SUPPLEMENT - Report 43: Quantifying the impact of vaccine hesitancy in prolonging the need for Non-Pharmaceutical Interventions to control the COVID-19 pandemic

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Table S1: Parameter Descriptions and Values:

Parameter	Symbol	Value	Description
Epidemiological Parameters			
Transmission parameter	β	-	Calculated from R_0
Basic reproduction number	R_0	3.0	Estimated from European data consistent with a doubling time of 3.5 days[1].
Mean Latent Period	$\frac{1}{\alpha}$	4.6 days	Estimated at 5.1 day[2-4]. The last 0.5 days are incorporated in the infectious periods to capture pre-symptomatic infectivity
Mean Duration of Mild Infection	$\frac{1}{\gamma_1}$	2.1 days	Incorporates 0.5 days of infectiousness prior to symptoms. In combination with mean duration of severe illness this gives a mean serial interval of 6.75 days[5].
Mean Duration of Severe Infection Prior to Hospitalisation	$\frac{1}{\gamma_2}$	4.5 days	Mean onset-to-admission of 4 days[6]. Values in the wider literature range from 1.2 days to 12 days[2-4,7,8]. Includes 0.5 days of infectiousness prior to symptom onset.
Mean Duration of Hospitalisation for non-critical cases if survive	$\frac{1}{\gamma_{3,1}}$	9 days	Median of values identified in [7-11]
Mean Duration of Hospitalisation for non-critical cases if die	$\frac{1}{\gamma_{3,0}}$	9 days	Median of values identified in [7-11]
Mean Duration in ICU if survive	$\frac{1}{\gamma_{4,1}}$	14.8 days	Mean duration in ICU of 13.3 days from a study across 42 countries[12]. Ratio of duration in critical care if die: duration in critical care if survive of 0.75 and 60.1% probability of survival in ICU[13].
Mean Duration in ICU if die	$\frac{1}{\gamma_{4,0}}$	11.1 days	Mean duration in ICU of 13.3 days from a study across 42 countries[12]. Ratio of duration in critical care if die: duration in critical care if survive of 0.75 and 60.1% probability of survival in ICU[13].
Mean Duration in Recovery after ICU	$\frac{1}{\gamma_5}$	3.4 days	Working assumption
Mean duration of naturally acquired immunity	$\frac{1}{\rho}$	365 days	Assumed value based on published data of protection to reinfection. Protection is reported to last at least 8 months [14-16]
Infection fatality ratio (IFR)	$\mu(a)$	-	Age-dependent[17]
Hospitalisation rate	$\phi(a)$	-	Age-dependent[18] .
Vaccination parameters			
Vaccine efficacy against infection	$v_{inf}(a)$	94%; 63%	We assumed infection-blocking efficacy is the same as reported vaccine efficacy against clinical disease. Values were selected to cover the range of approved vaccines efficacies reported to date [19,20]
Vaccine efficacy against disease	$v_{dis}(a)$	60%	Estimate based on reported vaccine effectiveness data in the UK which suggests ~86% efficacy against hospitalisation/death compared to ~65% against mild disease for a single dose of the Pfizer vaccine [21,22]. The assumed value of 60% generates 98% efficacy against hospitalisation/death for the high efficacy vaccines and 85% for the moderate efficacy vaccine, with both representing two dose schedules.

Vaccine duration of protection	$1/\varphi$	Lifelong	Assumption. No data currently available but estimates from MERS vaccines suggest durability of at least 1 year[23].
Age-dependent rate of vaccination	$\kappa(a)$	-	Population-dependent: set such that number of people vaccinated per day in each age group achieves target coverage by the end of the vaccination period
Mean time to develop vaccine-acquired immunity following second dose	$1/\omega$	7 days	Based on immunogenicity data from Phase II trials in which antibody titres plateau ~7 days post dose 2 [23-27]
Vaccine schedule		21 days	2 doses modelled 21 days apart[19,20,28,29]. Efficacy follows 2nd dose (so only modelling final dose of any vaccine schedule)
Age-targeting of vaccination		Individuals over 15 years old are targeted	Vaccination is targeted prioritising elderly age groups

