Public Health England

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WARWICK
THE UNIVERSITY OF WARWICK

Impact of COVID-19 vaccines on mortality in England

December 2020 to February 2021

Contents

Background

Vaccination against COVID-19 commenced in England on 8 December 2020, initially using the Pfizer-BioNTech mRNA vaccine. The Oxford-AstraZeneca vaccine was then added to the programme from 4 January 2021.

The target groups for vaccination followed the Joint Committee on Vaccination and Immunisation (JCVI) prioritisation and so residents and staff of care homes for the elderly, individuals over the age of 80 years and health and social care workers were the first to receive vaccination. The programme was subsequently extended to those aged over 70 years, plus individuals in the Clinically Extremely Vulnerable group in mid-January, those aged 60 years and older in February and those aged 50 years and older in March.

Over the course of the vaccine rollout (from 6 January 2021) a national lockdown was introduced which included 'stay at home' measures and closure of non-essential retail, hospitality and personal care services and school closures for most children.

Both the lockdown and the vaccination programme are likely to have impacted on incidence of COVID-19 cases, hospitalisations and deaths, therefore there are challenges in estimating the impact of either intervention alone.

Taking into account observed deaths with COVID-19 and emerging real world evidence of the effectiveness of COVID-19 vaccines Public Health England (PHE) and the University of Warwick have estimated the number of deaths prevented by vaccination in England between the start of the vaccination programme and the end of February 2021.

Methods

COVID-19 deaths were defined as any death within 28 days of a positive SARS-CoV-2 test.

Approach 1

The daily impact of vaccination on deaths was estimated based on vaccine effectiveness against mortality multiplied by vaccine coverage. Observed deaths were then divided by the impact to estimate the expected deaths in the absence of vaccination.

Vaccine effectiveness against mortality was based on the most recent PHE estimates of effectiveness of vaccination against symptomatic infection (58%) and of death given infection (54%) which combined gives 81% protection against death. In order to allow for the time taken to develop an immune response to vaccination and for a mortality endpoint, we assumed it would take 31 days before the effect of vaccination on deaths is observed. For example, the coverage of 64.9% in age 80+ on 19 January applies to deaths on 19 February.

The calculation was done in the 70 to 79 year olds and 80+ separately. The overall total is cumulated across all days until 28 February 2021 and across age 70 to79 and 80+ years age groups.

Approach 2

Using a dynamic age-structured model, that has been continually matched to national and regional data throughout the pandemic, we compare simulations with and without vaccination. The model has been matched to the pattern of deaths, hospital admissions, hospital occupancy and Pillar 2 cases across 10 regions (7 NHS regions: East of England, London, Midlands, North East, North West, South East and South West; and the 3 devolved nations: Scotland, Wales and Northern Ireland), and reliably captures these metrics.

