Potential impact of face covering on the transmissibility of SARS-CoV-2 in the UK

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20th April 2020

Summary

- Hong Kong, Taiwan, South Korea and mainland China have been the most successful populations at maintaining COVID-19 case reproduction numbers at or below 1 since the start of February and have all strongly encouraged face covering
- WHO recommends that countries consider the universal use of surgical masks for community protection during severe influenza pandemics. No scientific evidence on cloth masks was available during the recent update
- However, direct use of evidence from influenza household studies for SARS-CoV-2 suggests low efficacy for face covering. Assuming that isolation is already effective, the maximum implied marginal impact of face covering on transmissibility would be a reduction in R of only 3.5%, e.g. from 1.03 to just below 1
- There are important observations that should prevent us generalizing low efficacy estimates from influenza household studies to COVID-19 in the workplace and community
    - Better compliance in household influenza studies could have pushed infection risk reduction from 8% closer to 30%
    - Influenza household RCTs do not control for compliance, e.g. at meal times, nor do they identify which individuals in the household sleep in the same room
    - The relative balance between the underlying mechanisms of transmission for SARS-CoV-2 are unlikely to be the same as those for influenza
- Contact tracing interventions present an opportunity to ask cases about their recent history of face covering and hence estimate accurate efficacy
- Given that pooled analysis from influenza RCTs should not be generalized to COVID-19, in the time available, I was unable to provide a numerical value on the effectiveness or otherwise of wearing face masks for COVID-19 outside the home in the UK

Background

The emergence of the SARS-CoV-2 virus at the end of 2019 and global pandemic of COVID-19 disease has resulted in substantial variation in both disease-associated per capita mortality and population-level behaviour change. Variation in the use of face covering outside health care settings is a specific example of differences between countries: Hong Kong, Taiwan, South Korea and mainland China have been the most successful at maintaining reproduction numbers at or below 1 since the start of February and have all strongly encouraged face covering. The next most successful population during that period has been Singapore which did not recommend masks until a recent cluster of cases and resulting lockdown.

Face coverings can be separated into three broad groups. N95 masks are designed for use in healthcare settings as good protection for source and recipient. Their use is intended to establish a partial seal between the mask and face so that the vast majority of both inhaled and exhaled air passes through the filter of the mask. There is considerable evidence that they are effective in high risk environments. However, they require fit-testing to be fully effective and are currently a scarce resource in the UK. Surgical masks are designed for use in general clinical settings to provide some level of source and recipient protection. They do not attempt to establish a seal between mask and face, but they include a filter made from non-woven material that has proven efficacy as a barrier against respiratory droplets and can even block some aerosols [1]. Surgical masks are also currently a scarce resource in the UK. Cloth face coverings are currently being recommended for use when N95 and surgical masks are not available [2,3]. They are being made from a variety of materials and recommended as source protection for asymptomatic individuals in the workplace and community.

WHO recommends masks for community protection during influenza pandemics

At the end of 2019, prior to the initial outbreak of COVID-19, the World Health Organisation (WHO) commissioned an extensive update of their guidelines for the use of non-pharmaceutical interventions against influenza from Hong Kong University, led by Ben Cowling [4]. The updated guidelines recommended to countries that they consider recommending widespread use of face masks for symptomatic individuals for community protection during severe epidemics and pandemics. Although the evidence was only moderate and based on 10 randomized controlled trials (RCTs), the potential harms were low. The report also stated that reusable cloth masks were not recommended. However, this was because the group found no scientific evidence on the benefit of cloth masks, not because there was any evidence of a difference between them and surgical masks (B. Cowling, personal communication).

Direct use of influenza evidence for COVID-19 suggests low efficacy for face covering

The same 10 RCTs included in the WHO report were analysed in more detail in Ref [5]. They were made up of 7 household studies, 2 studies of university accommodation and 1 study of Hajj pilgrims. The pooled efficacy estimate for using masks with or without increased hand hygiene was an 8% reduction in risk of infection. This reduction in risk was based on the

number of confirmed infections in a control group compared to the number in intervention groups over the entire period of the pooled studies.

If we assume that self-isolation is working effectively for COVID-19 in the UK, then the primary benefit of face coverings will be to reduce asymptomatic (including pre-symptomatic) transmission. Taking a precautionary stance to avoid mistakenly not recommending facemasks, and using the most recent evidence, we should assume up to 44% of SARS-CoV-2 transmission occurs prior to symptoms [6,7]. Therefore, based directly on pooled analysis of influenza RCTs above, the largest expected benefit from mask wearing would be a 3.5% reduction in the reproduction number R. The maximum marginal impact of this amplitude change in transmissibility would be to reduce R from 1.03 to just below 1, which represents a very narrow justifying scenario.

