Modelling the impact of the mandatory use of face coverings on public transport and in retail outlets in the UK on COVID-19-related infections, hospital admissions and mortality

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Abstract

Introduction The rapid spread of the pandemic caused by the severe acute respiratory syndrome coronavirus 2(SARS-CoV-2)(COVID-19) virus resulted in governments around the world instigating a range of measures, including mandating the wearing of face coverings on public transport/in retail outlets. Methods We developed a sequential assessment of risk reduction provided by face coverings using a step-by-step approach. The United Kingdom Office of National Statistics(ONS) Population Survey data was utilised to determine the baseline total number of community-derived infections. These were linked to reported hospital admissions/hospital deaths to create case admission risk ratio/admission-related fatality rate. Results Overall, we show that only 7.3% of all community-based infection risk associates with public transport/retail outlets. The reported weekly community infection rate was 29,400 new cases at the start (24th July). The rate of growth in hospital admissions and deaths for England was around -15%/week, suggesting the infection rate, R, in the most vulnerable populations was just above 0.8. In this situation, average infections over the evaluated 13week follow-up period was 9,517/week. With face covering of 40% effectiveness, this reduced average infections by 844/week, hospital admissions by 8/week and deaths by 0.6/week; a fall of 9% over the period total. If, however, the R-value rises to 1.0, then average community infections would stay at 29,400/week and face coverings could reduce average weekly infections by 3,930, hospital admissions by 36 and deaths by 2.9/week; a 13% reduction. These reductions should be seen in the context of 102,000/week all-cause hospital emergency admissions in England and 8,900 reported deaths in the week ending 7thAugust 2020. Conclusion We have illustrated that the policy on mandation of face coverings in retail outlets/on public transport may have limited value in reducing hospital admissions/deaths. Impact appears small compared to all other sources of risk, thereby raising questions regarding effectiveness of the policy.

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ABSTRACT

Introduction

The rapid spread of the pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2/)(COVID-19) virus resulted in governments around the world instigating a range of measures, including mandating the wearing of face coverings on public transport/in retail outlets.

Methods

We developed a sequential assessment of the risk reduction provided by face coverings using a step-by-step approach. The United Kingdom Office of National Statistics (ONS) Population Survey data was utilised to determine the baseline total number of community-derived infections. These were linked to reported hospital admissions/hospital deaths to create case admission risk ratio and admission-related fatality rate. We evaluated published evidence to establish an infection risk reduction for face coverings. We calculated an Infection Risk Score (IRS) for a number of common activities and related it to the effectiveness of reducing infection and its consequences, with a face covering, and evaluated their effect when applied to different infection rates over 3 months from 24^{th} July 2020, when face coverings were made compulsory in England on public transport/retail outlets.

Results

We show that only 7.3% of all community-based infection risk is associated with public transport/retail outlets. In the week of 24^{th} July, The reported weekly community infection rate was 29,400 new cases at the start (24th July). The rate of growth in hospital admissions and deaths for England was around -15%/week, suggesting the infection rate, R, in the most vulnerable populations was just above 0.8. In this situation, average infections over the evaluated 13 week follow-up period, was 9,517/week with face covering of 40% effectiveness, this reduced average infections by 844/week, hospital admissions by 8/week and deaths by 0.6/week; a fall of 9% over the period total. If, however, the R-value rises to 1.0, then average community infections would have stayed at 29,400/week and mandatory face coverings could reduce average weekly infections by 3,930, hospital admissions by 36 and deaths by 2.9/week; a 13% reduction.

These reductions should be seen in the context that there was an average of 102,000/week all-cause hospital emergency admissions in England in June and 8,900 total reported deaths in the week ending 7th August 2020.

Conclusion

We have illustrated that the policy on mandatory use of face coverings in retail outlets/on public transport may have been very well followed, but may be of limited value in reducing hospital admissions and deaths, at least at the time that it was introduced, unless infections begin to rise faster than currently seen. The impact appears small compared to all other sources of risk, thereby raising questions regarding the effectiveness of the policy.

