

Title: Impact of population mask wearing on Covid-19 post lockdown

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COVID-19, caused by SARS-CoV2 is a rapidly spreading global pandemic. Although precise transmission routes and dynamics are unknown, SARS-CoV2 is thought primarily to spread via contagious respiratory droplets¹. Unlike with SARS-CoV, maximal viral shedding occurs in the early phase of illness¹, and this is supported by models that suggest 40-80% of transmission events occur from pre- and asymptomatic individuals^{2,3}. One widely-discussed strategy to limit transmission of SARS-CoV2, particularly from presymptomatic individuals, has been population-level wearing of masks. Modelling for pandemic influenza suggests some benefit in reducing total numbers infected with even 50% mask-use⁴. COVID-19 has a higher hospitalization and mortality rate than influenza⁵, and the impacts on these parameters, and critically, at what point in the pandemic trajectory mask-use might exert maximal benefit are completely unknown.

We derived a simplified SIR model to investigate the effects of near-universal mask-use on COVID-19 assuming 8 or 16% mask efficacy (Supplementary information for relevant parameters and references). We decided to model, in particular, the impact of masks on numbers of critically-ill patients and cumulative mortality, since these are parameters that are likely to have the most severe consequences in the COVID-19 pandemic. Whereas mask use had a relatively minor benefit on critical-care and mortality rates when transmissibility (R_{eff}) was high (Fig. 1a), the reduction on deaths was dramatic as the effective R approached 1 (Fig. 1b), as might be expected after aggressive social-distancing measures such as wide-spread lockdowns⁵. One major concern with COVID-19 is its potential to overwhelm healthcare infrastructures, even in resource-rich settings, with one third of hospitalized patients requiring critical-care. We incorporated this into our model, increasing death rates for when critical-care resources have been exhausted (Fig. 1c). Our simple model shows that modest efficacy of masks could avert substantial mortality in this scenario. Importantly, the effects on mortality became hyper-sensitive to mask-wearing as the effective R approaches 1, i.e. near the tipping point of when the infection trajectory is expected to revert to exponential growth, as would be expected after effective lockdown.

In order to understand the generality of the effect of mask wearing upon home confinement removal, we also analysed the potential effects of mask-wearing for data provided by a more comprehensive and realistic model of the COVID-19 infection, which included modelling of different levels of social-distancing measures on infection and likely deaths⁵. When home-confinement is lifted but other social-distancing measures are in place, such as school closure and case isolation, wearing masks can maintain the benefits of home-confinement, both in terms of deaths (Fig. 1d) and critical-care bed use (Fig. 1e).

Limitations of our study include the relatively straightforward model we employed, as well as assumptions of high compliance with mask-wearing and their potential efficacy, for which definitive evidence in pandemics is lacking⁶. Despite these limitations, our model suggests that mask-wearing might exert maximal benefit as nations plan their ‘post-lockdown’ strategies and suggests that mask-wearing should be included in further more sophisticated models of the current pandemic. Since otherwise similar countries are currently devising different mask-wearing scenarios, the current situation offers an unprecedented opportunity to gather evidence on the real-world utility of population mask-wearing for implementation in this and future pandemics.