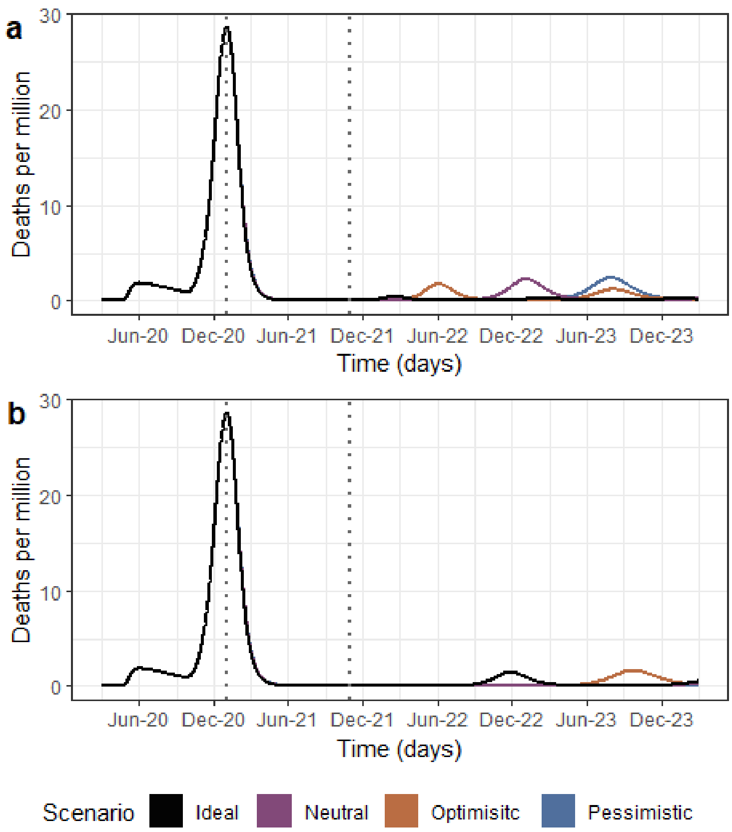

Figure S1 - COVID-19 dynamics for different reproductive number profiles. Profiles were estimated for each vaccine hesitancy scenario in order to achieve herd immunity (R_{eff} =1) and control the pandemic. **a)** Daily projected deaths per million for a high vaccine efficacy. **b)** Daily projected deaths per million for a moderate vaccine efficacy. Black line shows an ideal scenario without vaccine hesitancy and 98% of individuals above 15 years old, are vaccinated. Orange shows an optimistic scenario with low vaccine hesitancy, purple shows a neutral scenario and blue line shows a pessimistic scenario with high vaccine hesitancy. In each scenario, vaccination coverage per age group varies according to vaccine hesitancy.

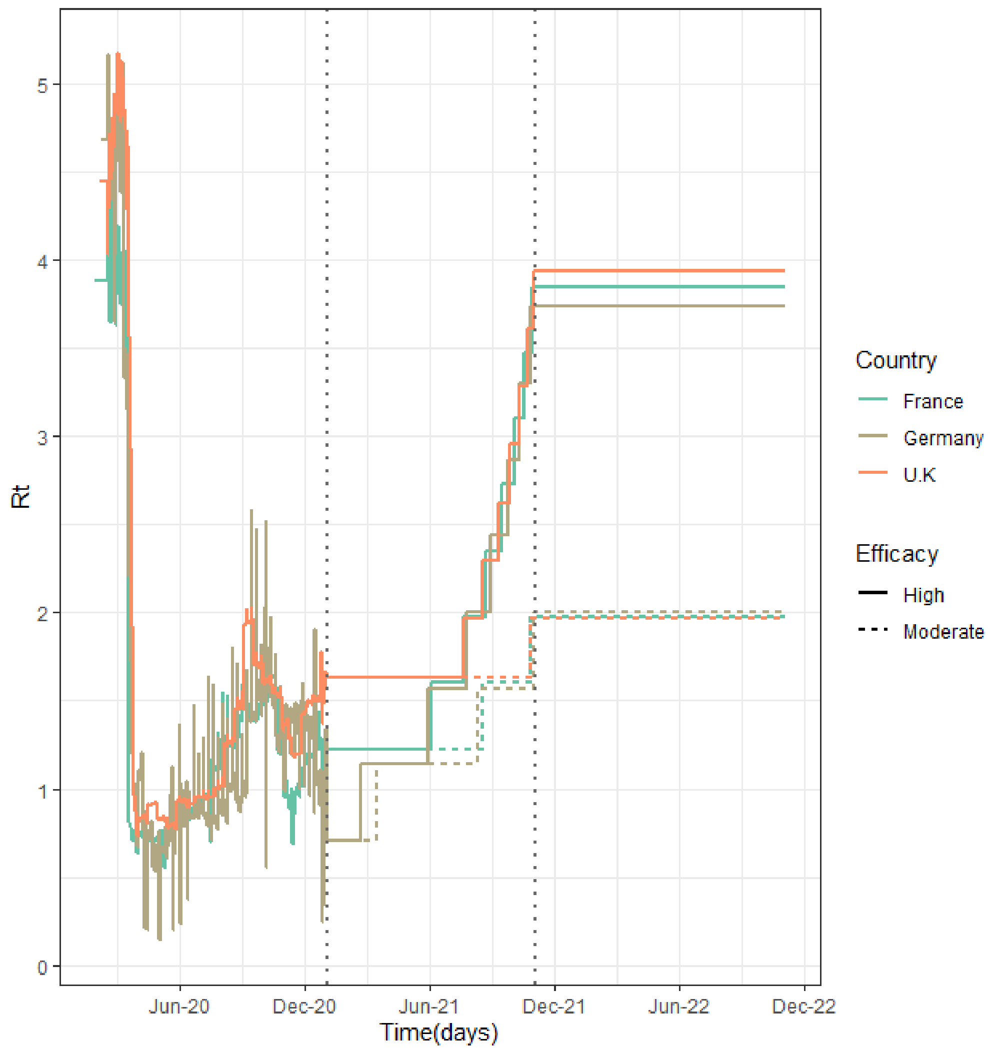

Figure S2 - Reproductive number profile for country specific simulations. Profiles, before vaccination begins, are taken from model fittings to country-specific data (https://mrc-ide.github.io/global-lmic-reports/). After vaccination starts, NPIs are lifted based on an ideal vaccination coverage over time. Reproductive number is set to increase in ten steps from the value at the beginning of vaccination to an average initial reproductive number. Continuous lines show profiles for a high efficacy vaccine. Dotted lines show profiles for a moderate efficacy vaccine.

