**Supplement S1. An illustration of how the raw data has been analyzed.**

The data shown is for males aged 18-39, 60-69 and 90+. This example is from the ONS data file ending at May-22 [38]. Effective vaccination lies ***below*** the unvaccinated line.

**Supplementary material S2.** Estimated proportion of reported deaths in England which are missing from the ONS vaccination study, by age band.

**Table S2.** Estimated proportion of reported deaths in England which are missing from the ONS vaccination study, by age band.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Age band** | **ONS study (England)** | **England & Wales** | **Estimated England** | **Proportion in ONS study** |  |
| **2021** | **2021** | **2021** | **Included** | **Missing** |
| 18-39 | 6,461 | 10,553 | 9,887 | 65% | 35% |
| 40-49 | 10,184 | 15,146 | 14,191 | 72% | 28% |
| 50-59 | 27,484 | 36,489 | 34,187 | 80% | 20% |
| 60-69 | 54,731 | 67,639 | 63,372 | 86% | 14% |
| 70-79 | 113,651 | 135,075 | 126,555 | 90% | 10% |
| 80-89 | 164,640 | 194,742 | 182,458 | 90% | 10% |
| 90+ | 103,744 | 116,142 | 108,816 | 95% | 5% |

**Footnote:** Data for England and Wales is from the ONS published data for 2021. Deaths in England have been estimated from total deaths in Wales and England in 2021. England = 93.7% of the total for England and Wales. To be included in the ONS vaccination study persons had to be registered with a GP practice located in England and a resident of England during the 2011 census. Deaths in the ONS study are a composite of the Jan-Mar 2021 in the file ending May-22 and Apr-Dec 2021 in the file ending Dec-22 [38]. This only elevates the included deaths by 1% in each age band. The ONS file is progressively updated. As such, included deaths are lower closest to the end of the period. Hence at May-22 the file ending May-22 has 30485 total deaths compared to 37587 in the file ending Dec-22.

**Supplementary material S3.** Role of time after vaccination on the ratio of COVID-19 to non-COVID-19 deaths

The ONS data has two splits for the length of time a death occurs after vaccination, namely, up to 21 days (3 weeks) and 21 days and above. Table 9 in the first ONS file covering January 2021 to May 2022 presents data relating to COVID-19 and non-COVID-19 deaths for the weeks after vaccination. This file was chosen because it contains less data in the Omicron period which has an age profile which is highly skewed to deaths over 80 years [23].

This data has been converted into a ratio between the two and is presented in Figure S3.1 where the ratio reaches a peak at 2 to 3 weeks after vaccination – 2 weeks for the younger ages progressing to 3 weeks for the older ages. Also, the magnitude of the peak in the ratio seems to increase with age reaching a maximum of 21% for over 80 years.

The minimum point for the ratio occurs at 9 to 11 weeks – 9 to 10 weeks for younger and 11 weeks for older ages. This minimum is less pronounced in the younger ages.

**Figure S3.1.** Effect of the number of weeks after vaccination on the ratio of COVID-19 to non-COVID-19 deaths. A sixth order polynomial has been used to approximate the shape of the trend. The number of deaths increases with age.

Figure S3.2 shows the effect of age upon the ratio of COVID-19 to non-COVID-19 deaths in the up to 21 days (3 weeks) and over 21 days groups as per the time periods used in the ONS study, plus an up to 12 weeks and a 12+ weeks group, i.e., more longer-term. As can be seen, the effect is especially age dependent for the up to 3 weeks group, and even for the up to 12 weeks and 12+ weeks effects. In both cases the effects are greatest above the age of 59 years. The only solution to such effects is to use time as a continuous variable as has been done in several studies conducted in Hungary.

We have also looked at the effect of weeks after vaccination on the profile of non-COVID-19 deaths and there seems to be some evidence that these non-COVID-19 deaths peak at weeks 9 to 10 after COVID-19 vaccination (data not shown). We are not aware that a similar study has been conducted for other types of vaccination. That such would occur is plausible given that the propensity to die will be influenced by immune state – howsoever influenced by the nonspecific effects of vaccination.

**Figure S3.2.** Effect of age on the ratio of COVID-19 to non-COVID-19 deaths for two time-intervals, namely, one based on 21 days (3 weeks) as per the ONS study or a longer period based on 12 weeks. The number of deaths increases with age from 202 deaths for age 10-39 up to 16335 for age 80-89.