What is already known about this topic?

The rapid spread of the pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (COVID-19) virus has resulted in governments around the world instigating a range of measures to limit spread and facilitate economical recovery.

One of these measures, adopted by several countries, includes the use of face coverings in enclosed spaces were social distancing is not possible, including public transport.

What does this article add?

Around 7% of all community-based infection risk is associated with public transport and retail outlets.

This contrasts with 57% associated with work or study, for those aged 16 years and over.

The benefits of public wearing of face masks compared to all other sources of risk, needs continually to be evaluated. Wearing of face masks in the work place may be more effective.

Introduction

The international coronavirus disease (COVID-19) pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus has resulted in governments around the world instigating a range of measures to limit spread and facilitate economical recovery. One of these measures, adopted by several countries, includes the use of face coverings in enclosed spaces were social distancing is not possible.

In the United Kingdom (UK), after initially suggesting that face coverings were not necessary, the UK government introduced mandatory use of face coverings on public transport on the 15th June 2020, and in retail outlets on the 24th July 2020.[1] This was aimed at offsetting some of the additional infection risks being taken by reduced social distancing from 2 metres to '1 metre plus', thereby facilitating easing of restrictions and supporting plans to stimulate the economy, particularly in the hard-hit retail sector. One of the drivers to the implementation of this policy was the review published by the Royal Society of Medicine and the British Academy which stated that 'cloth face coverings are effective in reducing source virus transmission, i.e., outward protection of others, when they are of optimal material and construction (high-grade cotton, hybrid and multilayer) and fitted correctly and for source protection of the wearer' [2]

UK government guidance at the time stated that; '*The best available scientific evidence is that, when used correctly, wearing a face-covering may reduce the spread of coronavirus droplets in certain circumstances, helping to protect others'.* [1] This statement is undoubtedly true. However, the real-world impact of the use of face-covering on public transport and in retail outlets in the UK has received little attention. At the time of writing this article, there are no data to assess this objectively.

While data is emerging from other countries on the impact of precautionary measures, including the use of face coverings, these address the issue from a range of perspectives. For example, Hseih et al attempted to estimate the impact by examining the co-incidence of mass mask use and influenza infections.[3] However, it is difficult to determine whether the take-up of face coverings wearing was responsible for the observed changes. Chu et al performed a systematic review and meta-analysis of 172 observational studies across 16 countries and six continents, on three precautionary measures, including the use of face coverings .[4] They suggested that face masks have value in reducing the spread of infection. However, in the assessment of face masks, the majority of studies were in healthcare settings; only three (n=725; examining the SARS virus in China and Vietnam) were from non-healthcare settings, where wearing face masks was associated with a lower risk of infection (relative risk 0·56, 95% CI 0·40 to 0·79). The American College of Physicians also raises questions around the evidence to support the effectiveness of face coverings in reducing transmission.[5]

While there is a debate about the effectiveness of face coverings in terms of the spread of infections, there is also an argument that such analysis should also assess the wider consequences, including economic and mental health-associated effects. To our knowledge, there is no published data on the economic impact of the use of face coverings in the UK, though Goldman Sachs estimated that introducing national mandatory use of face coverings could potentially prevent additional restrictions that would otherwise cost around 5% of US GDP.[6] Furthermore a recent short review by Tian et al[7] found that, in relation to face coverings, the evidence indicates that a higher-level specification of face masks are essential to protect health care workers from COVID-19 infection and that community face coverings in the case of well individuals could be beneficial in certain circumstances, where transmission may be pre-symptomatic.

In terms of mental health, while it may be argued that, irrespective of the actual effectiveness, the mandating of use of face coverings in enclosed spaces provides a measure of reassurance to the wearer, there are potentially wider mental health implications which make a thorough assessment critical, particularly at a time when mental well-being is being stretched to the limits.[8,9,10] Wearing of face coverings may provide a degree of short-term reassurance to people with some types of mental health challenge,[11] whilst others may perceive the increased use of face coverings as heightening their sense of threat and insecurity.[12]

Given the potential physical, social, economic and mental implications of implementing this policy, we sought to model its potential impact. Using available data, we examined the number of infections, hospital admissions and hospital deaths potentially prevented by the use of face coverings in retail outlets and on public transport.