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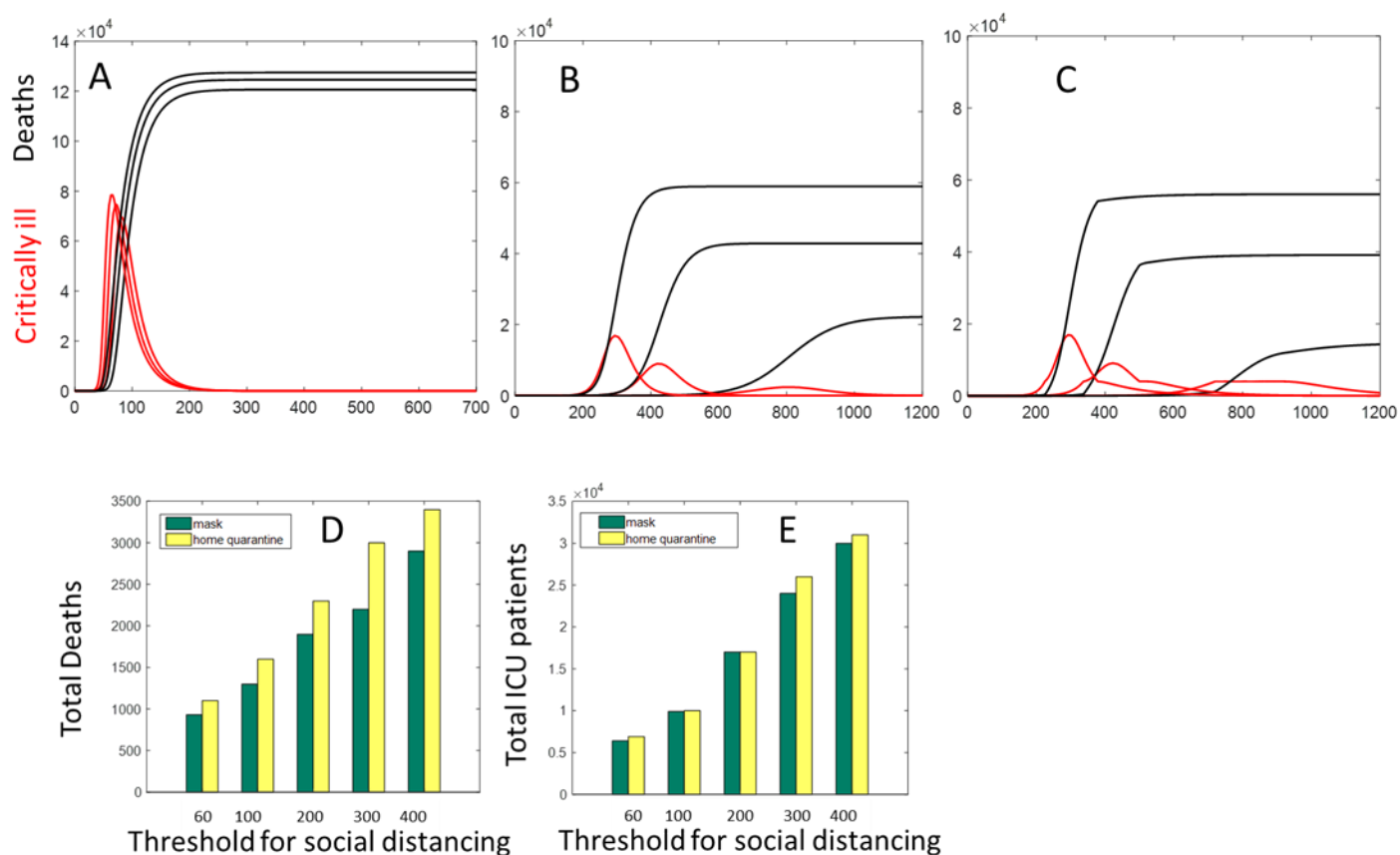


Figure 1. Mask effectiveness on mortality varies by R_{eff} (A) Number of critically ill patients (red) and total deaths (black) for an epidemic spreading with R_0 of 2.2 (see Supplementary information for parameters) in a simple SIR model, x-axis represents time in days. The different curves are computed for a reduction of infectivity of 0, 8 and 16%. (B) Same as A, but for an epidemic spreading with R_0 of 1.3. Note that the reduction in infectivity by mask wearing has a larger effect. (C) Same as B but taking into account increase in death when beds are unavailable for critically-ill patients. (D-E) Analysis of the data of Ferguson *et al* (ref 5, Table 4). Assuming a 10% reduction in infectivity, mask wearing may be at least as effective as home confinement at reducing deaths (D) or preventing overwhelming icu beds (E). The different bars (1-5) are different thresholds (“triggers”) for implementing social measures in the Ferguson *et al* model.