

A Review Article on Effectiveness of Face Mask against COVID-19 Transmission

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ABSTRACT

COVID-19 has been declared an epidemic by WHO on 11 March 2020. As of today, May 7, 2021 this virus has infected over 156.7 million people with recorded 3.3 million deaths worldwide according to statista.com (German online database company). Currently due to its rapidly mutating features and emerging new variants, WHO has not yet come up with a worldwide standard medical treatment protocol? Prevention alongside proactive health precautions has always been the primary choice of actions to be implemented to curb the spread of infectious diseases in general population. The goal of this text review is to assess the effectiveness of the face mask against the novel Corona virus. 11 studies were included in this article review. A study emphasized that non-valved N95 is way more effective than other masks available on market. Also, another study stated that mask efficacy is equally hooked into its fabric and fit. Two studies established the mask and respirator's efficacy in preventing respiratory virus transmission and Corona virus. More studies in controlled contexts, alongside mask efficacy in different strain spread and studies of infections in institutions, healthcare facilities and community places are needed for a better explanation of the effectiveness of mask against COVID-19.

Key words COVID-19, Mask, Facemask, SARS-CoV-2, Healthcare facilities

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INTRODUCTION

The world population is under threat due to rapidly galloping COVID-19 spread worldwide due to globalization and international travel. There is currently no nation on earth that remains unaffected by this virus. Due to its highly communicable characteristics, it has questioned the overall global health character and government authority to immediately introduce preventive and pro-active measures to repress its spreading and decline its impact [1]. It's a global health emergency now. The first case was registered in Wuhan province of China on December 26, 2019, when a 41 years old adult male (seafood market worker) was brought to the Wuhan's central hospital with the chief complaint of fever, unproductive cough and dizziness. Later diagnosed with a newly discovered respiratory illness which known as named SARS-CoV-2, is very closely associated with the bat SARS like Corona viruses family (genus beta Corona virus, subgenus sarbecovirus). SARS-CoV-2 is primarily transmitted as an airborne disease by respiratory route in between humans [2]. But due to its nobility, many governments strictly implanted preventive measures to curtail the spread of the

disease. Corona virus has not only impacted individual health but has set major setbacks and brought uncertainty to almost all sectors including financial services and edged major governments to global recession. World health organization has come up with basic health guidelines to aware general population and brought this fight against COVID-19 to individual level to completely eradicate COVID-19 pandemic from the face of earth. Face masks and other protective measures are very crucial in fight against this unprecedentedly transmitting virus. Research studies on such topics are needed to better formulate and manage this global health emergency. Face mask efficiency can be determined by different type of clinical trials, epidemiologic studies and laboratory studies [3].

Initially hand hygiene, facemask were limited to medical caregivers, hospital staff and symptomatic patients. Later it was identified that there has been proof of asymptomatic carriers of this disease infecting other healthy individuals, which leading to increasing universal demands, though unpredictable, of face mask and face protection items by the common population as a protective gear to fight against COVID-19 [4]. There has been no specific treatment available for this disease till now. Infected person comes with the chief complaint of fever, pneumonia like symptoms, cough, body ache and some shows gastro intestinal symptoms which can lead to

death in high risk patients [5]. The surgical face masks was mainly invented for protection of patients from hospital based infection and reduce infection transmission from surgeon to patients during open surgery and vice versa [6]. Infection by droplets can occur *via* physical contact of the infected person or by settling of release droplet on mucosal surface directly or indirectly [7]. These findings highlighted the importance of such studies to understand the role of face masks and other face coverings in containing COVID-19 spread.

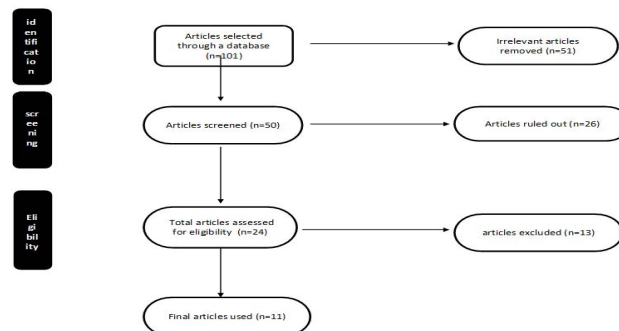
Establishing the importance of face mask against COVID-19 spread is such a complicated topic but also a need of hour to aide scientific and regulatory authorities to keep them updated to formulate better future plans. This article review talk about the existing knowledge about different type of mask as well as its other components like fitting, filtration efficiency, usefulness and side effects. Different options for face masks are readily available in market for ex-home crafted mask, surgical mask, valved N95 mask, non-valved N95 mask. Mask is being produced by using single layer, double layer or even triple layers mounted over one another. Fabric, internal layer and external layer are the 3 types of layers which are being used in production of face masks. In recent years, filtration materials like Nano fibers are also being used in production of face mask [8]. The main mechanism of action for filtrations through the layers of mask are used is droplet diffusion. Another factor which plays a major role in deciding efficacy of face mask is leakage of tiny droplets. Numerous scientific studies had been conducted till now related to mask use in the healthcare setting, in the general population and other health services. These studies were different based on settings, actions, designs, intervention and participants. This study aimed to analyze the existing knowledge on the scientifically proven efficacy of face protection in the form of face mask against the COVID-19.

