Office for National Statistics

Statistical bulletin

Coronavirus (COVID-19) hospital admissions by vaccination and pregnancy status, England: 8 December 2020 to 31 August 2021

Estimates of coronavirus (COVID-19) hospital admission rates in England by vaccination status in pregnant and non-pregnant women: Experimental Statistics.

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1 . Main points

- Among both pregnant and non-pregnant women, age-standardised rates of coronavirus (COVID-19) hospital admission were lower among those who were vaccinated compared with those who were unvaccinated when first infected.
- COVID-19 vaccination was associated with a similar reduction in the rate of COVID-19 hospital admission in pregnant and non-pregnant women, suggesting that vaccination is as effective in pregnant women at reducing COVID-19 hospital admission as it is in non-pregnant women.
- Compared with those who were unvaccinated, the rate of COVID-19 hospitalisation was 83% lower for double-vaccinated pregnant women and 82% lower for double-vaccinated non-pregnant women; this was after adjusting for factors related to vaccine uptake and risk of COVID-19 hospitalisation.
- For both pregnant and non-pregnant women, the reduction in risk of COVID-19 hospital admission relative to those unvaccinated was greater among those double-vaccinated more than 90 days before infection than those single-vaccinated more than 90 days before infection.
- There was no statistical evidence that the association between vaccination status and COVID-19 hospital admission varied according to the stage of pregnancy when infected.

WARNING: These are Experimental Statistics, which are statistics that are in the testing phase and not yet fully developed.

Statistician's comment

"Today's analysis shows that COVID-19 vaccines protect pregnant women from severe COVID-19 outcomes. Being vaccinated reduces the risk of hospital admission in a similar way for both women infected with COVID-19 during pregnancy and women who are not pregnant when they are infected. In future work, we plan to compare birth outcomes by vaccination status in women infected with COVID-19."

Vahé Nafilyan, Senior statistician, Health Analysis and Life Events Division, Office for National Statistics

2 . Overview of data sources and method

The study covers 815,477 women aged 18 to 45 years in England who first tested positive for COVID-19 in national testing programmes, or who tested positive or were diagnosed with COVID-19 in hospital, between 8 December 2020 (the start of the vaccine roll-out programme in the UK) and 31 August 2021, with no evidence of prior infection. Of these, 33,549 women (4.1% of the study population) were identified as pregnant at the time of infection.

The data source for the study was the Office for National Statistics' (ONS) Public Health Data Asset. A more detailed description of the data sources and methodology is available in our Methodology for Coronavirus (COVID-19) hospital admissions by vaccination and pregnancy status.

3 . Age-standardised rates of COVID-19 hospital admission

Among both pregnant and non-pregnant women, the age-standardised rate of coronavirus (COVID-19) hospital admission was higher for those who had not received a COVID-19 vaccine than for those who had been vaccinated at least 14 days before they were first infected with COVID-19.

WARNING: Age-standardised rates of COVID-19 hospital admission should not be compared between pregnant and non-pregnant groups. This is because pregnant women are more likely to have hospital contact than women in the general population, including as a precautionary measure following COVID-19 infection.

Among women who were identified as not pregnant when they were first infected with COVID-19, the rate of COVID-19 hospital admission was 1,488.1 per 100,000 infections for those who were unvaccinated. This is compared with 421.6 per 100,000 infections for those who had received one dose of a vaccine, and 435.3 per 100,000 infections for those who had received two doses.

Table 1: Age-standardised rates of COVID-19 hospital admission (per 100,000 infections) among women who were not pregnant when first infected with COVID-19, by vaccination status, England: 8 December 2020 to 31 August 2021

Vaccination status	Number of COVID-19 hospital admissions	Age-standardised rate	Lower 95% confidence limit	Upper 95% confidence limit
Unvaccinated	7,028	1,488.1	1,452.7	1,523.4
Single-vaccinated	435	421.6	380.5	462.7
Double-vaccinated	531	435.3	397.6	473.0

Source: Office for National Statistics – Coronavirus (COVID-19) by vaccination and pregnancy status, England: 8 December 2020 to 31 August 2021

Notes

1. Based on women in England aged 18 to 45 years who were present in the ONS Public Health Data Asset and infected or diagnosed with COVID-19 between 8 December 2020 to 31 August 2021.

2. COVID-19 hospital admission was defined as hospital inpatient episodes with an International Classification of Diseases, tenth Revision (ICD-10) code for either U07.1 (COVID-19, virus identified) or U07.2 (COVID-19, virus not identified) recorded as the primary diagnosis and occurring within 120 days of first COVID-19 infection.

