

Effectiveness of Facial Masks in the Prevention of COVID-19 Infections

Abstract:

The COVID-19 virus, SARS-CoV-2, is thought to transmit mostly by respiratory droplets from coughing or sneezing when people are in close proximity. It is advised to wear a face mask or respirator (N95/KN95) to prevent the spread of COVID-19-causing SARS-CoV-2. Although few studies have examined their real-world efficacy in preventing SARS-CoV-2 infection, well-fitting face masks and respirators efficiently filter virus-sized particles in laboratory settings. Mathematical modelling demonstrates that wearing masks significantly slows the transmission of SARS-CoV-2 and lowers the chance of infection, particularly when paired with other non-medical interventions (such as maintaining a safe social distance). In many studies, it has been discovered that both N95 masks and ordinary masks are effective. This study is aimed at evaluation effectiveness of wearing facial masks at preventing Covid-19 infections.

Keyword : COVID-19 Infections, Facial Masks, N95 masks, Disease, Aerosol

Introduction:

The only option to slow the spread of the virus is through prevention up until a comprehensive public vaccination programme is implemented. The COVID-19 virus, SARS-CoV-2, is thought to transmit mostly by respiratory droplets from coughing or sneezing when people are in close proximity (within 6 feet of each other). Quarantine and self-isolation for those who have a confirmed or potential infection, restrictions on shelter-in-place, hygienic practises like routine hand washing and cleaning of potentially contaminated surfaces, social detachment, and the wearing of face masks are all examples of prevention measures. When with individuals outside of their family, the US Centers for Disease Control and Prevention (CDC) advises "wearing fabric face coverings in public situations, especially when other social distancing measures are difficult to maintain." [1-4]

"It is advised to wear a face mask or respirator (N95/KN95) to prevent the spread of COVID-19-causing SARS-CoV-2. Although few studies have examined their real-world efficacy in preventing SARS-CoV-2 infection, well-fitting face masks and respirators efficiently filter virus-sized particles in laboratory settings. Randomly chosen California citizens who had gotten a test result for SARS-CoV-2 between February 18 and December 1, 2021, were involved in a test-negative design case-control study. 652 case participants and 1,176 matched control participants (residents with negative test results for SARS-CoV-2) who self-reported being in indoor public settings during the two weeks prior to testing and who reported no known contact with anyone with confirmed or suspected SARS-CoV-2 infection during this time had their use of a face mask or respirator assessed. In comparison to never using a face mask or respirator in indoor public settings, there was a decreased adjusted likelihood of a positive test result. Wearing N95/KN95 respirators or surgical masks was linked to significantly lower adjusted odds of a positive test result compared to not wearing any face mask or respirator among the 534 participants who indicated the type of face covering they typically used". [5]

“Mathematical modelling demonstrates that wearing masks significantly slows the transmission of SARS-CoV-2 and lowers the chance of infection, particularly when paired with other non-medical interventions (such as maintaining a safe social distance). Model simulations for the state of New York in the USA showed that 80% compliance with mask laws would avoid 17–45% of fatalities from COVID–19—even if the masks used had a 50% filtering efficacy. If 80% of people used these masks in public, COVID-19 mortality would be reduced by 24-65% when infection rates are lower, as was first reported in the state of Washington. Even masks with a filtering effectiveness of only 20% might accomplish this. In these model trials, wearing a mask decreased the frequency of infections and thus, the number of fatalities. If mask use began early in an epidemic, when infection rates are still low, the benefit was best”. [6,7]

“Numerous ecological studies have also offered strong proof that regulations requiring everyone to wear masks have been linked to decreases in the number or frequency of illnesses and fatalities. The different kinds of masks (clothes, surgical, or N95) worn in the population were not differentiated in these research. This correlation is strengthened by the fact that, in many instances, other mitigating measures (such as closures of schools and workplaces, suggestions for social isolation, and hand hygiene) had already been implemented before the implementation of mask wearing policies, following which the reductions were noticed. According to a research that looked at changes in infection growth rates in 15 states and the District of Columbia before and after mask mandates, rates were rising prior to the mandates' enactment and dramatically slowing down thereafter, with the longer the mandates had been in effect”. [8,9]

According to a meta-analysis, N95 masks were superior to surgical masks, which were superior to single-layer fabric masks. Numerous empirical investigations have demonstrated that characteristics including mask fit, material, and layer count have an impact on mask efficacy. For instance, a research that looked at five adjustments to medical procedure masks, such as moving ear loops around and improving the mask/face seal, discovered that these steps boosted the fitted filtration effectiveness of masks by between 60.3% and 80.3%. [1,10-12]

Wearing masks reduces viral load and infectiousness of patients:

“Aerosols and droplets can spread SARS-CoV-2. SARS-CoV-2 can survive in aerosols for three hours, according to experiments. Direct touch between people can potentially transmit an infection. Although SARS-CoV-2 can stay infectious on steel surfaces for up to 48 hours and on plastic surfaces for up to 72 hours, transmission from surfaces is presently thought to be less likely. Even if the index person exits a confined place just before the victim enters it, SARS-CoV-2 is definitely still contagious. It was not able to eliminate out that squash centre workers present at the same time as the individual to be infected were asymptomatic carriers, despite the case report suggesting this for the changing area of a squash centre”. [6]

Patients with COVID-19 have been observed to have high viral titers of SARS-CoV-2 in their saliva. These virus levels are equally as high in asymptomatic or presymptomatic individuals and mostly occur in the URT. These titers were greatest at the time of patient presentation. Approximately 40 to 45 percent of SARS-CoV-2 infections appear to be in asymptomatic individuals. SARS-CoV-2 virus counts in children are comparable to those in adults, according

to an investigation of patient age and SARS-CoV-2 viral loads. Another study found no appreciable difference in saliva loads between children who had moderate symptoms and those who did not. These results lend credence to the idea that masks should be worn by both adults and children. [13]

“Smaller droplets evaporate, and the non-soluble components stay in the air as droplet nuclei, whereas the majority of big droplets fall to the ground within 1.5 to 2 metres of the speaker. This indicates that at distances of less than 1.5 to 2 metres from the speaker than at farther distances, the exposure to droplets in exhaled air is significantly more severe. Even at closer ranges (15 cm from the mask), a face covering lowers the amount of droplets by 60-95% (cotton mask) and 99% or more (surgical mask and N95 mask without valve)”. [6]

Any effective policy intervention must correctly address transmission caused by infectious patients who exhibit little or no symptoms and may not be aware that they are ill in order to avoid the consequences of these disease features. attention will be on other transmission vectors, such as speaking, breathing, and touch, because those who exhibit symptoms, such as coughing and sneezing, are often expected to stay at home. [13]

For SARS-CoV-2, information on the viral load that will infect or afflict 50% of those exposed (ID-50) is mostly absent. Since there is no effective therapy, it is unethical to conduct experimental infection studies on humans. Macaques that receive an intratracheal inoculation of 0.5×10^6 PFU of SARS-CoV-2 excrete the virus but often do not show signs of sickness. A dosage of 4.75×10^6 PFU will cause mild to severe illness when administered. Therefore, the severity of the disease appears to rely on the infectious dosage, as is the case, for instance, with influenza. [6]

Finding safe distance:

“When a person speaks, coughs, or breathes, droplets and droplet nuclei can travel up to 8 metres (26 feet). there are possible dangers at the advised range, the spreading distance of droplet/droplet nuclei is seen to be more than the social distancing of 1.8 m (6 ft). Even at 1.8 m (6 ft) of social distance, there is still a considerable danger of infection from the patient's virus-carrying droplets when a patient comes into close contact with another person. Through improved dispersion of the droplets in the air, environmental variables like wind and humidity can make the risk factors even worse”. [14]

In June 2020, the WHO began advising wearing masks as a component of a comprehensive strategy to stop the spread of SARS-CoV-2. This is in line with the advice given by the Chinese health bureau at the start of the pandemic. For healthcare professionals, wearing a face mask lowered their chance of COVID-19 infection by 70%. In addition, a cohort research in Beijing discovered a direct link between index patients' mask use and a lower incidence of household infections. [15]

Above a distance of 1.2 metres, the exposure to air breathed by another person reduces dramatically in enclosed areas. According to a study of healthcare personnel, failing to maintain a minimum distance of 1.8 metres between themselves and influenza patients increased their

chance of contracting the illness. Therefore, a minimum separation of 1.8 m (6 ft) from patients with respiratory illnesses is advised by the US health authorities (CDC). The minimal distance of 1.8 m may not always be adequate since virus-containing aerosols in inhaled air can travel up to 8 m, for example while sneezing. SARS-CoV-2 replication-competent SARS-CoV-2 was still detectable 90 minutes after aerosol discharge in experimentally produced aerosols, which had an infectious SARS-CoV-2 half life of 1.1 hours. [6,16-18]

Johnson et al. discovered that whereas seven out of nine patients' influenza could be identified without a mask, no influenza could be detected by RT-PCR on sample plates at 20 cm distance from coughing patients wearing masks. According to Milton et al., 37 influenza patients who were wearing surgical masks had 3.4-fold less viral copies in their exhaled breath. An enhanced sampling technique based on a controlled human aerosol model was employed by Vanden Driessche et al. The authors were able to find any aerosol that could have leaked over the edges of the mask by taking a homogenous sample of all the air surrounding the patient. When using a surgical mask in comparison to not wearing one, the airborne *Pseudomonas aeruginosa* load was reduced by 88% in their six cystic fibrosis patients who coughed up contaminated aerosol particles. Wood et al. discovered that employing a N95 mask or surgical mask reduced the concentration of *P. aeruginosa* aerosol at 2 m from the source for their 14 cystic fibrosis patients who coughed up a lot of viable aerosol. [13,19-22]