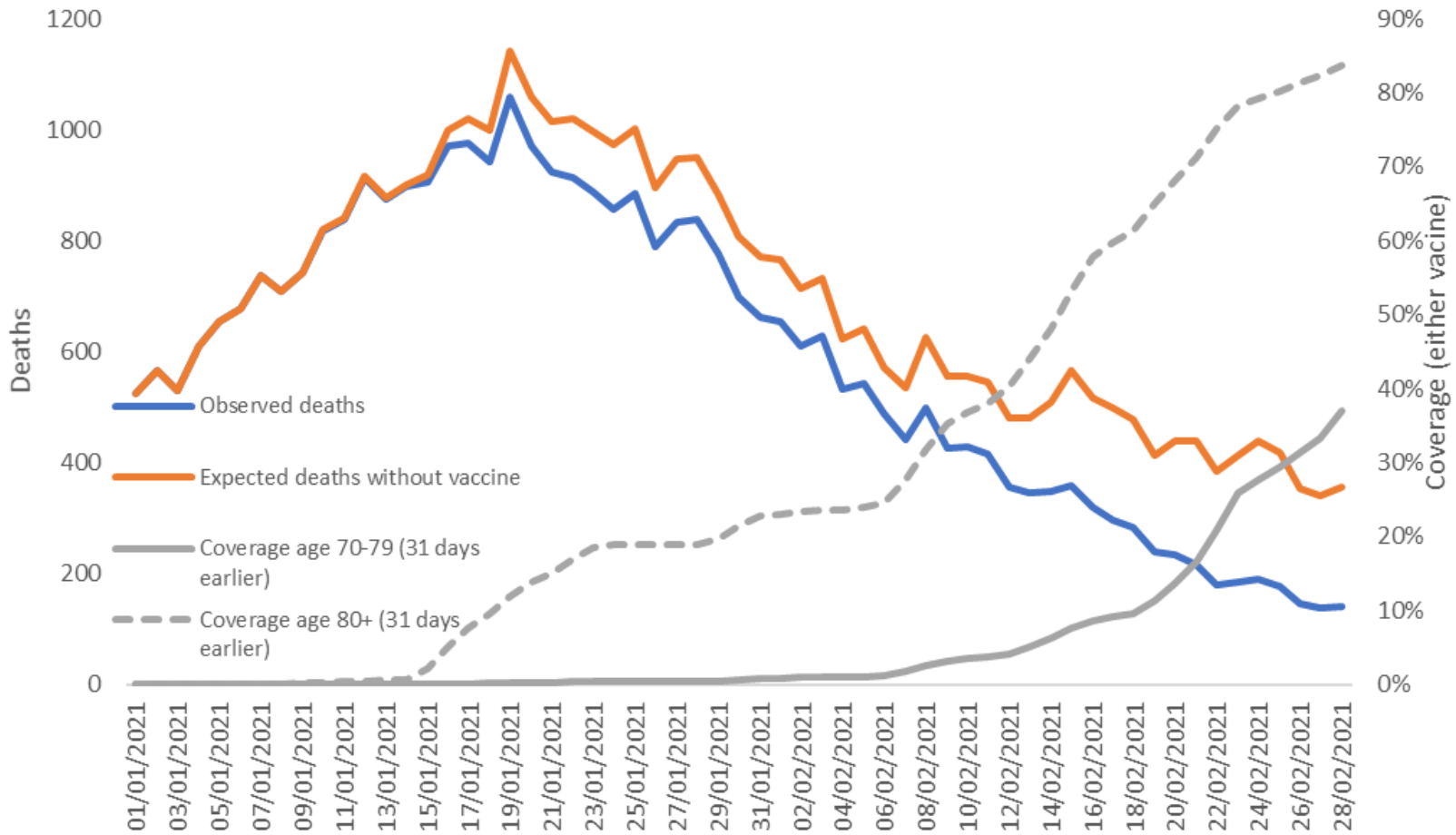
Since December, the model has also included the action of vaccination and captures both prevention of infection and reduction in severe illness and deaths. The model incorporates the vaccine doses that have been administered to date, and assumes that a first dose prevents 65% of infections and 82% of deaths (these values being a weighted average between the 2 vaccines deployed in the UK: Pfizer-BioNTech and Oxford-AstraZeneca). We then run multiple simulations that explore the range of estimated parameters (the posterior distribution of the parameter set) to obtain the mean and distribution of infections, hospital admissions and deaths over time and by age. Here, for England, we compare deaths (defined as death within 28 days of a positive test) until the end of February 2021 under the current vaccination programme and our best estimates for vaccine efficacy, with the counterfactual scenario without vaccination but with the same pattern of lock-down restrictions.

Results

Approach 1

Vaccine coverage, observed deaths and expected deaths using approach 1 are shown in Figure 1. By the end of February 2021, it is estimated that 5,900 deaths were averted in individuals aged 80 years and older and 200 in individuals aged 70 to 79 years giving a total of 6,100 deaths averted in individuals aged 70 years or older.

Figure 1: Daily Observed COVID-19 deaths aged 70+ and expected numbers in the absence of vaccination using the back calculation method