Methods

Baseline data on community infections

We developed a sequential assessment of the risk reduction provided by face coverings using a step-by-step approach. As a baseline, we utilised the Office of National Statistics (ONS) Population Survey data to determine the baseline total number of community-derived infections.[13]The ONS Population Survey released on the 24th July 2020[13] provided data that estimated, for the most recent week for which data was available (13 to 19 July 2020). This excluded those in hospitals, care homes or other institutional settings (but not those who work in these settings). This baseline figure of 2,800 cases per day is used in subsequent modelling.

Step 1: Source of infection.

We considered the impact on the number of infections within the community rather than in hospitals or care homes, as these are where people using retail and public transport will be most reflected. There will be some cross infections but the level of this is beyond the scope of this analysis but is likely to be small.

Given that it is unlikely that people displaying more severe symptoms of infection would use public transport or visit retail outlets, we then utilised ONS and wider literature data to estimate the proportion of asymptomatic or pre-symptomatic cases.

The ONS data suggests that only around one-third of individuals testing positive for COVID-19 on a swab test reported having symptoms.[14] This was based on self-reported symptoms and therefore may be an underestimate. According to Diana et al, transmission by pre-symptomatic people accounts for around 40-60% of transmissions and asymptomatic cases accounts for around 15% of transmissions, indicating that between 55 and 75% of infections may be derived from people without symptoms.[15] While posted on the preprint service website, medRxiv, early in the pandemic, these data were reviewed and assessed by the Centre for Evidence-Based Medicine on 23rd July 2020.[16]According to Yin and Jin, there is no difference in transmissibility between those with and without symptoms.[17] For the modelling, we used a conservative estimate of 80% of infections from pre- or asymptomatic cases.

Step 2: Infection risk by activity.

We calculated an Infection Risk Score (IRS) for a number of common activities. Firstly, based on location, we categorised daily activities into the following: home, work, public transport, retail outlets, other activities (indoors) and, other activities (outside). We calculated the average length of time spent per day on each of these activities. This was based on the United Kingdom Time Use Survey, 2014-2015,[18] as quoted in a Scottish government report,[19] and a Resolution Foundation report in July 2020.[20] This describes average minutes per day spent by those aged 16 years and over on the following activities: (a) Paid work, (b) Unpaid work (sub-divided into housework; shopping, services and household management; childcare; travel; construction and repairs; and voluntary work), (c) Study and (d) Leisure: (sub-divided into TV and other leisure; social life, culture and entertainment; and sports and outdoor leisure). Each of these categories was assigned to one of the groups listed in Table 1, with 8 hours allocated to sleep (based on the Resolution Foundation report,[20] which quotes the United Kingdom Time Use Survey as assigning 8.5 hours to sleep for the 18-64 age group). For the modelling, we assumed that 50% of all travel time was using public transport and that the category defined in the United Kingdom Time Use Survey as 'shopping, services and household management' comprised 50% of time allocated to various forms of shopping, including for groceries, clothing and that undertaken for leisure. We realise that these are likely to be overestimated but elected to take a conservative approach.

Each activity was then assigned a risk of infection. This was based on a risk stratification approach used by the Texas Medical Association,[21] which was then sense-checked using ONS data which allows assessment of the infection risk associated with working from home versus working in other environments.[22][23]

These two components were combined to calculate the activity IRS, this was then summed. The % of this total allowed us to assess the percentage contributions to the risk associated with each activity, all other aspects assumed being equal..

We elected to use conservative over-estimates of the IRS associated with transport/retail activities. It should be noted that having to wear face coverings may inhibit frivolous or spontaneous travel and shopping activities, and hence the proportion of time spent on these activities following the implementation of the mandatory policy may decrease, at least after an initial surge following the easing of restrictions.

Step 3: Impact of the use of face coverings.

