Weekly COVID-19 age-standardised mortality rates by vaccination status, England: methodology

Detailed quality and methodology information for coronavirus (COVID-19) age-standardised mortality rates by vaccination status, initially published for Weeks 1 to 26 2021 in "Deaths involving COVID-19 by vaccination status and vaccine manufacturer, England: deaths occurring between 2 Jan and 2 July 2021".

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1 . Data sources

Age-standardised mortality rates are calculated for vaccination status groups using the Public Health Data Asset (PHDA) dataset. The PHDA is a linked dataset combining the 2011 Census, the General Practice Extraction Service (GPES) data for pandemic planning and research, and the Hospital Episode Statistics (HES). We linked vaccination data from the National Immunisation Management Service (NIMS) to the PHDA based on NHS number, and linked data on positive coronavirus (COVID-19) Polymerase Chain Reaction (PCR) tests from Test and Trace to the PHDA, also based on NHS number.

The PHDA dataset contains a subset of the population and allows for analyses to be carried out that require a known living population with known characteristics. These characteristics include age-standardised mortality rates (ASMRs) by vaccination status and the use of variables such as health conditions and census characteristics.

2 . Definitions

Deaths involving COVID-19

For this analysis we define a death as involving coronavirus (COVID-19) if either of the ICD10 codes, U07.1 (COVID-19, virus identified) or U07.2 (COVID-19, virus not identified), are mentioned on the death certificate. In contrast to the definition used in the weekly deaths released, deaths where the ICD10 code U09.9 (Post-COVID-19 condition, where the acute COVID-19 had ended before the condition immediately causing death occurred) is mentioned on the death certificate and neither of the other two COVID-19 codes mentioned are not included, they are likely to be the result of an infection caught a long time previously. Therefore, they are not linked to the vaccination status of the person at date of death. Deaths involving U10.9 (Multisystem inflammatory syndrome associated with COVID-19) where U07.1 or U07.2 are mentioned are also excluded. This is a rare complication affecting children and there are no such deaths in our dataset for the data released in "Deaths involving COVID-19 by vaccination status and vaccine manufacturer, England: deaths occurring between 1 Jan and 2 July 2021".

Vaccination status and age

COVID-19 vaccination status is determined on the date of death occurrence if a death has occurred, and on the last day of each week if not. Possible values are:

- unvaccinated

- vaccinated with the first dose only, date of death/last day of week is within 21 days of vaccination

- vaccinated with the first dose only, date of death/last day of week is 21 days or more after vaccination

- vaccinated with both the first and second dose, date of death/last day of week is date of second vaccination or later

Age is age in years on date of death if a death has occurred, or the age on the last day of each week if not. Children aged 10 years and under are not included when calculating the aged-standardised mortality rate (ASMR), as numbers are very small because of the linkage to the 2011 census.

3 . Changes in population structure of coronavirus (COVID-19) vaccination status groups

The plots in Figures 1 to 3 show how the population size and age and sex structure of the coronavirus (COVID-19) vaccination groups changes over time, as more people are vaccinated according to the vaccine roll-out priority groups. As probability of mortality is related to age and sex, the count of deaths will differ as the age and sex structure of the groups differs, as well as with the changing size of the group population.

Figure 1: Number of people in each vaccination group varied by week

Number of people who are alive at the beginning of each week by vaccination status, England, deaths occurring between Week 1 and Week 26 (week ending 8 January 2021 to week ending 2 July 2021)