COVID-19 in workplaces and the community is not influenza in households

There are important observations that should prevent us generalizing quantitative findings from household mask studies of influenza to the workplace and community use of face coverings during the present COVID-19 pandemic.

COVID-19 is more severe than any strain of influenza since 1918 [8]. Therefore, levels of compliance to interventions are likely to be higher than would be the case during an influenza RCT. For example, in one of the 10 studies used as evidence by WHO [9], there was a substantial delay for many households from the onset of symptoms to enrollment in the trial. For a subset of households that started the intervention soon after the onset of symptoms in the index case, the reduction in risk of infection was considerably higher in the intervention groups. Using a mechanistic inference model, the per day reduction in risk of infection across the whole study was 27% for the group wearing masks [10].

Household contacts that may result in the transmission of respiratory viruses are very different from those that would occur in the workplace or community. Influenza RCTs do not control for compliance at meal times nor do they identify which individuals in the household sleep in the same room. Therefore, the reduction in risk of transmission between typical mask wearing source-recipient pairs in these RCTs compared to typical non-mask wearing pairs is likely to be different than would be expected in the workplace or community. In general, especially during the current pandemic, it seems reasonable to assume that face covering in the workplace or community could be substantially more effective than during household RCTs.

The relative balance between the underlying mechanisms of transmission for SARS-CoV-2 are unlikely to be the same as those for influenza. For example, the proportion of transmission that occurs via aerosol, compared to respiratory droplets, will likely be different between the two viruses. SARS-CoV-2 probably survives better in the environment. Given the assumed mechanism for face covering as a source control, such biological differences could also result in otherwise unexpected high rates of efficacy for face covering.

Good evidence for the efficacy of face covering could be generated quickly

A number of possible policies for transition out of lockdown include some form of contact tracing [7]. This intervention presents an ideal opportunity to ask each case about their recent

history of face covering and hence estimate an accurate efficacy once the syndromic status of their contacts is known. The degree of encouragement for face covering could then be adjusted depending on real-time robust efficacy estimates.

Conclusion

I do not believe pooled analysis from influenza RCTs in households can be generalized to COVID-19 but I was unable to find any substantial evidence to justify higher efficacy of face covering for illustrative modelling.

References

1. Leung NHL, Chu DKW, Shiu EYC, Chan K-H, McDevitt JJ, Hau BJP, et al. Respiratory virus shedding in exhaled breath and efficacy of face masks. Nat Med. 2020. doi:10.1038/s41591-020-0843-2

2. Greenhalgh T, Schmid MB, Czypionka T, Bassler D, Gruer L. Face masks for the public during the covid-19 crisis. BMJ. 2020;369: m1435.

3. Howard J, Huang A, Li Z, Tufekci Z, Zdimal V, van der Westhuizen H-M, et al. Face Masks Against COVID-19: An Evidence Review. MEDICINE & PHARMACOLOGY. 2020. doi:10.20944/preprints202004.0203.v1

4. World Health Organisation. Non-pharmaceutical public health measures for mitigating the risk and impact of epidemic and pandemic influenza. 2019.

5. Jingyi Xiao, Eunice Y. C. Shiu, Huizhi Gao, Jessica Y. Wong, Min W. Fong, Sukhyun Ryu, et al. Non-pharmaceutical Measures for Pandemic Influenza in Non-healthcare Settings—Personal Protective and Environmental Measures. Emerging Infectious Disease journal. 2020;26: 967.

6. He X, Lau EHY, Wu P, Deng X, Wang J, Hao X, et al. Temporal dynamics in viral shedding and transmissibility of COVID-19. Nat Med. 2020. doi:10.1038/s41591-020-0869-5

7. Ferretti L, Wymant C, Kendall M, Zhao L, Nurtay A, Abeler-Dörner L, et al. Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing. Science. 2020. doi:10.1126/science.abb6936

8. Verity R, Okell LC, Dorigatti I, Winskill P, Whittaker C, Imai N, et al. Estimates of the severity of coronavirus disease 2019: a model-based analysis. Lancet Infect Dis. 2020. doi:10.1016/S1473-3099(20)30243-7

9. Cowling B, Chan K, Fang V, Cheng C, Fung R, Wai W, et al. Facemasks and Hand Hygiene to Prevent Influenza Transmission in Households: A Randomized Trial. Ann Intern Med. 2009. Available: http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=Retrieve&list_uids=19652172&dopt=abstractplus

10. Lau MSY, Cowling BJ, Cook AR, Riley S. Inferring influenza dynamics and control in households. Proc Natl Acad Sci U S A. 2015;112: 9094–9099.