The effectiveness of face coverings in reducing infections will be dependent on two broad factors: (i) the proportion of infections that are due to aerosols and other airborne routes of transmission and, (ii) the efficacy of face coverings of reducing the spread of such airborne-associated infections. Neither of these is likely to be 100%.

Face coverings are unlikely to be effective in mitigating against all transmission routes. The World Health Organisation (WHO) published a detailed assessment of routes of transmission.[24] The European Centre for Disease Prevention and Control states that infection is understood to be mainly transmitted via large respiratory droplets.[25] However, the proportion of infections caused by airborne or other routes that could be prevented by face coverings, while less than 100%, is difficult to quantify. Indeed, 80% might be considered a conservative estimate.

Furthermore, the efficiency of face coverings in regard to preventing airborne transmission is likely to be highly variable,[26] not least due to the wide range of types of face coverings used (from scarves to surgical-grade masks), and their correct usage (as emphasised in UK government guidance[1]). Indeed, laboratory-based experimental data from van der Sande et al suggests that home-made face coverings offered around 29-78% protection against aerosol transmission over short periods, while surgical masks provided 50-91% protection.[26] Efficiency in population settings, and in cases of prolonged contact, is likely to be lower and more variable than these estimates. However, on the other hand, if two people who come into close contact are both wearing face coverings, infection risk is likely to be further reduced.

Combined, the reduction in infection risk associated with the use of face coverings were modelled as using a range of values covering estimates (20%, 40%, 60% and 80%) as example scenarios.

Assessment of the impact of the use of face coverings on infections, hospital admissions and deaths.

Using this stepped approach, we assessed the potential impact of face coverings on (a) number of current and consequent future infections, (b) number of hospital admissions and (c) number of hospital deaths.

The ONS Coronavirus (COVID-19) Infection Survey pilot[11] reported the modelled daily incidence infection rate for each week based on exploratory modelling. At the time of writing, the modelling used to calculate the incidence rate was a Bayesian model and used all swab test results to estimate the incidence rate of new infections for each different type of respondent who tested negative when they first joined the study. This can be multiplied by 7 to give an expected total number of new community infections each week from all sources. The number reported in the week before the imposition of face coverings on the 24th July 2020 was taken as the baseline for this study

NHS England [27] reported daily hospital COVID-19 admission data which included all people admitted to hospital who already had a confirmed COVID-19 status at the point of admission and those who tested positive in hospital after admission. Inpatients diagnosed with COVID-19 after admission were reported as being admitted on the day before their diagnosis. Admissions included data from all NHS acute hospitals and mental health and learning disability trusts, as well as independent service providers commissioned by the NHS. It was assumed that patients would be admitted 7 days after their original infection and so a ratio of hospital admission to the previous week's number of infections enabled us to calculate an infections admission rate (IAR). However, in these admitted patients, infections might have occurred within either the community, care homes or hospital so we conservatively assumed that 50% of this infection hospitalisation rate occurred within the community.

NHS England, [28] also reported daily the deaths of patients who had died in hospitals and had either tested positive for COVID-19 or where COVID-19 was mentioned on the death certificate. All deaths were recorded against the date of death. In our analysis, the length of stay in hospital before death was assumed to be 2 weeks so the ratio of total deaths to the total admissions 2 weeks previously give an estimate of hospital admissions fatality rate (AFR). We conservatively assume that the AFR from community admissions are similar to those from care homes and hospital infections.

The benefit of any mitigation measure was assessed not only as those avoided directly but also those consequent future infections. We estimated this based on the re-infection rate (R-value) and re-infection cycle time, over a defined period (three months). We utilised three months as, by the end of this period, the situational outlook would likely be reviewed. European Centre for Disease Prevention and Control[24] report viral RNA shedding peaking in the second week after infection so a conservative re-infection cycle time of 8 days was applied from 24th July 2020. At this time, the UK Government reported an R-value range for the UK of 0.7-0.9 and a growth rate was given as -4% to -1% as of 24th July 2020.[25] Consequently, three R values; namely 0.8 (the accepted level at the time of the introduction of mandatory face coverings), 1.0 (a worsening to equilibrium) and 1.2 (the pandemic restarting) were used in our analysis. For each of these, we calculated the total number of consequent future infections that could be expected to flow from the original infections.