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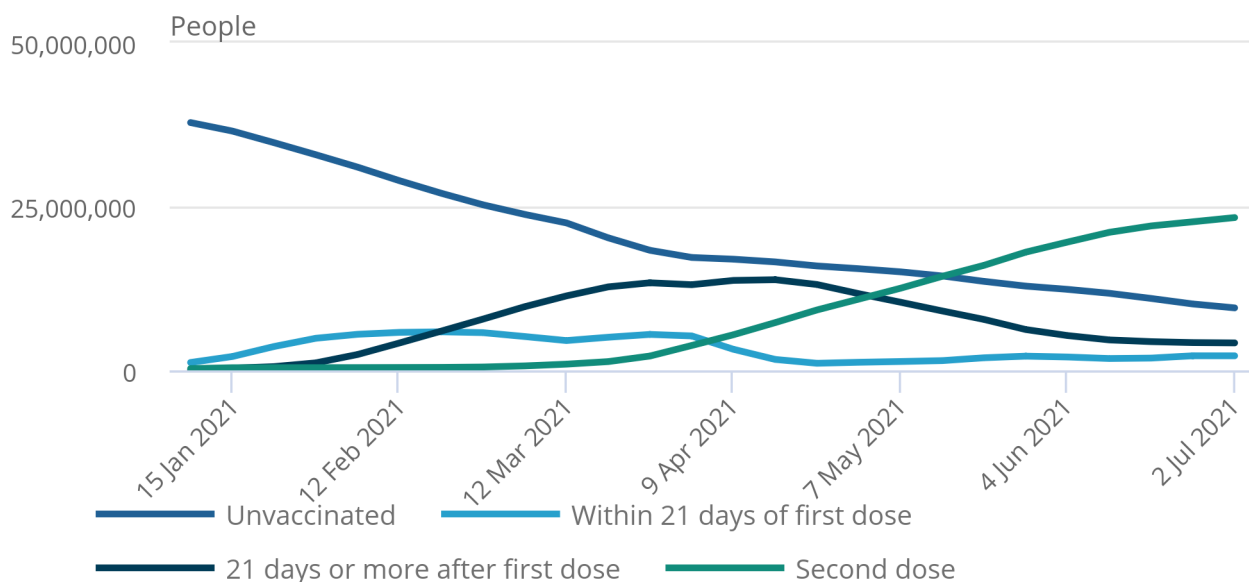
Source: Office for National Statistics – Public Health Data Asset, National Immunisation Management Service

Notes:

1. Office for National Statistics (ONS) figures based on death registrations up to 28 July 2021 for deaths that occurred between Week 1 and Week 26 (2 January and 2 July 2021).

2. Values are calculated using the Public Health Data Asset, a linked dataset of people resident in England who could be linked to the 2011 Census and GP Patient Register.

3. Deaths were defined using the International Classification of Diseases, tenth revision (ICD-10). Deaths involving coronavirus (COVID-19) are defined as those with an underlying cause, or any mention of, ICD-10 codes U07.1 (COVID-19 virus identified) or U07.2 (COVID-19, virus not identified). Please note, this differs from the definition used in the majority of mortality outputs.

