



Public Health
England

Protecting and improving the nation's health

Direct and indirect impact of the vaccination programme on COVID-19 infections and mortality

Contents

Background.....	3
Methods and results.....	3
Acknowledgements.....	5
References.....	5

Background

Four coronavirus (COVID-19) vaccines have now been approved for use in the UK. Rigorous clinical trials have been undertaken to understand the immune response, safety profile and efficacy of these vaccines 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. PHE publish weekly reports looking at vaccine effectiveness and the impact of vaccination on the population (1).

Here we examine the direct and indirect impact of the vaccination programme on COVID-19 infections and mortality.

Methods and results

The PHE/Cambridge real-time model has been used to track the COVID-19 infection throughout the pandemic, providing key epidemic insights, including estimation of the reproduction number, R , to the Scientific Pandemic Influenza subgroup on Modelling (SPI-M) and to the Scientific Advisory Group on Emergencies (SAGE). The application to data from the first wave has been published in [Real-time nowcasting and forecasting of COVID-19 dynamics in England: the first wave](#) (2). Since the first wave, the model has been constantly improved to capture the pandemic activity as it develops, in particular to account for the impacts, both direct and indirect, of the vaccination programme. The direct impact of vaccination is the number of deaths saved in those that get infected, whereas the indirect effect incorporates the additional prevention of infections. The history of real-time modelling outputs can be found at [Nowcasting and Forecasting of the COVID-19 Pandemic](#) (3), with the most recent results on which the figures here are based is currently available at [COVID-19: nowcast and forecast](#) (4).

Vaccination rates in the model are based on the actual number of doses administered, and the vaccine is assumed to reduce susceptibility to COVID-19 as well as mortality once infected. Estimates for vaccine efficacy are based on the best available published results (5). To infer the impact of vaccination, the model was fitted to both ONS prevalence and daily COVID-19 mortality data in England, resulting in posterior samples for a range of epidemiological parameters. The posterior samples were then used to simulate the number of infections and deaths that would have occurred without vaccination ([Figure 1](#)). Finally, the total impact was calculated by comparing the infection and mortality estimates with vaccination versus the simulated outcomes without vaccination ([Figure 2](#); [Table 1](#)). The figures in [Table 1](#) are expected to continue to grow rapidly as the number of deaths in the no-vaccination scenario is still showing exponential growth.

The no-vaccination scenario assumes that no other interventions are implemented to reduce incidence and mortality. Therefore, the findings presented here should be interpreted as the

impact of the vaccination programme on infection and mortality assuming no additional non-pharmaceutical interventions were implemented. In practice it is impossible to predict what interventions would have been implemented in the absence of vaccination, although it is reasonable to assume that lockdown measures would have remained in place for substantially longer.

Figure 1. Inferred and predicted incidence, mortality and prevalence with and without vaccination in England

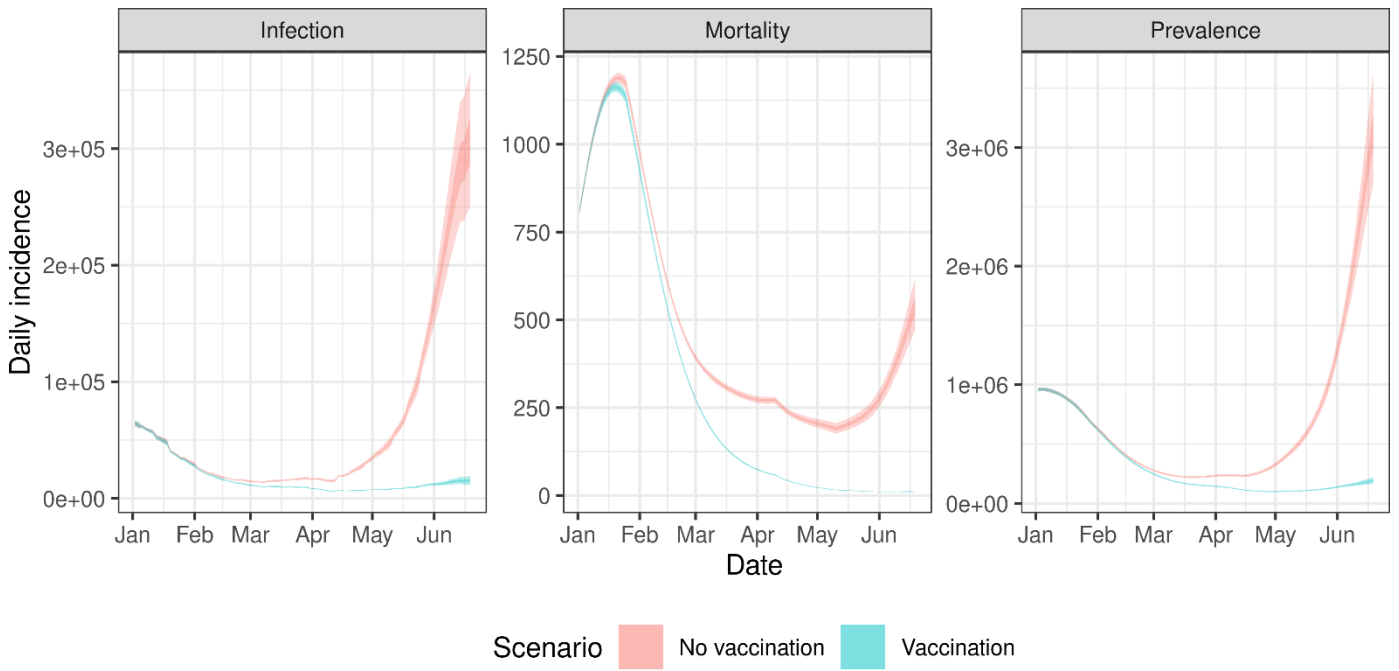


Figure 2. Averted number of infections (left) and deaths (right) due to vaccination (cumulatively)

