall VJ, Foulkes S, Saei A, Andrews N, Oguti B, Charlett A and others. 'COVID-19 vaccine coverage in health-care workers in England and effectiveness of BNT162b2

mRNA vaccine against infection (SIREN): a prospective, multicentre, cohort study' Lancet 2021

12. Shrotri M, Krutikov M, Palmer T, Giddings R, Azmi B, Subbarao S and others. 'Vaccine effectiveness of the first dose of ChAdOx1 nCoV-19 and BNT162b2 against SARS-CoV-2 infection in residents of long-term care facilities in England (VIVALDI): a prospective cohort study' Lancet Infectious Diseases 2021
13. Menni C, Klaser K, May A, Polidori L, Capdevila J, Louca P and others. 'Vaccine side-effects and SARS-CoV-2 infection after vaccination in users of the COVID-19 Symptom Study app in the UK: a prospective observational study' The Lancet Infectious Diseases 2021
14. Harris RJ, Hall JA, Zaidi A, Andrews NJ, Dunbar JK, Dabrera G. 'Effect of vaccination on household transmission of SARS-CoV-2 in England' New England Journal of Medicine 2021
15. V Shah AS, Gribben C, Bishop J, Hanlon P, Caldwell D, Wood R and others. 'Effect of vaccination on transmission of COVID-19: an observational study in healthcare workers and their households' medRxiv 2021: 2021.03.11.21253275
16. Eyre DW, Taylor D, Purver M, Chapman D, Fowler T, Pouwels KB, Walker S, Peto T. 'The impact of SARS-CoV-2 vaccination on Alpha and Delta variant transmission' medRxiv 2021: 2021.09.28.21264260
17. COVID-19 vaccine effectiveness against the Omicron BA.2 variant in England
18. Clifford S, Waight P, Hackman J, Hue S, Gower CM, Kirsebom FCM, Skarnes C, Letley L, Lopez Bernal J, Andrews N, Flasche S, Miller E. 'Effectiveness of BNT162b2 and ChAdOx1 against SARS-CoV-2 household transmission: a prospective cohort study in England' medRxiv 2021.11.24.21266401; doi: 10.1101/2021.11.24.21266401
19. Vousden N and others. 'Impact of SARS-CoV-2 variant on the severity of maternal infection and perinatal outcomes: data from the UK Obstetric Surveillance System national cohort' medRxiv 2021
20. Kadiwar S and others. Were pregnant women more affected by COVID-19 in the second wave of the pandemic? The Lancet 2021: volume 397, issue 10,284, pages 1,539 to 1,540
21. University of Edinburgh. 'Outputs and information for the public'
22. Public Health Scotland. 'Scottish Intensive Care Society Audit Group report on COVID-19, 23 September 2021'
23. Adhikari EH and others. 'COVID-19 cases and disease severity in pregnancy and neonatal positivity associated with Delta (B.1.617.2) and Omicron (B.1.1.529) Variant Predominance' Journal of the American Medical Association 2022: volume 327, issue 15, pages 1,500 to 1,502. doi: 10.1001/jama.2022.4356. PMID: 35325015; PMCID: PMC8949750
24. Stock SJ, Moore E and others. 'Pregnancy outcomes following Delta and Omicron SARS-CoV-2 Infection in Scotland: A Population-Based Cohort Study.' Available at SSRN

25. Zambrano LD and others. 'Update: characteristics of symptomatic women of reproductive age with laboratory-confirmed SARS-CoV-2 infection by pregnancy status: United States, January 22 to October 3'
26. 'JCVI issues new advice on COVID-19 vaccination for pregnant women'
27. 'Pregnant women urged to come forward for COVID-19 vaccination'
28. 'JCVI announcement regarding COVID-19 vaccination during pregnancy and next steps'
29. Goldshtein I and others. 'Association between BNT162b2 vaccination and incidence of SARS-CoV-2 infection in pregnant women' Journal of the American Medical Association 2021: volume 326, issue 8, pages 728 to 735
30. Dagan N and others. 'Effectiveness of the BNT162b2 mRNA COVID-19 vaccine in pregnancy' Nature Medicine 2021: volume 27, issue 10, pages 1,693 to 1,695
31. Gray KJ and others. 'Coronavirus disease 2019 vaccine response in pregnant and lactating women: a cohort study' American Journal of Obstetrics and Gynecology 2021: volume 225, issue 3, pages 303 e1 to e17
32. Halasa NB, Olson SM, Staat MA and others. 'Effectiveness of maternal vaccination with mRNA COVID-19 vaccine during pregnancy against COVID-19-associated hospitalisation in infants aged under 6 months: 17 States, July 2021 to January 2022' MMWR Morbidity and Mortality Weekly Report 2022: volume 71, pages 264 to 270
33. 'Key information on COVID-19 in pregnancy | UKOSS | NPEU'
34. Stock S and others. 'COVID-19 vaccination rates and SARS-CoV-2 infection in pregnant women in Scotland' Research Square 2021
35. 'CDC COVID data tracker: vaccination among pregnant people' (accessed 30 August 2022)
36. Shimabukuro TT and others. 'Preliminary findings of mRNA COVID-19 vaccine safety in pregnant persons' New England Journal of Medicine 2021: volume 384, issue 24, pages 2,273 to 2,282
37. Kharbanda EO and others. 'Spontaneous abortion following COVID-19 vaccination during pregnancy' Journal of the American Medical Association 2021: volume 326, issue 16, pages 1,629 to 1,631
38. Magnus MC and others. 'COVID-19 vaccination during pregnancy and first-trimester miscarriage' New England Journal of Medicine 2021
39. Zauche LH and others. 'Receipt of mRNA COVID-19 vaccines and risk of spontaneous abortion' New England Journal of Medicine 2021: volume 385, issue 16, pages 1,533 to 1,535
40. Stock S and others. 'Early pregnancy outcomes following COVID-19 vaccination and SARS-CoV-2 infection: a national population-based matched cohort study' 19 August 2022, PREPRINT (Version 1)
41. Wilson EB. 'Probable inference, the law of succession, and statistical inference' Journal of the American Statistical Association 2012: volume 1,927, issue 22, pages 209 to 212
42. 'Public Health Scotland COVID-19 statistical report' 19 May 2022

# About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation's health secure.

UKHSA is an executive agency, sponsored by the Department of Health and Social Care.



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