Review article

A review on the effectiveness of various masks in protection against COVID-19

Remya Vinod¹, Swathi¹, Vinod Chandran²

¹Department of Anatomy, K. S. Hegde Medical Academy, NITTE (Deemed to be University) Deralakatte, Mangalore, Karnataka, India
²Department of Biochemistry, Kasturba Medical College Mangalore, Manipal Academy of Higher Education, Manipal, Karnataka, India

(Received: February 2022 Revised: August 2022 Accepted: September 2022)

Corresponding author: Remya Vinod. Email: remya@nitte.edu.in

ABSTRACT

As of June1st 2021, more than 17 crore people have been infected with COVID-19 across the globe, and almost 3 crore people have been infected in India. The virus can spread through even normal actions like talking with particle emission rates inversely correlating with word frequency and volume, which can be reduced by covering the mouth. However, there is debate concerning the effectiveness of the various face mask types in preventing respiratory infections. Many have reported that wearing a mask is uncomfortable, especially when worn for long hours and while performing strenuous activities. Another disease that has raised its head is mucormycosis. However, COVID-19 can be a serious infection in many, with many fatalities. It is not yet clear how much protection vaccines give, and in a hugely populated country like India, it may be very difficult to vaccinate the whole population. Moreover, the vaccination for pediatric groups has just started. So, it is imperative to wear masks that can be protective against infection. However, some people believe that a straightforward cotton mask is insufficient. We set out to analyze the efficacy of masks through this investigation. According to the results of this systematic review, there are no studies that give conclusive evidence that using face masks as recommended by current public health guidelines will stop this condition. This is a significant discovery that should be communicated to the scientific community and calls into question the rationale for inconsistent and differing public health recommendations.

Keywords: Mask; COVID19; pandemic; double mask; N95.

INTRODUCTION

The face masks were used to help prevent nasal and oral microorganisms from infecting surgical incisions. Aside from hand washing, covering face using mask is helpful in preventing the spread of infectious diseases, especially Covid 19 (1). With the available knowledge of respiratory diseases, it will be a paradox to believe that masks and respirators would be helpful in their prevention. Lengthy-lasting aerosol particles (2.5 m) are the principal source of transmission because they have a low minimum infectious dose and long residence duration.