Baseline effectiveness of face coverings and the IRS calculated above for retail outlets and public transport was applied to each scenario to calculate the expected infections, hospitalisations and deaths over the next 3 months. The sensitivity of the results to the assumptions on face-covering effectiveness was tested by calculation the above for no face coverings (0%), 20%, 40%, 60% and 80%.

Results

Baseline data & proportion of pre-symptomatic and asymptomatic cases.

Based on the ONS survey data, we modelled the impact of face coverings based on 2,800 community cases per day. Of these, 80% are estimated to be due to transmission from pre-symptomatic and asymptomatic cases. These generate a baseline figure for assessment of the impact of face coverings of 2,240 community cases.

Infection risk by activity.

Table 1 shows the calculated IRS for each of the 6 common activities. This shows that around 7.3% (4.3/58.9) of all community-based risk of infection is associated with public transport and retail outlets (4.0% for public transport and 3.3% for retail outlets). Hence, any measure to reduce infections within these sectors will have a relatively minor impact. In contrast, 57.1% of the risk was associated with paid work and 28.3% with activities carried out at home.

Impact of face coverings on Infection Risk Score

We then assessed the impact of the use of face coverings in retail outlets and on public transport on the overall IRS, using the four different degrees of effectivenesses of face coverings in reducing transmission, namely 20%, 40%, 60% and 80%. Table 1 shows that risk score reduced from 58.9 to 58.0 (1.5% reduction in overall risk) for a face covering-associated efficacy of 20%, to 57.2 (2.9% reduction in overall risk) for an efficacy of 40%, to 56.3 (4.4% reduction in overall risk) for an efficacy of 60%, and to 55.5 (5.8% reduction in overall risk) for an efficacy of 80%. A surgical mask, as used in hospitals, with an efficacy of over 90% would only reduce overall risk by 6.6% up to the maximum 7.3%.

Impact on current and future infection

At the start of the period beginning 24th July 2020, the ONS community survey reported a daily incidence of 0.78/10,000 (0.4-1.49); equivalent to 4,200 new community infections each day. The latest ONS community incidence report at the time of writing was 0.44 (at 7th August 2020). This is the equivalent to a fall of 14%/week. Hospital admissions and deaths are falling at similar rates. This all suggests that the underlying R-value in the population was just above 0.8.

In the 4 weeks prior to the 13th August 2020, the community infection admission rate, including an assumed 50% from community infections, would then be 0.9%. The admission fatality rate during the same period was found to be 8.2%.

Figure 1a shows graphically the impact of the different assumed R-value (0.8, 1.0, 1.2) on the infection outcomes over the 13 weeks and the potential cumulative numbers for both with or without face coverings for the 3 levels of R then on infections (Figure 1b), community hospitalisation (Figure 1c) and deaths (Figure 1d). We show, for each of the assigned R-value, the impact of wearing face coverings in public transport and retail environments on new infections/week, cumulate deaths, hospital admissions and cumulative infections.

This showed, based on 4,200 new community infections/day (29,400/week), and R-value of 0.8 (both derived from ONS data from the time of introduction of mandatory face coverings at the end of July 2020) and a 40% effectiveness of face coverings, that the number of direct and indirect infections associated with public transport and retail outlets over the 3 months would be reduced from 124,000 by 11,000; a reduction of 9%.

If the infection rate was to increase to and stayed at, 1.0 then weekly infections would remain at 29,400 (or 382,200 over 3 months). A 40% effective face covering worn in public transport and retail could reduce the 3 month total by 51,000 or 13%.

Impact on hospital admissions and death rates

Supplementary Table 1 showed that, based on data from the ONS and NHS England, that the average rate of hospitalisation (reduced by 50% to remove hospital and care home admissions, as justified in the Methods section) over the previous week was 0.9% of community infections. Deaths in hospital, when linked to hospital admissions recorded over the prior 2 weeks, were found to be 8.2% of these admissions.