Among women who were identified as pregnant when they were first infected with COVID-19, the rate of COVID-19 hospital admission was 6,736.6 per 100,000 infections for those who were unvaccinated. This is compared with 2,181.9 per 100,000 infections for those who had received one dose, and 1,589.5 per 100,000 infections for those had received two doses.

Table 2: Age-standardised rates of COVID-19 hospital admission (per 100,000 infections) among women who were pregnant when first infected with COVID-19, by vaccination status, England: 8 December 2020 to 31 August 2021

Vaccination status	Number of COVID-19 hospital admissions	Age-standardised rate	Lower 95% confidence limit	Upper 95% confidence limit
Unvaccinated	1,807	6,736.6	6,252.9	7,220.2
Single-vaccinated	60	2,181.9	1,432.7	3,090.2
Double-vaccinated	28	1,589.5	900.6	2,503.9

Source: Office for National Statistics – Coronavirus (COVID-19) hospital admissions by vaccination and pregnancy status, England: 8 December 2020 to 31 August 2021

Notes

1. Based on women in England aged 18 to 45 years who were present in the ONS Public Health Data Asset and infected or diagnosed with COVID-19 between 8 December 2020 to 31 August 2021.

2. COVID-19 hospital admission was defined as hospital inpatient episodes with an International Classification of Diseases, tenth Revision (ICD-10) code for either U07.1 (COVID-19, virus identified) or U07.2 (COVID-19, virus not identified) recorded as the primary diagnosis and occurring within 120 days of first COVID-19 infection.

4 . Relative rates of COVID-19 hospital admission by vaccination status

We used Cox proportional hazards regression to estimate how the risk of COVID-19 hospital admission varied by vaccination status for pregnant and non-pregnant women. This was after adjusting for factors linked with vaccination uptake and the risk of COVID-19 hospitalisation (view our Methodology for Coronavirus (COVID-19) hospital admissions by vaccination and pregnancy status for more detail).

We calculated hazard ratios for COVID-19 hospital admission for those who were vaccinated (one dose or two doses) at least 14 days before they were first infected relative to those who were unvaccinated.

Among women who were pregnant when first infected with COVID-19, the rate of COVID-19 hospital admission was 76.3% lower for those who had received one dose of a vaccine, compared with those who were unvaccinated. A similar reduction in risk of COVID-19 hospital admission was observed for women who were not pregnant when they were first infected with COVID-19; the rate of COVID-19 hospital admission was 78.6% lower for those who had received one dose of a vaccine than for those who were unvaccinated

The rate of COVID-19 hospital admission was 83.1% lower for double-vaccinated women who were pregnant when first infected with COVID-19, compared with unvaccinated pregnant women. For double-vaccinated women who were not pregnant when first infected with COVID-19, the rate of COVID-19 hospital admission was 81.6% lower than for unvaccinated non-pregnant women.

These results suggest that COVID-19 vaccination is equally effective at reducing COVID-19 hospital admission in pregnant and non-pregnant women.

There was no statistical evidence that the association between vaccination status and rates of COVID-19 hospital admission differed according to stage of pregnancy at time of infection.

Figure 1: Rates of COVID-19 hospital admission were lower among vaccinated pregnant and non-pregnant women compared with unvaccinated women

Hazard ratios for COVID-19 hospital admission for single-vaccinated and double-vaccinated women relative to unvaccinated women, stratified by pregnancy status when first infected with COVID-19, England: 8 December 2020 to 31 August 2021

Notes:

1. Adjusted for age, calendar time of infection, region, Index of Multiple Deprivation (IMD) decile group, Rural /Urban classification, ethnic group, English language proficiency, country of birth, keyworker status, highest qualification held, disability status and health status.

Download the data

.xlsx

On average, the number of days between vaccination and COVID-19 infection was longer in the double-vaccinated group than the single-vaccinated group. Therefore, we stratified the analysis by time since last COVID-19 vaccination: 14 to 90 days before infection versus more than 90 days before infection.

Among both pregnant and non-pregnant women, the reduction in risk of COVID-19 hospital admission compared with those who were unvaccinated was similar for those who had received one or two doses of a vaccine 14 to 90 days before infection. For those who had been vaccinated more than 90 days before infection, a greater reduction in risk of COVID-19 hospital admission was observed among those who were double-vaccinated than those who were single-vaccinated.

This indicates greater waning of vaccine effectiveness for preventing COVID-19 hospital admission after one dose of the vaccine than after two doses of the vaccine, in both pregnant and non-pregnant women.