4. Vaccination status is defined on the date of death where a death has occurred, and on the last day of the week if not.
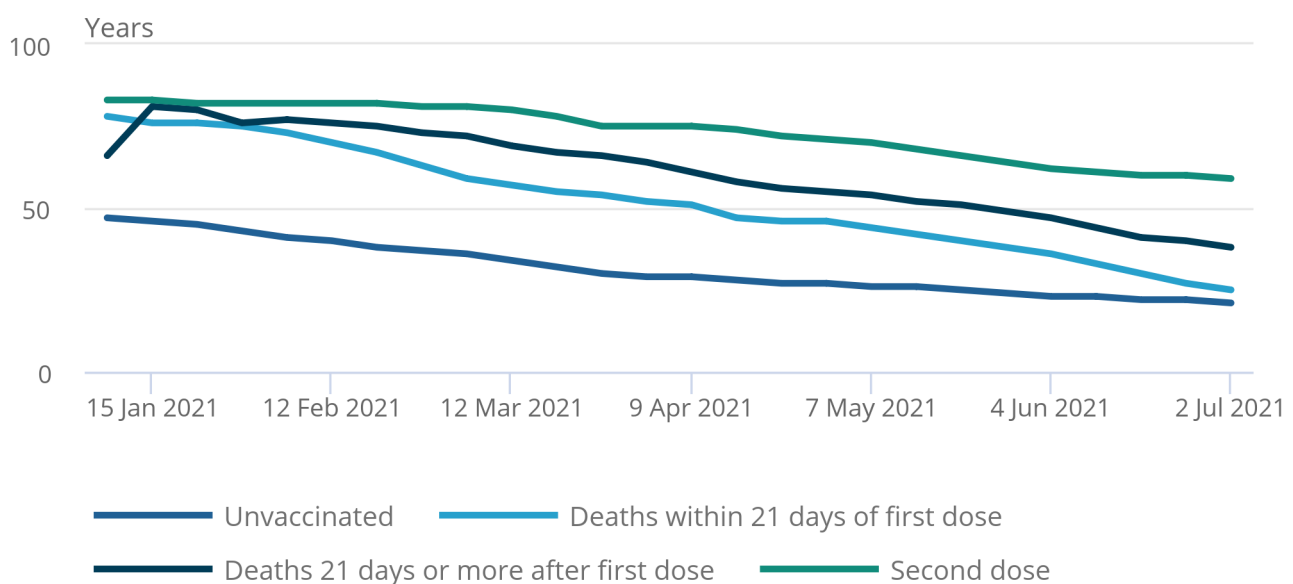
The overall population decreases from week 12 as we include individuals aged 10 years and over in our analysis, but the Public Health Data Asset (PHDA) dataset only includes individuals registered in the 2011 Census. This means that, from week 12, the population will decrease due to deaths occurring but will not increase as more individuals reach 10 years of age, as these individuals are not included in the PHDA. The effect on the age-standardised mortality rates (ASMRs) should be minimal as the deaths of persons not in the population in the PHDA dataset will not be included, and numbers of deaths of people in this age group are relatively low.

Figure 2: The median age of people in each vaccination status group varies by week

Median age of people who were alive at the beginning of each week by vaccination status, England, deaths occurring between Week 1 and Week 26 (week ending 8 January 2021 to week ending 2 July 2021)

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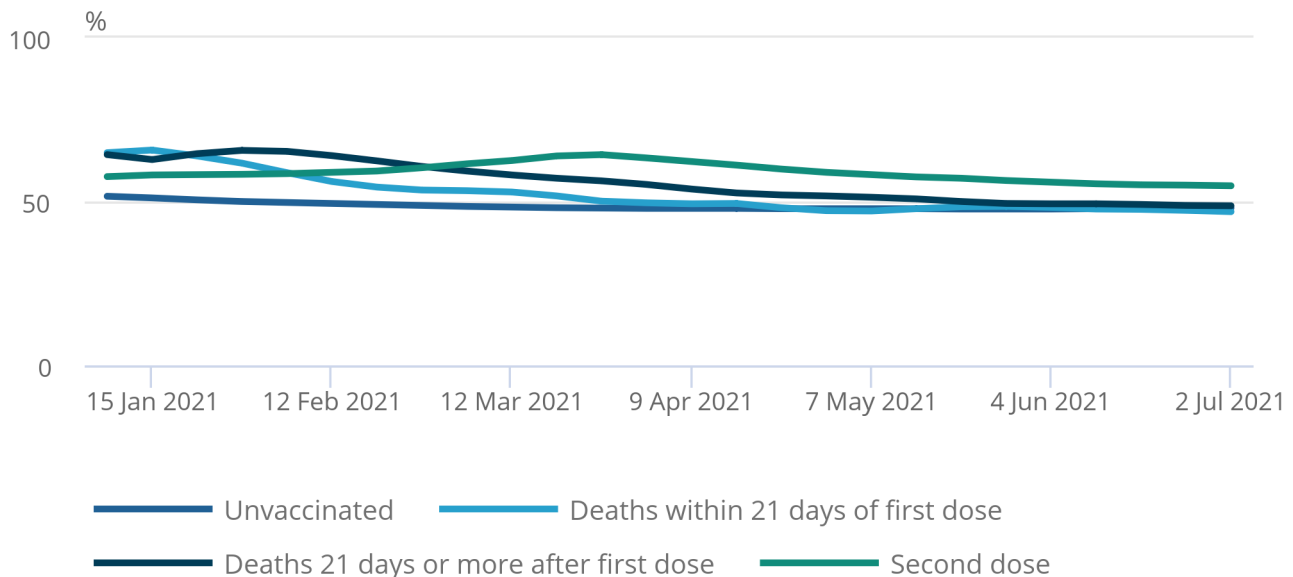
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4. Age and vaccination status are defined on the date of death where a death has occurred, and on the last day of the week if not.