LITERATURE REVIEW

In this review we explored the role of face mask among the healthcare settings and in common population during the COVID outbreak. We revealed the efficacy of different type of face mask in prevention of COVID-19 transmission in order to decrease mortality and morbidity with or without vaccination or in absence of no availability of specific treatment protocol [8,9]. Appropriate usage of the face mask with addition of hand wash plays a major role to reduce the disease transmission in healthcare system and in general public health. We explored varieties of face mask and its efficacy in multiple settings and experiments.

Material and methods: Guidelines laid by the PRISMA declare nations were thoroughly followed while conducting this text review. A literature search was performed on the web research portal PUBMED using different key terms. Search key terms used were "mask", "facemask", "COVID-19", "SARS-CoV-2". Articles published up to the month of April 2021 were used for data processing. Primary search resulted from 101 citation supported abstracts and titles, out of which 12 irrelevant studies were excluded. 24 articles were selected for full text review. Exclusion of studies was made due to the following reasons: Hypothesis, meta-analysis, systematic review, not in English, editorials. Finally, 11 articles were fully assessed, thoroughly

evaluated and then included during this study.



Result: The survey articles were significantly different in terms of participants, intervention, actions and designs. So this study mainly focused on the outline of, results, their application, and limitations. Prospective observational studies by Williams, et al. they devised a unique device to detect and measure exhaled SARS-CoV-2 in hospitalized patients with this disease. They undertook two concomitant FMS (face mask sample) and NPS (nasopharyngeal sample) of COVID-19 positive patients at the university hospital of Leicester NHS UK for over 2 days. Patients were instructed to wear a modified duck billed facemask for duration of 30 min and nasopharyngeal swab was taken without any delay. "Radiological data, demographic, clinical data along with International Severe Acute Respiratory and Emerging Infections Consortium (ISARIC) mortality and deterioration scores had been taken additionally into the record. By using RT-qPCR technique, they processed the used masks by the way of removal, dissolution and evaluation of sampling matrix strips which were attached with in the masks. Copy numbers of viral genome had been assessed and results were classified into 3 categories: Negative, medium and low; low: ≤ 999 copies (copies less than and equal to 999); medium: 1000–99,999 copies (copies within range of 1000–99,999) and high $\geq 100,000$ copies (copies equal to and more than 100,000) per strip for Face Mask Sample (FMS) or per 100 μ l for Nasopharyngeal Sample (NPS)" [3]. 100 numbers of 102 face mask sample and nasopharyngeal swab were taken from overall 66 routinely positive patients and with their median age 61 (IQR49-77).

Out of which face mask sample positive rate was 38% of individuals and concomitant nasopharyngeal swab was positive in 50%. And at the time of sampling 21(32%) of patients were not symptomatic. Respiratory symptoms at sampling time were associated with high face mask sample viral load and a shorter interval between sampling and symptom onset (face mask sample high: median (IQR) 2 days (2 to 3) vs. face mask sample negative: 7 days (7 to 10), $p=0.002$) [2]. This study was limited by size, age, ethnicity and other comorbidities. Asadi, et al. examined the effectiveness of face covering and face masks in commanding droplets and aerosol tiny particles emission from various expiratory activities [10]. They calculated the outward emissions of tiny particles and aerosol (micron size) by complete healthy individuals while representing 4 expiratory activities breathing, coughing, talking and mandible movement with no mask and also while wearing different kinds of home crafted masks and medical grade masks [4]. Mask tested during studies were a surgical mask, KN95

respirator without vent, one layer towel (SL-P), one layer cotton T-Shirt (SL-T), two layer cotton t-shirt (DL-T), and vented N95 respirator. They recruited a total of 10 numbers of volunteers (6 men 4 women) all of whom were healthy nonsmokers. In their experimental setup, they used aerodynamic particle size (APS TSI model3321) to measure the particles' concentration range from 0.3 to 0.5 μm . And therefore, inside the HEPA filtered streamline flow hood, the APS was placed to attenuate the background tiny particle concentration. Participants were instructed to sit in such a manner so that their mouth was located ahead of a funnel attached via conductive silicone tube to the APS inlet. Then they were asked to perform different expiratory movements while with the mask on, mask off and with other different masks. Two pre-dominant findings were:

- The surgical masks, KN95 (unventilated respirators) and N95 (ventilated respirators) all materially lessen the number of release particles, apart that,
- Particles released from homemade mask which are made up of clothes substantially increase the outward emission of tiny particles without mask which is most likely from shedding fibers fragments. This was the result that complicated the evaluation of face mask efficacy against blocking expiratory particles outward emission.