When the R-value was 0.8, with face-covering effectiveness at 40%, average community hospital admissions fell from 86/week to 78/week and community infected hospital deaths fell from 7.0/week to 6.4/week (Table 2).

If R rose and stayed at 1.0, then expected average community-derived hospital admissions would be 265/week and 40% effective face coverings would reduce this by 36/week and reduce possible expected hospital deaths from 22/week to 19/week (Table 2).

The above findings can be put into the context that the ONS[30] reported 93% of adults had worn face coverings when shopping in the seven days to 21st August 2020. Furthermore, NHS England[31] reported that there were 102,000/week all-cause hospital emergency admissions in England in June 2020 down 27% on the previous year and there were a total of 8,900 reported deaths by the ONS[32,33] in the week ending 7th August of which 3,430 occurred in hospitals.

Discussion

We have modelled the potential impact of the use of face coverings worn in retail outlets and on public transport on the number of UK COVID-19 infections and associated hospital admissions and mortality rates. Overall, we demonstrated that only around 7% of all community-based infection risk for those aged more than 16 years of age is associated with public transport and retail outlets. This contrasts with 57%

associated with work or study, for those aged 16 years and over. This illustrates the limitations of the impact of any policy to reduce infections in the public transport and retail outlets sectors alone, irrespective of the efficiency of the intervention. It perhaps suggests that measures targeted at the workplace may be more worthwhile.

In addition to this, the requirement to wear face coverings may increase anxiety in some people and thereby result in a reluctance to utilise public transport and/or visit retail outlets. This may, therefore, reduce the time spent on these activities. While it is also possible that the use of face coverings may increase the confidence of other people, it is difficult to say whether this will negate the above effect. Certainly, public transport usage and retail footfall does not appear to have returned to pre-pandemic levels,[27,28] and hence the 7.3% may be an overestimate of the contribution of these activities to overall risk. However, in our modelling, given the difficulty in calculating this impact, we assumed this change in behaviour to be neutral.

For the determination of the impact of face coverings on reduction in infections, we used a range of R values to allow estimation of the potential change in the impact of face coverings in different phases of the pandemic that are relevant at this stage. The impact of any mitigation measure will have a more significant impact, at least in terms of overall numbers, the higher the R-value. We showed that, with an R-value of 0.8, with face covering of 40% effectiveness, average infections would be reduced by 844/week, hospital admissions by 8/week and deaths by 0.6/week; a fall of 9% over the period total. If, however, the R-value rises to 1.0, then average community infections would stay at 29,400/week and face coverings could reduce average weekly infections by 3,930, hospital admissions by 36/week and deaths by 2.9/week; a 13% reduction.

These reductions should be seen in the context of the reality that 93% of adults had worn face coverings when shopping in the seven days to 21 August 2020 [30] .These figures should be viewed with the perspective that there were a total of 437,500 emergency admissions reported [31] in June 2020, 17.3% lower than the same month last year and that all-cause deaths at the start of August 2020 were reported[32,33,34,35] at 1,270/day, of which 490 occurred in hospital.

This raises interesting questions around the timing of the implementation of the policies to mandate the use of face coverings in the retail and transport contexts; a time when the R-value was less than one (most UK government reports suggested 0.7-0.9) and the daily infection rate was relatively low in comparison to the peak in April 2020.[29] Use of face coverings in retail outlets and on public transport is of limited value, particularly when the R-value is below 1, in contrast to March/April 2020 when the R-value was much higher.

We also used a range of efficiencies of face coverings, reflecting the wide range of types of coverings,[1] variability in correct usage (particularly over prolonged periods) and uncertainty around which modes of transmission could be influenced by their use.[21] Realistically, an estimate of around 40% is likely to be a sensible conservative estimate, particularly in the context of the work by van der Sande et al.[23] Under this assumption, the modelling showed that, if the R-value was 0.8, the hospital deaths avoided would be less than 0.1/day and if, in the extreme case that R-value rose and stayed at 1.2, this could rise to 2 deaths/day avoided.