Types of Masks:

A surgical mask is primarily made for use by medical personnel, such as doctors and nurses, to protect them during surgical operations. Its purpose is to keep the wearer's lips and nose from producing liquid droplets or aerosols. Additionally, they are made to avoid contamination of surgical patients' bodily fluids by breathing particles from the user. Despite not being built to filter out viruses that are smaller than bacteria, surgical masks can be just as efficient as N95 respirators at protecting healthcare workers from the flu and respiratory droplets when an outbreak is occurring. [14]

According to the Centers for Disease Control and Prevention, medical masks should not be included in the mask suggestion. Because only healthcare professionals should wear these masks. In many research, it has been discovered that both N95 masks and ordinary masks are effective. According to Jefferson et al Cochrane .'s system review, surgical and N95 masks can both successfully stop the transmission of respiratory infections. Additionally, Long et al. reported that N95 respirators had a protective effect against bacterial colonisation that had been verified in a lab. Though when tested in the lab, it was discovered that N95 respirators were generally more effective than surgical masks and have better facial sealing characteristics, the currently available evidence has not yet proved the difference in protective efficiency between N95 masks and healthcare masks. [15]

N95 masks and other air filtering respirators can filter out pollutants, germs, and other particles before they reach the mouth and nose. According to a research using the MS2 virus, N95 masks are far more effective in preventing viral penetration than surgical masks. Using charge-neutralized sodium chloride aerosol spray at a relatively high airflow rate of 85 L/min and a

sizable breathing resistance, these N95s were evaluated for particle penetration. In order to mimic a high amount of exposure, the mask was clogged with aerosol particles. The study discovered avian flu virus moving through the N95 mask, but there were several additional elements at play, thus its transmission did not necessarily suggest direct infection. Additionally, influenza is often spread by tiny aerosol particles with a diameter of 1 to 10 μ m. [14]

Various types of face masks:

Governments and the WHO advise wearing masks during this COVID-19 epidemic to prevent the spread of SARS-CoV-2. The use of masks has adhered to a variety of government and community health group guidelines. The WHO and other public health organisations agree that masks can reduce the spread of viral respiratory illnesses, particularly in the case of COVID-19 [23].

Categories of face masks include:

1. Cloth face masks
2. Medical or surgical masks
3. Respirators:
 - (i) Filtering facepiece respirator
 - NIOSH respirator filter masks
 - (ii) Full-length face shield
 - (iii) Self-contained breathing apparatus (SCBA)

WHO recommends various kinds of masks for use in pandemic COVID-19 (Fig. 1). These types are mentioned as below:



Figure 1 shows the pictorial view of different types of masks: a. Surgical Mask b. Cloth Mask c. Cloth Mask with Head Loop d. Fold Model Type K95 Mask without Respirator with Head Loop e. Fold Model Type N95 Mask with Respirator and Head Loop f. Cup Model Type N95 Mask with Respirator and Head Loop g. Full-Length Face Shield.

N95 masks are more likely than other face masks to result in negative facial reactions. Additionally, N95 masks were reported to result in increased degrees of discomfort and nonadherence, possibly as a result of symptoms associated to pressure. In addition, N95 masks have the least air permeability and exert the most pressure compared to other types of masks, which could lead to an increase in the incidence of skin reactions. According to the study, using N95 masks was linked to widely reported facial symptoms such as acne, itching, and rashes [24].

Adverse effects of face masks:

Use of face masks for an extended period of time might harm the skin barrier and result in superficial maceration. Friction-related injury can result from increased pressure on anatomical sites like the zygoma and the nasal bridge. Additionally, a number of interrelated factors, including repeated use, pressure, and improper cleaning, can exacerbate underlying skin issues and possibly transmit bacteria [25]. Face masks, particularly N95 masks, offer a tight environment for protection as well as a warm and wet environment beneath the mask, all of which might promote negative reactions in skin microbial populations linked to facial dermatosis [26]. According to Hua et al study, friction, localised moisture from local expiration, and elevated temperature all had a negative impact on the epidermal barrier and antimicrobial defence. It has been demonstrated that wearing face masks increases sebum production even in places where the face mask is not in direct contact [27]. Similar research suggests that tight face masks may exacerbate acne by occluding the pilosebaceous unit. Formaldehyde, polypropylene, and other preservatives used in masks can potentially have a secondary effect of causing facial skin responses and aggravating skin disorders. Masks may also have metal clips, glue, or rubber straps that can cause allergic or irritating contact dermatitis. When all of these elements are present, inflammatory face dermatoses and unfavourable reactions may result. Face mask regulations may not be followed by patients who have negative reactions to them, which could allow COVID-19 and other respiratory infections to proliferate [28].

Conclusion:

The studies indicates that the mask significantly protects against COVID-19. Additional large-scale practical trials are required to assess the effectiveness of the face mask on the face in preventing the spread of SARS-CoV-2, and more research is still required to better characterise the protective impact of the mask on the larger population.

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