A limitation was that no direct quantification of virus emission or infectivity were done there, the results raised the likelihood that shedding of fiber particulates from infected cotton masks might function as sources of aerosol fomites [10]. In proof of principle studies by Emma, et al. "they tested low cost measurement of mask like homemade masks efficacy for filtering expelled tiny droplets during the speech". They tested the 14 most common available mask and their alternatives. In their control trials speaker not wearing any type of protective mask or any other face covering. "A 40s length time duration video was captured to record tiny droplets emission while speaking. Subjects were asked to repeat the given sentence "stay healthy people" for 5 times and filmed [11]. They used a lightweight sheet that was shined through the enclosure to detect light scattering from particles traversing the sunshine sheet. They used a Samsung galaxy S9 camera that was placed at a distance of 20 cm from the sunshine sheet to capture the expulsion of liquid tiny droplets during speech and duration in the air. Masks were ranged from below 0.1% that was fitted N95 mask to neck guitar 110%. The fitted N95 mask is that the safest as compared to the opposite mask that was tested. Few limitations were like inter subject variations differences in physiology, mask fit, head position, accent, etc. [11].

Steven, et al. tested the mask efficacy supported both fabric and fit. They assessed both leakage and fabric penetration because of poor fit. In their experiment, they introduced synthetic aerosol into the dummy lung. They also used a conical sheet of laser that surrounds the mannequin face where it illuminates the aerosol emission during artificial simulated breath marked FFP1, d) CE marked type 2 medical mask, e) bandana.

RESULTS

- Unmasked mannequin showed highest overall particle emission and scattering plume seems relatively dim.
- Triple layer masks showed some fabric pierce directly ahead of the mouth and little turbulent ooze from under the eyes.
- One layer mask showed extremely high penetration and a few oozes the brightest of the piercing aerosol is approx. 5 times more than even from the unmasked mannequin thanks to slower, border flow which filled the laser stream with aerosol
- Bandana showed high penetration but leakage was less intense.
- Medical mask and FFP1 mask showed no observable penetration but showed some turbulent jetliners from the cheek along with eyes [12]. The limitation was it had been unknown how dissimilar steam patterns could affect infectivity. Oozing jets pointed to the side and upward directions were supported the direction of local airflow and therefore the mannequin head was larger than 95% of the normal size of an adult head. Another study by Nancy H, et al. revealed that the corona virus present in respiratory droplets in 30-40% of those individuals who are not wearing facemasks. Respiratory droplets can travel far up to 70 cm without mask but droplets can't travel more than 35 cm distance if mask is worn [13].

DISCUSSION

This present review study emphasized the proven and available evidence of the effectiveness of the facemask to contain the spread of the Coronavirus. Because of its highly transmissible nature, it's posed threat to the governments and health system globally to emergency implementation of preventive measures to contain the transmission of Coronavirus. WHO and ANVISA (A Brazilian health regulatory agency) has recommended the general public to opt for non-professional masks [1]. To avoid the sudden shortages of medical masks and PPE. Countries like USA, South Africa, Brazil, and India, which have highly populated areas that have extremely high infection rates so the utilization of masks will surely eclipse any potential pitfall [3]. Individuals who utilize homemade fabric masks should look out to wash and sterilize them frequently to attenuate the likely hood of the release of aerosolized fomites [2]. The fore most productive preventive recommendation is frequent hand washing with hand wash, soap and water along with using alcohol based hand sanitizer, avoiding touching mouth, nose, eyes, proper coughing and sneezing by using tissue and into twisted elbow, wearing face mask if any respiratory symptoms persists, and also by keeping proper social distance of a minimum of 6 feet (2 meters) [1,14].

