International Epidemiological Association

International Journal of Epidemiology, 2020, 1–4
doi: 10.1093/ije/dyaa044
Opinion

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COVID-19 epidemic: disentangling the re-emerging controversy about medical facemasks from an epidemiological perspective

Ka Hung Chan [1,2]* and Kwok-Yung Yuen[3]

[1]Clinical Trial Service and Epidemiological Studies Unit, Nuffield Department of Population Health, University of Oxford, Oxford, UK, [2]Public Health Research Collaborative, Hong Kong SAR and, [3]Department of Clinical Microbiology and Infection Control, LKS Faculty of Medicine, University of Hong Kong, Hong Kong SAR

*Corresponding author. Big Data Institute, Old Road Campus, Headington OX3 7LF, UK. E-mail: kahung.chan@ndph.ox.ac.uk

Since the outbreak of the COVID-19 epidemic in Wuhan, China, in December 2019, there have been over 80 000 confirmed cases and 2700 deaths across 39 countries/regions worldwide as of 25 February 2020, with case numbers outside China now rising at an unprecedented rate.[1] This epidemic has induced concern worldwide and a sharp rise of demand for medical facemasks (surgical masks and respirators), especially in East Asia. Notably, China produced >50% of the world's supply of medical facemasks before the epidemic, but the daily production has now dropped from 20 million to 15 million, whereas the current demand in China alone is estimated to be >50 million per day.[2] These factors have resulted in an unprecedented global shortage of medical facemasks, which invites a re-emerging debate about their value in an epidemic.[2,3]

The contrasting views on medical facemasks are not limited to the public but also to governments and public health experts. The World Health Organization do not recommend that the public use facemasks, but rather that they cover the mouth and nose when sneezing or coughing[4]; the US Centers for Disease Control and Prevention recommend the use of facemasks for individuals with respiratory symptoms and any family members who have close contact[5]; and some (but not all) Chinese government officials and public health experts call for universal use of facemask in public spaces.[6,7] These inconsistencies in official guidelines and expert opinions confuse both the public and health care professionals, and hinder risk communications during the epidemic, especially in an increasingly globalized world with free flow of information.

Surgical Masks versus Respirators

Before going into the epidemiological evidence on the effectiveness of medical facemasks in preventing respiratory infection, it is important to clarify the difference between surgical masks and respirators. Respirators, formally known as 'disposable filtering half-facepiece respirators', are designed to reduce the user's exposure to airborne particles (e.g. fine dust generated from industrial processes such as grinding of metals, or biological aerosols generated from sneezing) by forming a tight-fit seal around the user's face, which requires a careful fit test before use and is difficult to achieve in the presence of facial hair.[8,9] The most common respirator being used by health care workers are N95 respirators, which should reduce inhalation exposure to airborne particles by at least 95% if worn properly. Surgical masks are chiefly designed to prevent droplet transmission from health care workers to surgical patients, or blood-borne infection from patients to health care workers during medical procedures, but they lack the air-tightness that respirators have, and are generally considered to be ineffective in preventing airborne infection.[8,10,11] Nonetheless, given the substantially higher cost

of respirators and the challenges related to manufacturing, fit testing, comfort and compliance, there has been growing interest in investigating the ability of surgical masks to prevent droplet-borne respiratory infection.[8,10,11]

Three key epidemiological questions

In order to disentangle the controversy about the value of medical facemasks during the COVID-19 epidemic, we need to ask three key epidemiological questions:

Question 1: Can infected individuals reduce the risk of spreading the virus to others by wearing facemasks?

The answer to this is unambiguous. By design, a facemask with sufficiently high filtering efficiency can act as a passive barrier to stop infected individuals from spreading pathogens through droplets or aerosol from talking, coughing or sneezing, and they can reduce fomite transmission by reducing the chance of people spreading their body fluids after touching their nose or mouth. If worn properly, facemasks are likely to be superior to active practices such as covering up the nose or mouth when sneezing or coughing, which could contaminate individual's hands or clothing and increase the risk of fomite transmission. This may be especially relevant for COVID-19, as emerging evidence suggests that transmission by asymptomatic or afebrile patients may play an important role in spreading the disease.[12–14]

Question 2: Can uninfected people reduce the risk of infection by wearing facemasks?

This is at the centre of the controversy. In this scenario, a facemask needs to block pathogens from external sources (e.g. infected individuals), which places significantly greater demand on the facemask's particle filtering efficiency and on user compliance. Health care workers are at particularly high risk of infection due to the nature of their jobs. Preventing health care workers from contracting and spreading infection is one of the key priorities in health care settings. There has been largely consistent randomized controlled trial (RCT) evidence in health care workers that wearing surgical masks and N95 respirators can reduce the risks of respiratory illnesses [including severe acute respiratory syndrome (SARS)] by 40–60%, after accounting for key confounders such as other protective equipment or hygiene measures.[8,11] However, uncertainty remains as to whether surgical masks are inferior to N95 respirators in preventing infection. A recent meta-analysis shows that, compared with surgical mask use, use of N95 respirators is associated with a >50% reduced risk of overall clinical respiratory illness but has no apparent superiority in preventing viral infection,[11] which is supported by a more recent large-scale RCT in an outpatient setting.[8] Despite the potential superiority of N95 respirators over surgical masks, the evidence in health care workers defies a common claim that surgical masks are ineffective for prevention because some coronaviruses (e.g. SARS-CoV-2) may be airborne in specific scenarios (e.g. during aerosol generating procedures) and/or can infect people through the mucous membranes of the eyes.