SARS-CoV-2 can spread through three main channels: contact, droplet, and aerosol, albeit the exact mechanisms of transmission are still unknown. Direct or indirect contact transmission is also possible. (2). A healthy person can contract the virus directly from an infected person when they shake hands or embrace each other which is known as direct transmission. However, transmission is considered indirect when a healthy individual comes into contact with any inanimate that has virus particles on it or uses a tool that has previously been used by an infected person (3). By using laser light scattering, it was shown that talking emits 1000 droplets on average per second, demonstrating the existence of super-spreaders for viruses (4) Speaking loudly and quickly causes particles to emit at corresponding speeds (5). As shown by laser light scattering, mouth covering or masking can significantly lower droplet emissions. As a result, masks serve as obstacles that block aerosols from carriers both symptomatic and asymptomatic. Masks have two crucial purposes. They first stop the development of gas clouds during coughing and sneezing, which reduces the quick, turbulent jets of aerosol that are directed at people or the environment (6,7). Second, the mask's several layers filter the aerosol and keep it from reaching the nasopharynx (8). Due to frequent exposure to tainted droplets, the mask becomes a virus collector. During respiration, the warm and muggy circumstances within the mask can hasten the virus's penetration and propagation to the inner side. As a result, the mask's capacity to stop aerosols from entering the respiratory system relies on the substance employed to block particle entry, how well mask fits and amount of air leakage, as well as the technique utilized when wearing the mask (9). Certified masks meet the standard requirements laid down by the government. Certified mask class includes respirators and medical masks. These have received CDC certification and meet all requirements for use by the general public. Non-oil-resistant masks, known as electret masks use electret filters, a type of filter facepiece respirator that protects against...
aerosols larger than 20 nm in size. Breathing is aided by a ventilation fan at the outer layer in these (10). Filtration characteristics are used to designate respirators. The four layers of N95 masks are: an inner layer, a mask filter layer, a support layer and an outer layer (11). Polypropylene (PP), a hydrophobic nonwoven material, makes up the outer layer and repels moisture from the environment. Melt-blown nonwoven PP in two layers make up the filter layer, which traps particles made of oil and other materials. The four operating principles of this filter layer are inertial impaction, interception, diffusion, and electrostatic attraction. Modacrylic makes up the support layer, adding added thickness and rigidity while also enhancing comfort. Hydrophobic nonwoven PP is also present in the innermost layer, preventing moisture from entering the mask and stabilizing filtration effectiveness (12). To reduce the danger of disease transmission, healthcare workers typically wear these firmly fitting garments. These masks are expensive, therefore, not everyone can afford them. The Food and Drug Administration classifies disposable, loose-fitting medical masks as medical devices. Aerosols are avoided in the medical setting by using these masks. A mask of this type has three layers. The inner layer absorbs moisture and aerosols from the user due to its hydrophobic nature. A filter in the middle layer keeps the facemask's two sides from being contaminated by airborne particles of a certain size. The hydrophobic nature of the outer layer causes it to repel aerosols and water droplets from the environment (13). Because it is not tightly attached to the face, this style of mask works better against large, coarse droplets than it does against little ones (14). But numerous studies have demonstrated that medical masks can stop coronaviruses and influenza viruses from spreading (15). Regarding masks made at home, there is no assurance that a straightforward mask will be able to reduce virus load. According to the type of fabric, the WHO has advised using non-medical masks made with three or more layers of woven or nonwoven material (16). Typical textile materials were found to have filtration efficiencies between 5 and 25%. Effective filtration is influenced by the thread count and number of cloth layers increasing filtration efficiency. A washed 2-layer nylon mask with ear loops and an aluminium nasal bridge, for example, has a higher filtering efficiency than a medical-grade procedure mask with ear loops. As medical masks are hard to come by during a pandemic, these masks are ideal alternatives (17). Reusable fabric masks are the ideal solution for the present pollution issue brought on by throwaway masks. Reusable fabric masks must be put up appropriately, before being marketed and these masks should carry information on the material's composition, thread count, weave, and several layers labelled on them. The surgical mask may not be sufficient to protect the user from airborne infections and may even be the source of airborne or droplet infection, according to fragments of data. However, in a high-risk setting, surgical facemasks and N95 respirators offer the best protection (18). According to a recent study by the University of North Carolina Health Care, wearing two face coverings can nearly double the effectiveness of filtering out SARS-CoV-2-sized particles, preventing them from getting to the wearer's nose and mouth and leading to COVID-19. According to research published in JAMA Internal Medicine, improved filtration is caused by removing any gaps or poorly fitting portions of a mask, not by layering on too much cloth.

The World Health Organization’s interim guidance on face mask usage in relation to COVID-19 notes that the evidence about the effectiveness and the legitimacy of the various forms of use of face masks in prevention of respiratory illnesses is eroding and debated. However, COVID-19 is a dangerous sickness with few available treatments that is spreading among a population with a weakened immune system. However, the majority of those surveyed reported negative side effects from prolonged use of N95 and surgical masks during COVID-19, including headaches, rash, acne, skin disintegration, and reduced cognition.

Mucormycosis, is one problem that has emerged recently and is more prevalent in patients whose immunity has been weakened because of COVID, diabetes, kidney illness, liver or heart disorders, age-related problems, or those taking medicine for autoimmune diseases such as rheumatoid arthritis. When these individuals receive steroids, their immunity is further lowered, which promotes the growth of the fungus. According to some medical professionals, "unhygienic masks" and poorly ventilated rooms may be contributing factors. People who are afraid of catching the virus frequently wear the same mask without washing it, which increases their risk of getting infected because fungus thrives in moist or unclean environments. Ideally, masks should be cleaned with hot water, a disinfectant, or at the least, sanitizer after a person comes inside from the outside. Used masks were found to have bacterial and fungal contamination on both their outside and interior surfaces (19).