This study shows that face coverings, even when appropriate materials are used, and handling and wearing are fully compliant, can only generate limited benefits when used at low reinfection rates. By preventing potential future infections, they may play a more important role at times when reinfection rates are high.

Given our findings, we suggest that guidance on the potential usefulness of face coverings might benefit from greater clarity of guidance that is better targeted to those most likely to benefit, and in activities where the impact is likely to be larger. For example, the availability of more effective, surgical standard face masks (with clear guidance on correct use) for those more vulnerable to serious consequences of infection, and in contexts where they are at greater risk (such as in the workplace) might be of greater impact in terms of reduction in hospital admissions and deaths.

This approach might also minimise the mental health consequences of widespread use of face coverings[36], including by sending a more reassuring and realistic message to the population around risk. It may also encourage economic activity both in terms of high street spending and return to work.

Finally, these findings in no way relate to the use of approved face coverings in the care of vulnerable, frail and older individuals in the care home, hospital or primary care setting.

Strengths and Limitations

We recognise that such modelling is based on a range of assumptions. To address this, we have sought to use UK government/ONS data wherever possible, as these are the data that are likely to have been used to inform policy. We have also erred on the side of caution in our estimates. Where estimates may differ widely (such as for face-covering efficiency in reducing transmission), or subject to change (such as R-value or number of daily cases), we have presented a range of scenarios to give a sense of the impact of face coverings at various levels of R face-covering effectiveness.

Conclusion

We have illustrated that the policy on mandatory use of face coverings in retail outlets and on public transport in the UK, may have limited value in reducing hospital admissions and mortality rates, at least given the time that it was introduced.

We suggest that a National Institute for Health and Clinical Excellence (NICE) review is merited, assessing the cost-effectiveness of the use of face coverings as a clinical intervention alongside other preventative measures, as a means of reduction in hospital admissions and indeed mortality.

Table 1. The contribution of different activities on Infection Risk Score and the impact of face coverings on infection risk

Table 2. Projections for average weekly values over the 3 months from the introduction of mandatory face coverings on

24th July 2020 (based on starting at 29,400 new cases/week)

Figure 1a. Expected number of new community cases each week over 13 weeks based on R values of 0.8, 1.0 or 1.2, including for the expected difference if face coverings are used on public transport and in retail outlets, and Cumulative over the period with & without face coverings showing amounts avoided for Figure 1b Total number of community cases, Figure 1c: Community hospitalisation and Figure 1d Hospital Deaths expected

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Table 1 The contribution of different activities on Infection Risk Score and the impact of face coverings on infection risk

	Time hrs/day	Relative Infection Risk	IRS	% of total IRS	IRS reduction (using
Location					**20% risk reductio**
Home (including sleep)	16.69	1	16.69	28.3%	16.7
Work/study	5.61	6	33.66	57.1%	33.6
Public Transport	**0.47**	**5**	**2.35**	**4.0%**	**1.9**
Retail	**0.39**	**5**	**1.97**	**3.3%**	**1.6**
Leisure Inside	0.44	7	3.05	5.2%	3.0
Leisure Outside	0.41	3	1.22	2.1%	1.2
Total Infection Risk Score			**58.96**		**58.0**
Percentage overall risk reduction					**-1.5%**

Table 2 Projections for average weekly values over the next 3 months from the introduction of mandatory

face coverings on 24th July 2020 (based on starting at 29,400 new cases/week)

Ongoing R-value	Mask Transmission Reduction	Community Cases	Community Hospitals Admissions	Community H
0.8	No Face Covering	9,517	86	7.0
	20%	9,083	82	6.7
	40%	8,673	78	6.4
	60%	8,286	75	6.1
	80%	7,920	71	5.8
1.0	No Face Covering	29,400	265	21.7
	20%	27,356	246	20.2
	40%	25,470	229	18.8
	60%	23,731	214	17.5
	80%	22,127	199	16.3
1.2	No Face Covering	108,358	975	80.0
	20%	98,637	888	72.8
	40%	89,804	808	66.3
	60%	81,780	736	60.4
	80%	74,492	670	55.0