Table 3. Hazard ratios for COVID-19 hospital admission for single-vaccinated and double-vaccinated women relative to unvaccinated women, stratified by pregnancy status and time since vaccination, England: 8 December 2020 to 31 August 2021

	Not pregnant			**Pregnant**		
Vaccination status	Hazard ratio	Lower 95% confidence limit	Upper 95% confidence limit	Hazard ratio	Lower 95% confidence limit	Upper 95% confidence limit
Single-vaccinated 14 to 90 days before infection	0.19	0.17	0.21	0.19	0.14	0.27
Double-vaccinated 14 to 90 days before infection	0.16	0.14	0.18	0.16	0.10	0.27
Single-vaccinated more than 90 days before infection	0.46	0.38	0.57	0.33	0.23	0.48
Double-vaccinated more than 90 days before infection	0.22	0.19	0.25	0.18	0.10	0.31

Source: Office for National Statistics – Coronavirus (COVID-19) hospital admissions by vaccination and pregnancy status, England: 8 December 2020 to 31 August 2021

Notes

1. Adjusted for age, calendar time of infection, region, Index of Multiple Deprivation (IMD) decile group, Rural /Urban classification, ethnic group, English language proficiency, country of birth, keyworker status, highest qualification held, disability status and health status.

5 . Future developments

This analysis forms part of a wider programme of work into COVID-19 in pregnancy. In future work, we plan to assess:

- birth outcomes following COVID-19 infection during pregnancy, by vaccination status
- COVID-19 vaccine uptake during pregnancy
- birth outcomes following COVID-19 vaccination during pregnancy

For an overview of existing evidence, see this recent Systematic review and meta-analysis of the effectiveness and perinatal outcomes of COVID-19 vaccination in pregnancy in the online journal, Nature Communications.

6 . COVID-19 hospital admissions by vaccination and pregnancy status, England data

Coronavirus (COVID-19) hospital admissions by vaccination and pregnancy status, England
Dataset | Released 11 July 2022
All data relating to “Coronavirus (COVID-19) hospital admissions by vaccination and pregnancy status, England”

7 . Glossary

Age-standardised rates

Age-standardised rates are used to allow comparisons between populations that may contain different proportions of people of different ages. The 2013 European Standard Population is used to standardise rates.

Confidence intervals

Confidence intervals use the standard error to derive a range in which we think the true value is likely to lie. A confidence interval gives an indication of the degree of uncertainty of an estimate and helps to decide how precise a sample estimate is. It specifies a range of values likely to contain the unknown population value. These values are defined by lower and upper limits.

Coronavirus and COVID-19

Coronaviruses are a family of viruses that cause disease in people and animals. They can cause the common cold or more severe diseases, such as COVID-19. COVID-19 is the name used to refer to the disease caused by the SARS-CoV-2 virus, which is a type of coronavirus. The Office for National Statistics (ONS) takes COVID-19 to mean presence of SARS-CoV-2 with or without symptoms.

Cox proportional hazards regression

Cox proportional hazards regression is a statistical model used to measure the association between a time-to-event outcome (such as COVID-19 hospital admission) and a characteristic of interest (in this case, vaccination status). It can be used to adjust for other characteristics expected to be related to both the characteristic of interest and the outcome.

Hazard ratio

A hazard ratio is a measure of how often a particular event occurs in one group compared to how often it occurs in another group (the reference group), at any particular point in time. A hazard ratio greater than 1 shows that the rate of the event occurring is higher in the group of interest compared with a reference group, while a hazard ratio of less than 1 shows that the rate is lower in the group of interest compared with a reference group.

8 . Measuring the data

These analyses use data from the Office for National Statistics' (ONS) Public Health Data Asset (PHDA). The PHDA covers England only and combines:

- Census 2011 records
- death registrations data
- electronic health records (Hospital Episode Statistics (HES) and General Practice Extraction Service (GPES) Data for Pandemic Planning and Research (GDPPR))
- National Immunisation Management Service (NIMS) data
- NHS Test and Trace (Pillar 1 and Pillar 2) data

The inclusion criteria for the study were:

- enumerated at the 2011 Census
- female self-reported sex according to their 2011 Census return
- aged 18 to 45 years at the start of the study period (8 December 2020)
- could be linked to the 2011 to 2013 NHS Patient Register (to obtain an NHS number)
- could be linked to at least one GDPPR record (to identify active NHS patients at the start of the pandemic)
- resident in England according to GDPPR and living in a private household according to the 2011 Census
- evidence of COVID-19 infection between 8 December 2020 and 31 August 2021
- no evidence of COVID-19 infection before 8 December 2020

Pregnancy status at time of first infection with COVID-19 was determined using NHS Birth Notifications data and HES data. Estimated conception date was calculated from the date of birth and the length of gestation provided on birth notifications.