Another uncertainty is whether previous immunity to coronaviruses that caused the common cold offer some degree of cross-protection. According to surveys conducted in nations afflicted by the COVID-19 outbreak, including Italy and Spain, the incidence of antibodies ranges from 1 to 10% nationwide and can reach 15% in severely affected urban regions. It is unknown how long people will remain immune to SARS-CoV-2 naturally, though. Seasonal coronavirus immunity is typically not very long-lasting, especially in patients who had milder illness manifestations. It

**Vinod et al: A review on the effectiveness of various masks in protection against COVID-19**

DOI: https://doi.org/10.51248/v42i5.1513

Biomedicine- Vol. 42 No. 5: 2022

871
may require many reinfections before substantial protection is established (20). This creates an ethical dilemma: Should governments immediately apply the precautionary principle and advise people to wear face masks on the grounds that we must lose something in order to potentially gain something from this measure? The precautionary principle: making choices in uncertain situations, European Commission, 2017. Rancourt, while others, claimed that there is "no clinical proof" connecting the two.

METHODS

Articles were searched in PubMed using the words Face mask OR N95 OR surgical mask OR Use of single mask OR double mask AND Covid-19 OR air borne diseases OR influenza like respiratory illness. Only articles in English and published between 2007 to 2021 were considered for review.

RESULTS

Using a mask to avoid COVID 19 (Table 1)

A systematic review on mask use in healthcare workers, community and sick patients by MacIntyre et al., (21) using 19 randomised controlled trials found that in the community masks were effective with or without hand hygiene. In healthcare workers, masks worked well if worn continuously throughout a shift. However cloth masks performed much worse than medical masks in terms of effectiveness. Hui et al., (22) did a comparison of expelled air dispersion distance in the human patient simulator with no mask, N95 and surgical mask. And they observed reduced expelled air dispersion distance with N95 and a surgical mask. However, Dbouk, et al.,(22) observed that masks didn’t offer much protection.

Table 1: Using a mask to avoid COVID 19

<table>
<thead>
<tr>
<th>Ref no</th>
<th>Author</th>
<th>Year</th>
<th>Study design</th>
<th>Subject</th>
<th>Results</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>MacIntyre, C.R</td>
<td>2020</td>
<td>Systematic review</td>
<td>Health care workers, community &amp; sick patients</td>
<td>Masks worked well if worn continuously throughout a shift. Cloth masks performed much worse than medical masks in terms of effectiveness.</td>
<td>Masks may be useful as source control in case of COVID 19 pandemic</td>
</tr>
<tr>
<td>22</td>
<td>Hui, D.S</td>
<td>2012</td>
<td>Experimental study</td>
<td>Human patient simulator</td>
<td>Comparison of expelled air dispersion distance in human patient simulator with no mask, N95 &amp; surgical mask. Reduced expelled air dispersion distance reduced with N95 &amp; surgical mask</td>
<td>The N95 mask is more effective than a surgical mask in preventing expelled air leakage during coughing</td>
</tr>
<tr>
<td>23</td>
<td>Dbouk, T</td>
<td>2020</td>
<td>Experimental study</td>
<td>Volunteers</td>
<td>Without the surrounding wind speed the droplets from cough can just travel very short distance before falling on the ground. Droplet cloud affects both adults as well as children who are within the trajectory of falling droplets</td>
<td>This study shows that, when a person coughs, the wind speed in an open space environment significantly influences the distance that airborne disease-carrier droplets travel</td>
</tr>
<tr>
<td>24</td>
<td>Tang, W</td>
<td>2009</td>
<td>Experimental study</td>
<td>Human volunteers with and without a mask</td>
<td>Wearing surgical or N95 masks block the formation of jet or redirect in less harmful direction</td>
<td>Surgical and N95 masks serve an important purpose in preventing airborne virus transmission</td>
</tr>
<tr>
<td>25</td>
<td>Ma, Q. X</td>
<td>2020</td>
<td>Experimental study</td>
<td>Models to mimic human breath</td>
<td>Hand washing with soap or chlorine could remove most of the virus from the hand. Use of masks could block most of the virus in aerosols</td>
<td>Mask wearing and instant hand hygiene slow the exponential spread of the virus</td>
</tr>
</tbody>
</table>
Tang et al., (24) conducted a study on human healthy volunteers using a schlieren optical system for coughing with and without masks for aerosol infection control. They used standard surgical and N95 masks in the study. The unmasked cough produced a turbulent air jet which extended across the schlieren field of view. Standard surgical mask blocked the forward momentum of the cough jet and aerosol content; however, allowing leakage through sides. N95 masks reduced leakage through sides in addition to reducing the momentum of cough. Surgical and N95 masks serve an important purpose in preventing airborne virus transmission as they reduce the turbulent jet produced by cough from reaching the breathing zone of other people. Ma et al., (25) evaluated the effectiveness of 3 types of masks and instant hand wiping in blocking avian influenza virus in aerosols and removing it from hands respectively. They noted a decline in the amount of virus with hand washing using the Ct values obtained through RT-PCR. Using syringes to mock human breath they examined the effectiveness of masks to block aerosols and found that the masks blocked most of the virus with the amount of virus blocked being highest in descending order for N95 mask, surgical mask and cloth mask.