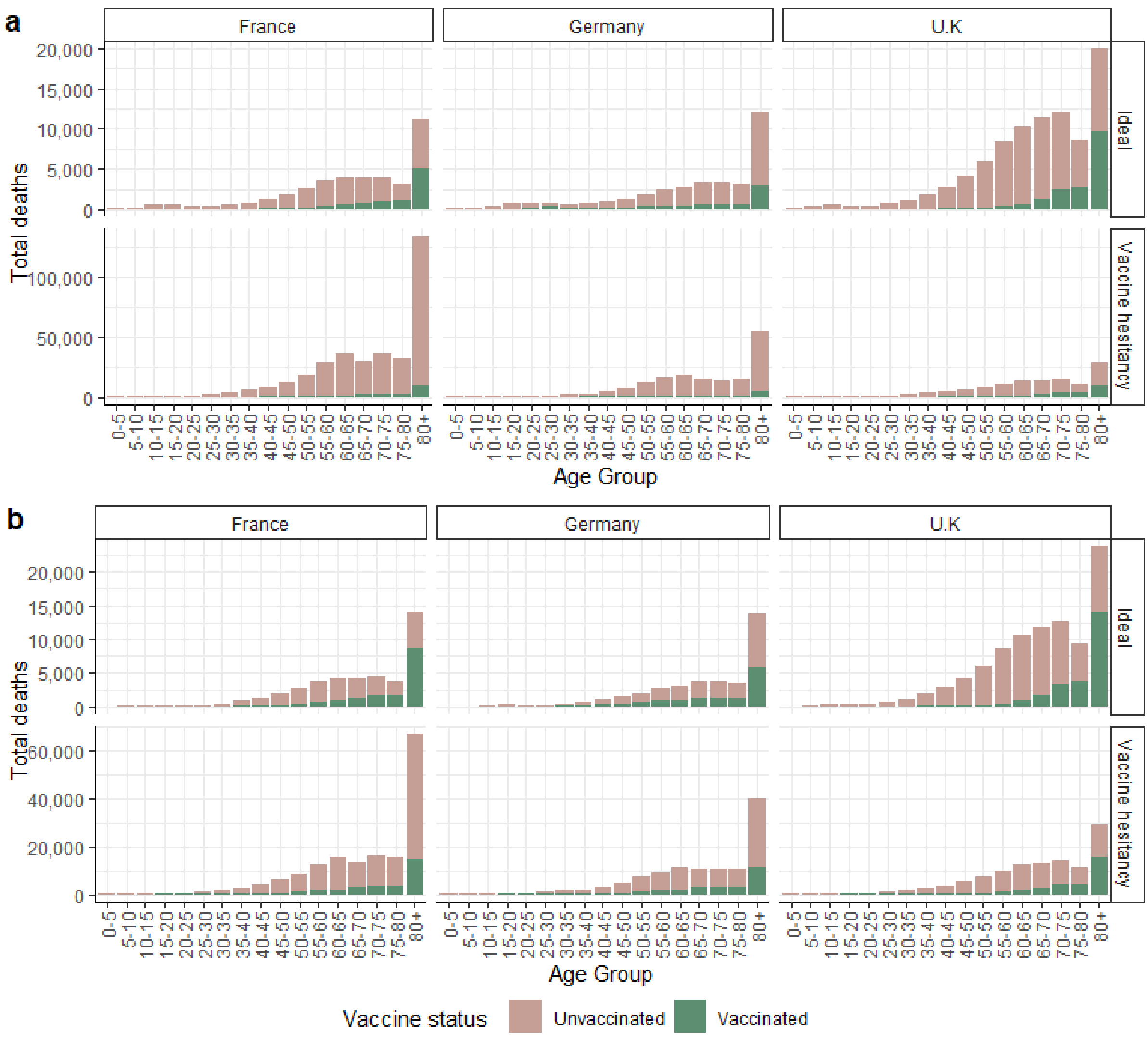

Figure S3 - Projected deaths per age group for each country. **a)** Total deaths for a vaccine with high efficacy. **b)** Total deaths for a vaccine for moderate efficacy. Values are shown for the vaccinated and unvaccinated populations. Two scenarios are presented: An ideal scenario, where 98% of the population older than 15 years old is vaccinated, and a vaccine hesitancy scenario, where coverage for people over 15 years old is based on vaccine acceptance in each country. Total deaths are estimated over a two-year period since vaccination starts.

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