Key Assumptions: Asymptomatic=80%; Retail/Public Transport Infections=7.3%; Case Hospitalisation Admission Rate =0.9%; Hospital Admission Fatality Rate=8.2%

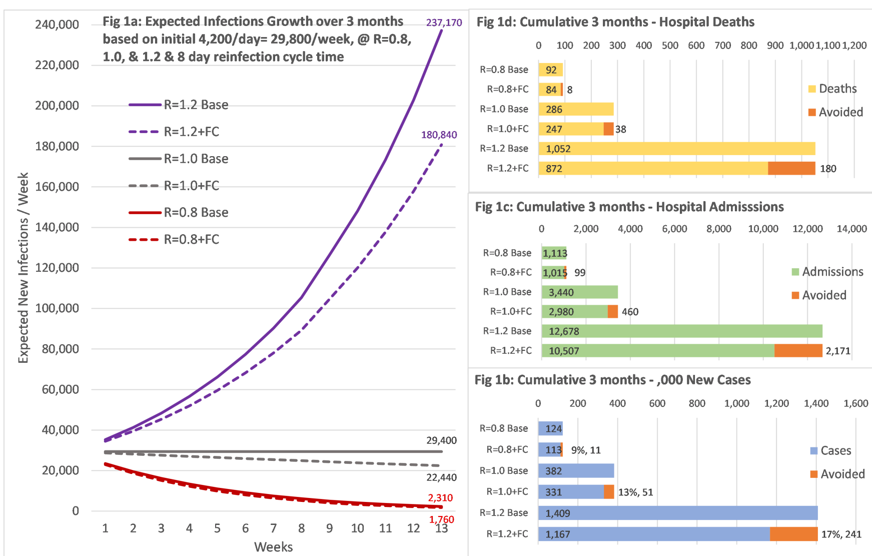

Figure 1. Expected number of new community cases each week over 13 weeks based on R values of 0.8, 1.0 or 1.2 and 40% effectiveness of face coverings (FC). (a) for the expected difference if face coverings are used on public transport and in retail outlets, and cumulative over the period with and without face coverings showing amounts avoided for the total number of community cases (b), community hospitalisation (c) and hospital deaths expected (d)

Supplementary Table 1: Weekly COVID -19 Community Infections, Hospital Admissions and Hospital Deaths.

	Incidence rate per 10,000 people per day	Lower 95% confidence/credible interval	Lower 95%
26 April to 10 May	2.14	0.57	0.57
26 April to 17 May	1.57	0.71	0.71
26 April to 24 May	1.43	0.86	0.86
26 April to 30 May	1.00	0.71	0.71
26 April to 7 June	0.86	0.57	0.57
26 April to 13 June	0.71	0.57	0.57
8 June to 21 June	0.59	0.27	0.27
14 June to 27 June	0.64	0.34	0.34
22 June to 5 July	0.30	0.14	0.14
6 July to 12 July	0.31	0.13	0.13
13 July to 19 July	0.52	0.28	0.28
20 July to 26 July**	**0.78**	**0.40**	**0.40**
27 July to 2 August**	**0.68**	**0.38**	**0.38**
3 August to 9 August**	**0.69**	**0.42**	**0.42**
7 August to 13 August**	**0.44**	**0.22**	**0.22**
Average for last 4 weeks			

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`Table1.2.docx` available at https://authorea.com/users/312300/articles/479250-modelling-the-impact-of-the-mandatory-use-of-face-coverings-on-public-transport-and-in-retail-outlets-in-the-uk-on-covid-19-related-infections-hospital-admissions-and-mortality

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`Table2.2.docx` available at https://authorea.com/users/312300/articles/479250-modelling-the-impact-of-the-mandatory-use-of-face-coverings-on-public-transport-and-in-retail-outlets-in-the-uk-on-covid-19-related-infections-hospital-admissions-and-mortality