**Use of N95 Vs Surgical masks (Table 2)**

According to randomised trial conducted by Loeb et al., there was no much difference between the use of N95 and surgical mask in preventing influenza. Compared to N95, inability of surgical mask in providing proper seal did not seem to have much effect in preventing influenza like illness (26). In laboratory setting , N95 had shown better protective ability compared to surgical masks. However, in actual clinical setting, there was no significant difference in protection against respiratory illnesses when use of N95 & surgical masks were considered(27). Review of studies by Long et al., (28) and Iannone et al., (29) also confirmed that use of N95 did not lower the risk of respiratory illness when compared to surgical masks. Use of N95 as a recommendation for general public & non high risk medical staff who are not in contact with patients with respiratory illness cannot be justified.

**Table 2: Use of N95 vs surgical masks**

<table>
<thead>
<tr>
<th>Ref no</th>
<th>Author</th>
<th>Year</th>
<th>Study design</th>
<th>Subject</th>
<th>Results</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Loeb, M</td>
<td>2009</td>
<td>Randomised trial</td>
<td>Nurses</td>
<td>23.6% of subjects contracted influenza in the surgical mask group, and 22.9% contracted the same in the N95 respiratory group</td>
<td>The use of a surgical mask compared with an N95 respirator resulted in non-inferior rates of laboratory-confirmed influenza</td>
</tr>
<tr>
<td>27</td>
<td>Smith, J.D</td>
<td>2016</td>
<td>Systematic review</td>
<td>Healthcare workers</td>
<td>No significant difference between N95 respirators and surgical masks in the laboratory-confirmed respiratory infections, influenza-like illnesses or reported workplace absenteeism</td>
<td>Insufficient data to determine definitively whether N95 respirators are superior to surgical masks in protecting healthcare workers against transmissible acute respiratory infections in the clinical setting</td>
</tr>
<tr>
<td>28</td>
<td>Long, Y</td>
<td>2020</td>
<td>Systematic review</td>
<td>Patients</td>
<td>No statistically significant differences preventing laboratory-confirmed influenza, laboratory-confirmed respiratory viral infection and influenza-like illness using N-95 respirators and surgical masks</td>
<td>The use of N-95 respirators compared with surgical masks is not associated with a lower risk of laboratory-confirmed influenza</td>
</tr>
<tr>
<td>29</td>
<td>Iannone, P</td>
<td>2020</td>
<td>Review article</td>
<td>Health care workers</td>
<td>Wearing N95 masks could prevent more clinical infections in trials but with low-quality evidence</td>
<td>No high-quality evidence on whether N-95 respirators are better than surgical masks</td>
</tr>
</tbody>
</table>
### Table 3: Effectiveness of double mask

<table>
<thead>
<tr>
<th>Ref no</th>
<th>Author</th>
<th>Year</th>
<th>Study design</th>
<th>Subject</th>
<th>Results</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Chughtai, A.</td>
<td>2013</td>
<td>Review article</td>
<td>Health care workers</td>
<td>Although doubling the layers in masks increased pressure drop, which suggests greater difficulty breathing, it did not improve the effectiveness of the filtering</td>
<td>Lack of enough evidence regarding effectiveness of cloth mask</td>
</tr>
<tr>
<td>31</td>
<td>Sharma, S.</td>
<td>2021</td>
<td>Experimental study</td>
<td>Volunteers</td>
<td>High momentum large-sized surrogate cough droplets can penetrate single or double-layer mask material to a significant extent. Negligible droplet ejection observed for triple layer of masks</td>
<td>Multiple layers offer more protection</td>
</tr>
</tbody>
</table>

**Effectiveness of double mask (Table 3)**

Based on experimental study conducted by Chughtai et al., (30), they have advised on the use of three layer masks. With the use of high-speed imaging along with physics-based analysis, they showed that high-momentum, large-sized (>250 micrometer) cough droplets can penetrate single- or double-layer mask material, whereas a three-layer masks can effectively block these droplets and can be used as a key tool against COVID-19 or similar respiratory diseases. In a review study conducted by Sharma et al., (31) more emphasis was given on the efficacy of cloth masks. Their research highlighted on improving in vitro filtration capacity by increasing the fineness of the fabric and number of layers.