Figure 3. The percentage females in each vaccination status group varies by week

Percentage of females amongst people alive at the beginning of each week by vaccination status, England, deaths occurring between Week 1 and Week 26 (week ending 8 January 2021 to week ending 2 July 2021)

Source: Office for National Statistics – Public Health Data Asset, National Immunisation Management Service

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Initially, there are more females in the vaccinated groups as there are more elderly females than men, and elderly people were prioritised for vaccination. In Week 26, there remains a higher percentage of females than males in the group that had received the second dose of a COVID-19 vaccine at least 21 days prior, however the proportions for other vaccination groups are similar.

4 . Age-standardised mortality rates

Age-standardised mortality rates (ASMRs) are used to allow for comparisons to be made between populations that may contain different overall population sizes and proportions of people of different ages. The 2013 European Standard Population is used to standardise age-specific rates to a consistent population. The formula used to calculate the weekly age-standardised mortality rates per 100,000 for week w is:

$$ASMR_w = \frac{1}{\sum_i ESP_i} \sum_i \frac{D_{i,w}}{P_{i,w}} \bullet 100,000 \bullet ESP_i$$

where:

- w is the week number for which we calculate the ASMR

- i is the age group

- ESP_i is the standard population for age group i

- $D_{i,w}$ is the number of deaths for age group i occurring in week w

- $P_{i,w}$ is the population for age group i alive at the beginning of the week w

To calculate the ASMRs by vaccination status, those aged under 10 years were not used, as the associated dataset includes only those aged nine years and over because it is linked to the 2011 census.

Confidence limits

95% confidence limits are calculated for the age-standardised mortality rates (ASMRs). You can find out more about confidence limits in this Population Health Metrics publication. For ASMRs where the total count of deaths is less than 100, Dobson's method is used, and where the total count of deaths is at least 100, the normal approximation is used.

With Dobson's method:

$$LCL = ASMR_w + \sqrt{\frac{\sigma^2(ASMR_w)}{\sum_i D_{i,w}}}(O_{lower} - \sum_i D_{i,w})$$

$$UCL = ASMR_w + \sqrt{\frac{\sigma^2(ASMR_w)}{\sum_i D_{i,w}}}(O_{upper} - \sum_i D_{i,w})$$

$_i D_{i,w}$ is the total count of deaths across all age/sex groups. O_{upper} and O_{lower} are the upper and lower 95% confidence limits for the total count of deaths based on the Poisson distribution.

$(ASMR_w)$ is the variance of the age-standardised mortality rate

$$\sigma^2(ASMR_w) = \frac{1}{(\sum_i ESP_i)^2} \sum_i \frac{ESP_i^2 D_{i,w}}{P_{i,w}^2}$$

with the normal approximation:
$$LCL = ASMR_w - 1.96 * \sigma(ASMR_w)$$
$$UCL = ASMR_w + 1.96 * \sigma(ASMR_w)$$

where $(ASMR_w)$ is the standard error of the ASMR, which is equal to the square root of the variance of the ASMR.