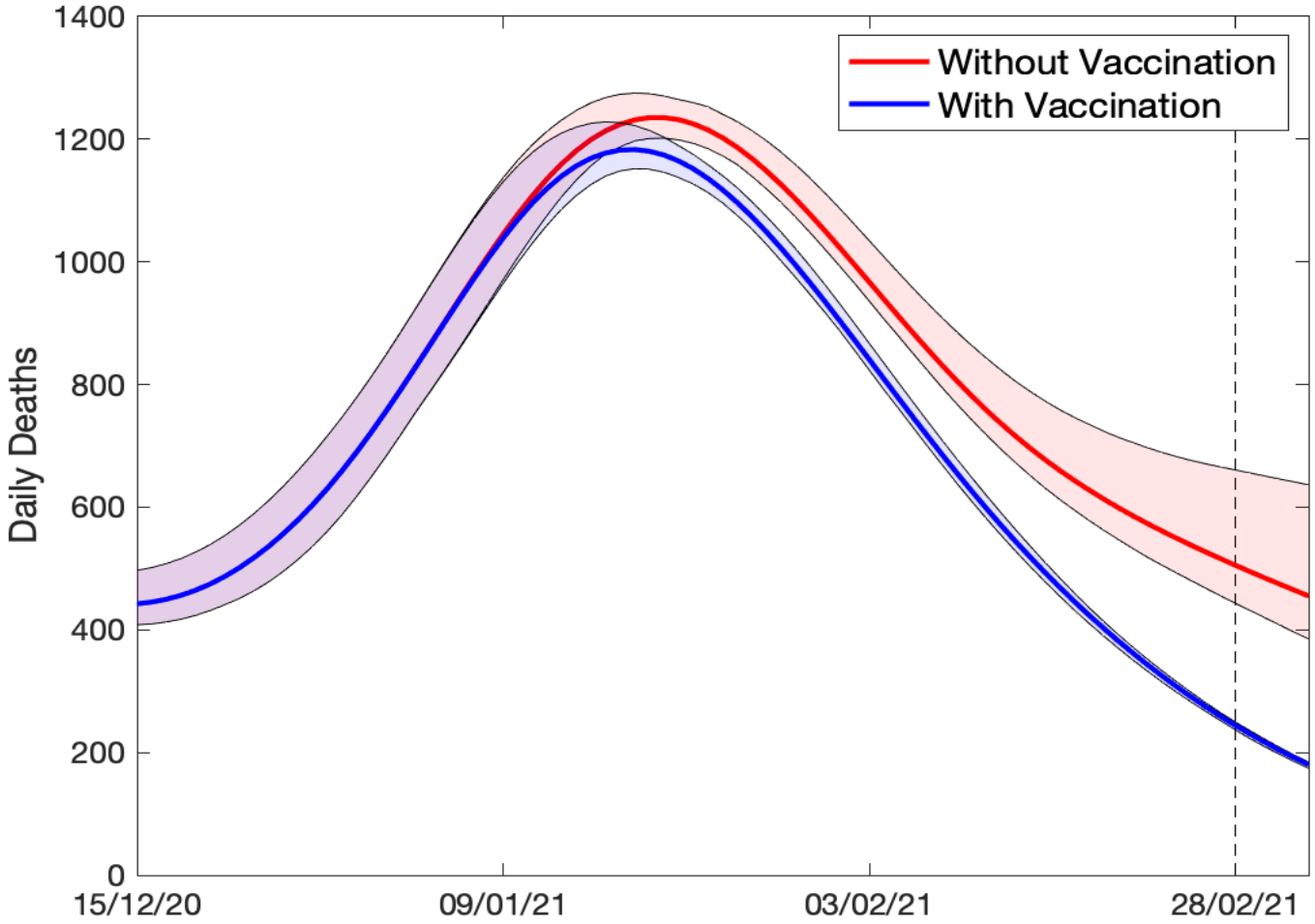


Approach 2

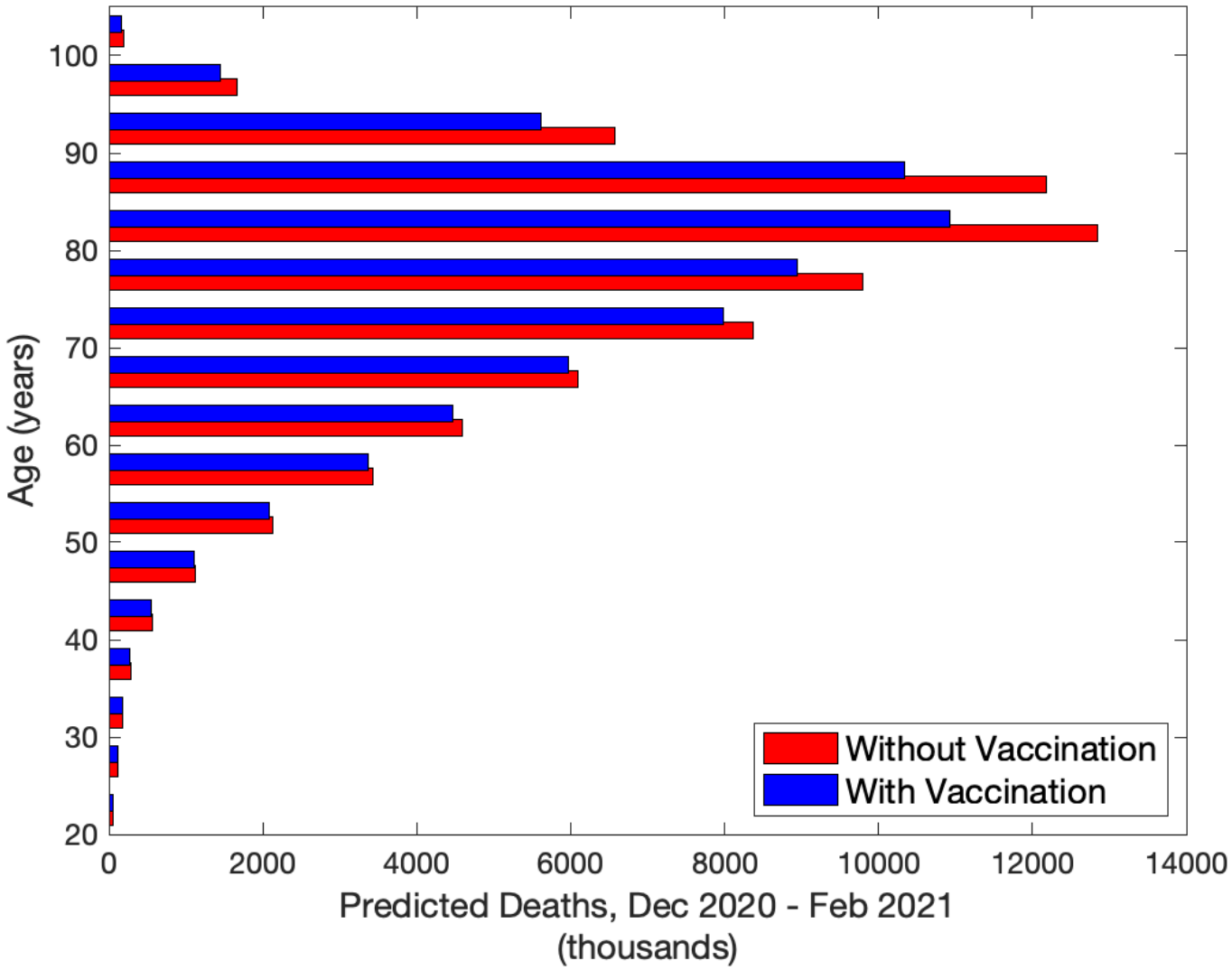
The mean and confidence intervals for the 2 scenarios (the current vaccination programme and no vaccination) are shown in Figure 2a. It is clear that the vaccination programme (blue line) has led to a significant decline in deaths compared to the predictions without vaccination (red line). The difference between the 2 curves is the impact that the vaccination programme has generated, which is estimated to be a saving of 6,592 deaths (95% CI 5,625 to 9,185). Effects by age are shown in Figure 2b, showing that the majority of the benefits of vaccination so far have been accrued in those over 80 years of age.

Figure 2: (a) Predicted dynamics of the number of daily deaths (within 28 days of a positive test) for the default model that captures historic patterns of vaccination (blue) and the counterfactual in which vaccination has been removed (red). (b) Simulation results from December 2020 to February 2021 considered against age.

(a)



(b)


Age (years)
100
90
80
70
60
50
40
30
20
0
2000
4000
6000
8000
10000
12000
14000
Predicted Deaths, Dec 2020 - Feb 2021
(thousands)
Without Vaccination
With Vaccination

Conclusions

Results using both approaches provided similar estimates suggesting that between 6,100 and 6,600 deaths have been averted as a result of the COVID-19 vaccination programme up to the end of February 2021.

The estimates using the Warwick model in Approach 2 are slightly higher than the back-calculation method in Approach 1. This may be because Approach 2 accounts for savings across all age groups (Figure 2b) and it also incorporates the secondary effects of the vaccine in blocking infection and hence transmission. Approach 1 also used a conservative estimate of vaccine effectiveness against mortality, using the previously reported estimate of 85% would have changed the number of deaths averted from 6,100 to 6,700. Early evidence suggests that vaccines also reduce transmission, therefore the figure of 6,100 deaths averted is likely to be an underestimation.

These findings provide further evidence that the COVID-19 vaccination programme is already having a significant impact on severe COVID-19 disease in England beyond the effect of the national lockdown. Furthermore, the true value of these vaccines may be in terms of future deaths we might now avoid if there is a resurgence of COVID-19 in the UK in the future.

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