Pregnancy status when first infected with COVID-19 was inferred based on estimated date of conception and the date of the earliest positive COVID-19 test recorded in NHS Test and Trace (Pillar 1 and Pillar 2) data or COVID-19 test or diagnosis in hospital records occurring in the study period. The latter includes hospital episodes with an International Classification of Diseases, tenth Revision (ICD-10) code for either U07.1 (COVID-19, virus identified) or U07.2 (COVID-19, virus not identified) recorded as the primary or secondary diagnosis.

We also searched hospital records for evidence of ongoing pregnancy and end of pregnancy. This was to identify women who were pregnant when they were infected but for whom a birth notification was not recorded (for example, pregnancies that ended in stillbirth before 24 weeks, which are not recorded in birth notifications, or pregnancies that were ongoing at the end of the study period). For a detailed description of the methodology used, see our accompanying Methodology for Coronavirus (COVID-19) hospital admissions by vaccination and pregnancy status.

COVID-19 hospital admission was defined as hospital inpatient episodes with an ICD-10 code for either U07.1 (COVID-19, virus identified) or U07.2 (COVID-19, virus not identified) recorded as the primary diagnosis and occurring within 120 days of infection.

This release also used data from the 2021 Census to update 2011 Census variables. 91.6% of the study population could be linked to the 2021 Census. For the remaining 8.4%, 2011 Census variables were used in the analysis.

9 . Strengths and limitations

Strengths

The primary strength of the study is using nationwide linked population-level data. This combines a rich set of demographic and socio-economic factors from the 2011 and 2021 Censuses with electronic health records, NHS Test and Trace (Pillar 1 and 2) data, National Immunisation Management Service (NIMS) data, and NHS Birth Notifications data.

For most participants in the study, sociodemographic and health variables were based on data from the 2021 Census. This meant that we could adjust for a range of up-to-date factors related to vaccine uptake and severe COVID-19 outcomes in the analysis.

Limitations

The Public Health Data Asset only contains information for individuals who were enumerated at the 2011 Census. It therefore excludes:

- people living in England in 2011 who did not participate in the Census (estimated to be approximately 5% of the population)
- respondents who could not be linked to the 2011 to 2013 NHS Patient Registers (5.4% of Census respondents)
- people who have immigrated since 2011
- people not registered with a general practitioner at the start of the coronavirus (COVID-19) pandemic

Misclassification of pregnancy status is possible because of limited data availability, especially in the first trimester and for women whose pregnancy ended before 24 weeks. Therefore, women who had been pregnant but were no longer so when they were infected with COVID-19 may be incorrectly classified as being pregnant.

People with asymptomatic COVID-19 may be less likely to seek a test via the NHS Test and Trace programme. Consequently, COVID-19 hospital admission rates reported in this release may overestimate the true rates in the general population as asymptomatic infections will be under-represented in the study population.

Pregnant women may be more likely to be tested for COVID-19 because a COVID-19 test is recommended by NHS England ahead of any planned hospital appointment. Since pregnant women attend regular obstetric appointments, this means that there may be more asymptomatic infections detected in the pregnant group.

COVID-19 hospital admissions were defined as inpatient admissions where COVID-19 was recorded as the primary diagnosis. However, this will include some hospital admissions where the initial reason for admission was not related to COVID-19 but the patient was subsequently diagnosed with, and treated for, COVID-19 while in hospital. This is likely to be more common among pregnant women, who are more likely to have hospital contact than women in the general population.

10 . Collaboration

This analysis was produced in collaboration with:

- Dr Ashley Akbari from Swansea University
- Dr Clara Calvert from the University of Edinburgh
- Dr Clare Gillies from the University of Leicester
- Daniel Ayoubkhani from the Office for National Statistics
- Dr Francesco Zaccardi from the University of Leicester
- Professor Kamlesh Khunti from the University of Leicester
- Loes Charlton from the Office for National Statistics
- Dr Luisa Zuccolo from the University of Bristol
- Professor Marian Knight from the University of Oxford
- Dr Pia Hardelid from University College London
- Dr Rachael Wood from the University of Edinburgh

11 . Related links

Methodology for coronavirus (COVID-19) hospital admissions by vaccination and pregnancy status
Methodology | Released 11 July 2022
Methods and data sources used to estimate coronavirus (COVID-19) hospital admissions by vaccination status in pregnant and non-pregnant women in England.