**DISCUSSION**

In our review on studies on masks giving protection against COVID 19, we found that masks per se won’t give sufficient protection, especially if it is worn intermittently; in addition, there could be leakage through the sides of the N95 mask. N95 masks are preferable to surgical masks, according to studies contrasting the two types of masks. However, the difference was only marginal. A double mask or triple masks offers more protection compared to a single-layer mask.

In total, 19 randomised controlled trials-eight in social contexts, six in clinical settings, and five as source controls were included in a study (21). A variety of interventions were used in the majority of these randomised controlled experiments and performance metrics. In the neighbourhood, masks seemed to be useful with or without good hand hygiene, and both are more protective when used together. A double-layer mask with a lower effective porosity and a higher effective thickness than a single-layer mask, greatly reduces the amount of droplets that can pass through the mask. A few locally sourced fabric masks with single and double layers were also tested in addition to surgical masks, and similar penetration behaviour was noted for single and double-layered masks as well.

The adverse effect of wearing masks also needs to be considered. In a study by Fikenzer et al., (32) it was discovered that capacity and comfort for cardiopulmonary exercise of healthy people were significantly hindered by FFP2/N95 face masks and decreased by surgical masks. Peak expiratory flow was considerably lower with a mask and forced expiratory volume was significantly lower. With the mask on, the peak blood lactate response was decreased. With and without the mask, cardiac output was comparable. Wearing the masks consistently caused significant discomfort, according to participants.

Policymakers have interpreted the diverse and somewhat scant primary material in a variety of ways. According to the World Health Organization, masks should only be used by people who have symptoms that point to covid 19 and should not be worn by anybody else save for medical professionals . WHO does agree, however, that public mask use in severe pandemics has a place as even a minimal protective impact could have a significant impact on transmission . The public was originally recommended against wearing masks during the COVID 19 pandemic by the US centers for disease control and prevention, however this advice was changed on April 4, 2020 . The improvised cotton mask that the CDC advised has not been tested in any of the aforementioned investigations. As far as we are aware, there are no public trials for face masks. Cloth masks were found to be the least effective, surgical face masks were typically used as "standard practice," moreover, there was no real control arm that did not include a mask in a three-arm trial to prevent influenza-like illness in healthcare workers (33).
The usefulness of the face mask in reducing the transmission of COVID-19, among this particular demographic of people who are not already diagnosed with COVID-19, was not the subject of any studies, according to the review search. We explored the paucity of data on the usefulness of face masks to stop the spread of COVID-19 among people without a medical diagnosis and how these findings affect the existing recommendations.

A prospective clinical trial of face mask use was conducted in a study by MacIntyre et al., (34) in response to the urgent need to clarify the clinical advantages of employing masks. The main results showed that over 50% of participants consistently used masks. Analysis revealed no distinction between the arms. Another study done by Cowling et al., (35) on the impact of non-pharmaceutical interventions examined that, for the prevention of COVID-19, the use of surgical masks and washing hands did not significantly differ across the arms.

CONCLUSION

This systematic review was unable to locate any studies that provided conclusive proof that wearing mask has protective role against COVID-19 in people who have not been diagnosed with COVID 19. However the public mask usage in severe pandemics have a minimal protective effect but have a significant impact on COVID-19 transmission. It is crucial to draw attention to the lack of scientific evidence because it calls into question the rationale behind the inconsistent and erratic public health advice for wearing a face mask that has been given to people who have not yet received a formal diagnosis of COVID-19 since the outbreak of COVID-19 began. Wearing a mask and wearing it properly can lower the chance of infection but not completely eliminate the risk of getting sick. The disease risk can be reduced when used along with non-pharmaceutical precautions such as hand washing, social seclusion, isolation, and vaccination.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES


DOI: https://doi.org/10.51248/v42i5.1513