Using household textiles could also be a potentially life-saving and cost effective anti-pandemic plan of action by cleaning textiles because it has proved to be very effective in destroying COVID-19 by heating at (700°C) for

5 minutes, by bleaching at 1:49 for 5 min, and by using detergents for 20 mins (47–50).” One study shows that washing and cleaning of face mask lessen its efficacy because due to washing fiber fragments of the mask shed off which impacts its quality of filtration. There for it is necessary that awareness should be spread among the people for its proper use and reuse through nurses and other healthcare worker.” House hold textile is more sustainable at community level at this crucial time when there is the shortage of medical disinfectants [5]. Double eight mask brace has also proven very effective in providing better protection against airborne viruses even when it is used with a simple surgical mask. Surgical mask, KN95, non-vented N95, FFP1 are proved very effective against COVID-19 [11-15]. Our study talks about both the advantages and disadvantages of all the methods which are being used as proactive measures. One major disadvantage of using face mask by general population and other face protective equipment is that at this period of time this will hamper the availability of mask to the needy people and health workers because of sudden surge in demand. According to the available data most common mode for transmission of Corona virus spread as well as influenza is aerosol. one study suggest that by using a bio aerosol collecting devices, surgical masks have the potential to reduce the release of virus particles in the surrounding only in the form of droplets not in the form of aerosol [6].

A study conducted in the process of measuring the efficacy of home crafted face mask and commercial face mask. In that study they use more than 20 healthy people to compare the different type of face mask on their efficacy to occlude viral droplets. They found that homemade mask were three times less effective than surgical mask and homemade mask made by cotton was 100% best material compare then other materials which used in making homemade mask. Face mask plays an important role in the list of preventive measures which reduces the transmission of Corona virus. Persons those who use homemade mask should wash them regularly or sterilize for reduce the chance of infection. Studies suggest that homemade cotton mask is less efficient then surgical mask while double layer homemade cotton mask is equally effective as surgical mask. Globally use of face mask by population has its own challenges. But according to the studies done in which they investigate the effect of N95 face mask on respiration while wearing the face mask with one hour sedentary trade mill exercise and found that there is no affect or very less effect of mask like N95 on respiration or ventilation. Although it minor effect the breathing resistance which was slightly increased while wearing the face mask but overall have no effect on tidal volume or other respiratory parameters. Home crafted mask is not as tight as N95 mask will have very less effect or respiratory resistance [16]. Studies suggest that long time use of face mask may affect frequency of headache. It may depend on the mask design, mask fitting, mask straps and other factors [17]. Other complaint like acne, rash and itching were also reported while wearing a face mask [18]. However surgical mask should not be used more than one time. We

have to discard it after one time use and take all the measurements while discarding the mask. In the other hand N95 mask should not be used in patients who have severe respiratory illness [19].

Face mask not only provide protection from novel Corona virus but it provides protections against other respiratory viruses and environment pollutants. In area where population density is higher, face mask play a vital role in protection of highly infections respiratory diseases [20,21].

If use properly a face mask is still a better choice in containing spread. Firstly, one has to do proper cleaning by hand washing, by gently holding the strips of a face mask one must apply it over his/her face with proper covering of nose and mouth. Adjust the mask without leaving any gap and avoid touching the mask. When removing the mask, one should remove it by holding strips from behind the ears and bring it forward away from the body and discard it immediately and follow hand hygiene procedure again to ensure no traces of virus left behind on hands and face. The usage of face mask along with frequently hand washing and social distancing can similarly lessen the unfold of COVID-19, as a protective masks may also lessen the probability of infection, however now no longer do away with the hazard for the transmission of COVID-19 [22-24]. Adherence to only single protective measure like face mask or only hand washing is not sufficient to stay protected from the reach of virus. It must be exercised with other protective measures like hand washing, social distancing, home isolation of suspected and infected person and immunization. Home prepared cloth mask should be allowed for general people but with proper fabric testing and guidelines to meet the surge demand. It has always been better to prefer such mask instead of no masking [25-26].

CONCLUSION

There is enough evidence from surveyed studies to support the effectiveness of facemask especially non-vented N95 respirator and surgical mask with good fitting and design to decrease the risk of COVID-19 transmission but it is not the final solution. It is proven effective in repressing the prevalence of COVID-19 infection among healthy population and healthcare workers. Due to the novelty of Corona virus, mask along with adherences to other health principles, frequent hand washing, PPE kits for health care workers and use of disinfectants can reduce the prevalence of COVID-19 in health care providers and general populations. Other general measures to prevent infection must be used along with compulsory universal masking, hand hygiene, social distancing to contain the spread of disease. More specialized and controlled studies are required to study the effectiveness of facemask against other emerging variants. Mask is not the final solution for this pandemic, vaccination is but vaccinating the global population is a very challenging job. In the meantime, universal masking's along without the other general health measures are very crucial to contain the spread of a

COVID-19 pandemic. Major's government around the world has been implementing lockdowns in phases to buy times for health care services but it is taking a heavy toll on economic activities and affected individuals lives and their families. Face mask, adequate social distancing and hand hygiene have been extensively used to bring people back to their normal lifestyle which is still a distant goal. But adherence to these precautionary measures at individual level has flattened the curve.

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