Trial evidence in the general population is, however, more limited, because it is practically challenging to carry out and there is high risk of non-compliance and cross-contamination.[15–17] Nonetheless, several case-control studies conducted in the general population in Hong Kong and Beijing during the 2003 SARS-CoV-1 outbreak found that frequent use of facemasks (predominantly surgical masks in both studies) in public spaces was associated with a >60% lower odds of contracting SARS compared with infrequent use, after accounting for key confounders.[18,19] Although the effectiveness could be overestimated in observational studies (as seen in studies among health care workers[11]) the lack of conclusive evidence does not substantiate claims that surgical masks are ineffective for the public, but calls for further research, particularly on the reason behind the failure of transferring the effectiveness observed in health care workers to the general population, and the strategies needed to boost the effectiveness. For example, non-compliance, such as incomplete coverage of the mouth and nose or frequent removal and re-use of the same facemask in public spaces, is frequently reported as a major challenge in previous studies; but these could be addressed through enhancing public health education.[15,16]

Question 3: Can widespread use of facemasks in a population can facilitate the control of an epidemic?

In addition to the potential direct benefits discussed above, the indirect impact of widespread use of facemasks must not be overlooked. First, it creates a social norm in the society and increases the level of risk perception among the general public, which may in turn improve personal hygiene behaviours.[16,20] Whereas the biggest direct benefit of facemasks use, if any, comes from infected individuals wearing them properly, the social norm may amplify such benefit by putting more pressure on individuals with respiratory symptoms to wear facemasks, and even asymptomatic patients are more likely to wear a facemask without the knowledge of their health condition. Furthermore, compared with other hygiene measures, wearing facemasks is a highly visible and iconic behaviour that might increase

the public's risk awareness and encourage them to seek other relevant health information and improve their personal hygiene behaviours, many of which have been proven to be effective in infection control (e.g. handwashing, social distancing).[15]

The widespread use of facemasks may also reduce other droplet-transmitted infectious diseases, thus alleviating some burden on a highly-stressed health care system during an epidemic.[16] In fact, Hong Kong, a metropolis of 8 million residents that is estimated to have some of the highest risks of importing COVID-19 from China,[21] is observing some of the world's highest rates of public facemask use, and it has experienced the shortest winter surge of seasonal influenza in the past 5 years during the first wave of the COVID-19 epidemic (5 weeks versus 12–18 weeks).[22] Further analysis is warranted to investigate this ecological linkage, but it is likely that widespread facemask use was not the only potential reason behind it, as the COVID-19 epidemic has also enhanced overall personal hygiene in the society and tightened infection control in health care settings.

Cost versus Benefit

Ultimately, the critical public health question is whether the potential benefits of facemask use outweigh the cost to the society. The sudden surge of demand on facemasks in East Asia (together with reduced productivity in China and other factors) has contributed to a global shortage that in turn has disrupted supplies to health care providers worldwide, who have the greatest need not only for COVID-19 but also for standard protective equipment. The shortage has also induced further panic in high-risk areas such as Hong Kong and China, which threatens effective risk communication, outbreak control measures and the economy. International cooperation and strong leadership are needed to handle the epidemic and its collateral damage. This includes stabilizing the global supply chain of facemasks (as well as other medical supplies) to high-risk areas, developing evidence-based and context-specific guidelines on infection control and risk communication strategies, and striking a fine balance between the cost and benefits of different interventions. It is also important for public health officials to educate the public that, whereas facemasks may have potential value in infection control in certain contexts: they must be worn properly to be effective; they are just one of the many relevant strategies; and panic buying or stockpiling of any medical supplies should be discouraged.

Conclusion

Epidemics of novel infection in humans are inevitable and no single strategy alone can control an outbreak successfully. When facing a public health emergency with limited empirical evidence, mechanistic and analogous evidence and professional judgement become important. In high-risk regions like China, widespread, proper use of facemasks, when coupled with comprehensive health education campaigns and other personal and environmental hygiene measures, may help to mitigate the COVID-19 epidemic, but may not be necessary nor cost-effective in low-risk areas where sustained human-to-human transmission is yet to occur. Instead of dismissing the potential value of facemasks based on the lack of evidence, further RCTs and cost-effectiveness studies should be conducted swiftly to clarify the controversy.

Conflict of Interest

None declared.

Author Contributions

KHC developed the first draft of the article, and all authors contributed to the subsequent revisions. KHC confirms that he had full access to all the data in the study and had final responsibility for the decision to submit for publication.

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