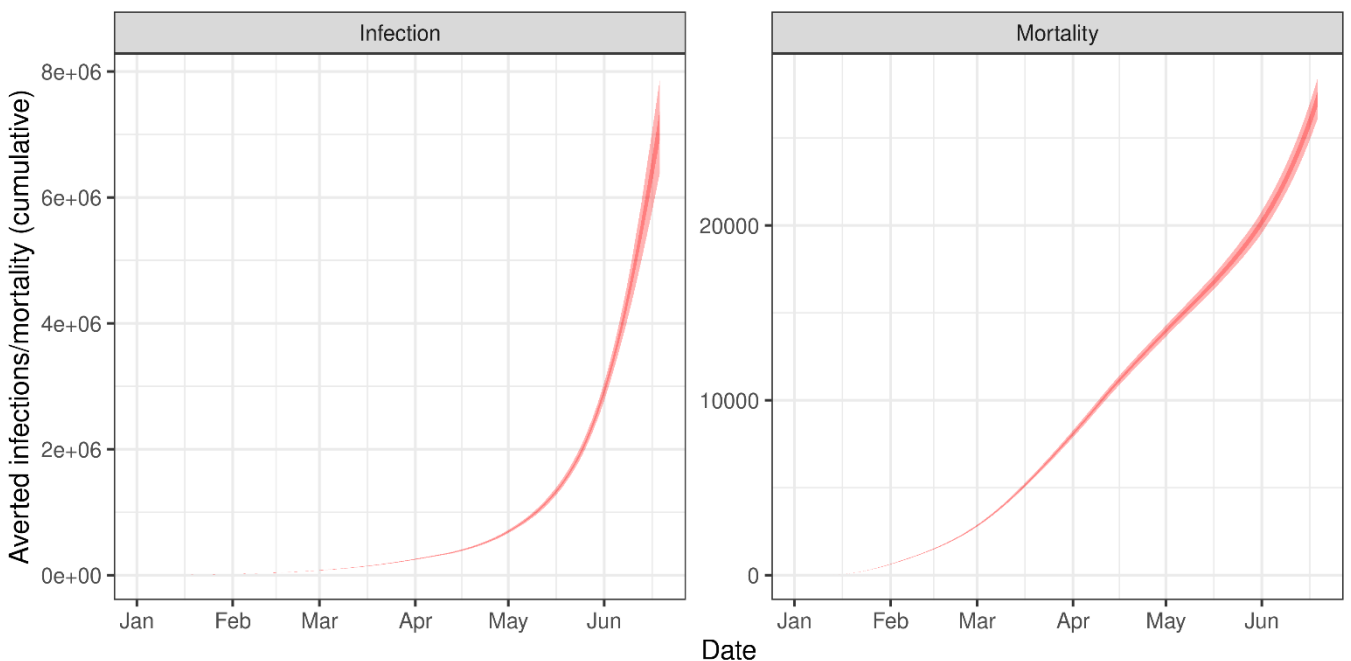


Table 1. Inferred reduction in infections and mortality as the result of vaccination up to 19 June 2021. (Infections are rounded to the nearest 1,000, deaths to the nearest 100.)

Model	Outcome	Reduction
ONS/Death	Infection	7151000 [6396000 , 7887000]
ONS/Death	Mortality	27200 [26100 , 28400]

Acknowledgements

The work presented in this report is joint work completed by PHE and Cambridge University's MRC Biostatistics Unit.

References

1. Public Health England. COVID-19 vaccine surveillance reports
2. Birrell Paul, Blake Joshua, van Leeuwen Edwin, Gent Nick and De Angelis Daniela (2021). 'Real-time nowcasting and forecasting of COVID-19 dynamics in England: the first wave' Philosophical Transactions of the Royal Society B 376: 20200279
3. MRC Biostatistics Unit. 'Nowcasting and Forecasting of the COVID-19 Pandemic'
4. Birrell, Paul, Joshua Blake, Edwin van Leeuwen, MRC Biostatistics Unit COVID-19 Working Group, Daniela De Angelis (2021) 'COVID-19: nowcast and forecast'. Published 25 June 2021
5. Public Health England (2021). COVID-19 vaccine surveillance report, Week 24

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-leading science, research, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

Public Health England
Wellington House
133-155 Waterloo Road
London SE1 8UG
Tel: 020 7654 8000

Website: www.gov.uk/phe

Twitter: [@PHE_uk](https://twitter.com/PHE_uk)

Facebook: www.facebook.com/PublicHealthEngland

© Crown copyright 2021

OGL

You may re-use this information (excluding logos) free of charge in any format or medium, under the terms of the Open Government Licence v3.0. To view this licence, visit [OGL](https://www.ogil.io). Where we have identified any third party copyright information you will need to obtain permission from the copyright holders concerned.

Published: 28 June 2021

PHE gateway number: GOV-8775



PHE supports the UN Sustainable Development Goals

