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Review Article

Facemasks and COVID-19 prevention: to use or not to use

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Abstract

There are uncertainty and conflicting opinions about the effectiveness of facemasks in prevention of COVID-19 either alone or with other non-specific measures in different settings. However, their use was recommended and even enforced by authorities in different countries and situations. Availability, types, utilization and acceptability of facemasks at community level are crucial for their effects on COVID-19 mitigation. There is a lack of strong evidence either in favor of or against the wide scale use of facemasks by the general public. The World Health Organization initially advised general public not wear masks but later advised masks for everybody. This narrative review highlights all these controversies and summarizes the updated recommendations.

Keywords: COVID-19, facemasks, medical masks, cloth masks, respirators

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1. Introduction

An unprecedented pandemic of COVID-19 began in late 2019, affecting millions of people worldwide. The COVID-19 is an infectious disease that spreads through droplets of respiratory discharges or saliva of the infected persons. (1-3) The current preventive strategies of COVID-19 infection rely on personal protective measures such as covering of nose/mouth when coughing or sneezing, use of facemasks and hand hygiene after contact with contaminated objects/materials or respiratory secretions. (4) There is insufficient evidence for the use of medical masks by healthy individuals at home or even in mass gatherings and there has been a debate on whether masks should be worn or not. (5, 6) However, the update of the CDC is to use a cloth face cover for the general public in settings where social distancing may not be achievable. (7) There is a dearth of information on the acceptability and efficacy of the different types of face masks in preventing COVID-19 infection. Furthermore, for ethical and moral reasons, the policy makers enforce wearing facemasks as a potential non-specific preventive measure being available nowadays.

Despite the lack of a definitive evidence on the effectiveness of wearing facemask in community, its use as respiratory protective measure is effective in preventing COVID-19 transmission. (5, 7) The

worldwide shortage of facemask during the pandemic has become a social concern. (8, 9)

The search strategy included PubMed, EMBASE, Cochrane Library databases, Medvix, Google scholar and grey literature for papers that reported or commented on the use masks during the current pandemic of COVID 19. We included all types of studies primary and secondary clinical studies that approached the use of masks for patients, healthcare workers, caregivers or the public during the pandemic with no exclusion criteria. Our search strategy included the following key terms (2019-nCoV OR 2019nCoV OR COVID-19 OR SARS-CoV-2 OR (Wuhan AND coronavirus) OR (Coronavirus Disease) AND 2019/12[PDAT]:2030[PDAT]) AND (Mask OR Facemasks OR Respirators OR Personal Protective Equipment).

2. Types of facemask

There are three types of facemasks: non-medical masks, medical masks (surgical and procedure) and respirators. All types cover the nose and face of wearers to protect them from respiratory droplets. (10-14)

a) Community (non-medical) masks

These are fabric/cloth masks used by the public to prevent spread of COVID-19 in combination with other hygienic measures. (15) They are not standardized and

are not intended for use by healthcare workers or in healthcare facilities. (16)

The performance of these facemasks varies with their shape and fit as well as the number of layers and fabric structural properties. (17, 18) They act as a physical barrier to small droplets secreted during talking, sneezing or coughing. These masks should not interfere with breathing, and should fit properly and be comfortable to wear. (13, 19)

The use of cloth masks should be addressed in policy documents of best practice in low- and middle-income countries. (17) It is recommended that healthy people wear a cloth face mask (simple, sustainable and economic) in public if there is shortage of surgical masks. (7, 13, 20)

b) Medical masks

These are disposable one-time use unfitted devices worn by healthcare worker, an infected person, or member of the public to reduce the spread of respiratory infections. There are two types of medical masks: surgical and procedure masks. (16, 21)

- i. Surgical masks were originally designed to protect the operating field from contaminants generated by the wearer. There are of two types; 1) Duck-billed or flat-pleated in shape, conforming to the bridge of the nose with a flexible piece, affixed to the head with two ties; and 2) Premolded, conforming to the bridge of the nose with a flexible piece, adhering to the head with a single elastic piece. (13, 22, 23)
- ii. Procedure masks are flat-pleated or duck-billed in shape and fasten to the head with ear loops. (22)

c) Respirators (Filtered Face Piece=FFP)

The respirator is a fitted device that protects the wearer against inhalation of harmful contaminants. Respirators can be disposable or reusable. (10, 21, 22)

Respirators (N95, FFP2, KN95 and P2) are worn to reduce the wearer's risk of inhaling hazardous airborne particles (e.g. infectious agents, dusts, gases, vapors). They are designed to fit tightly on the face with a minimum 95 percent filter efficiency at the most penetrating particle size. They are mainly used by healthcare workers to protect themselves during aerosol-generating procedures. (13, 16) The use N95 mask by

the public is not recommended. (24) Long et al. concluded that the use of N95 respirators compared with surgical masks is not associated with a lower risk of laboratory-confirmed influenza. They suggested that N95 respirators should not be recommended for general public and non-high-risk medical staff. (11) Compared to simple surgical masks, N95 respirators are more expensive, uncomfortable and irritating to skin. (24)

Correct uses of masks

The use of facemasks is important in healthcare settings where exposure is frequent and intense. Despite the lack of evidence for the use of medical masks by the general public, some authorities are enforcing their use in public places. (25) It was recommended that masks be worn by symptomized persons but not by healthy people in general. However, there is some evidence that voluntary wearing of masks by healthy or asymptomatic persons in the community can help decrease the transmission of COVID-19. (26)

Personal protective equipment (PPE) should be simple to remove after use without contaminating the user. Experience indicates that complex PPE increases risk of contamination during their removal. Masks must be changed every day however; many people have to use them repeatedly. (25)

Healthcare workers should adhere to proper donning, doffing and discarding protocols of face masks. (27, 28) To wear a facemask: inspect masks for damage and structural integrity; wash hands with soap and water or clean them with alcohol-based hand rub; put over the nose, mouth and chin; the colored side of the mask should face outside; fit flexible nose piece over the nasal bridge; secure on head with elastic or ties; fitting snugly around face with no gaps; and avoid touching or adjusting mask during use. Replace the mask with a new one as soon as it is damp and do not re-use single-use masks. (28-32)

To remove the mask: do not touch the front of the mask remove it from behind; if the mask has ties, untie the bottom, then top tie, remove from the face, used masks should be treated as medical waste; lastly clean hands with alcohol-based hand rub or preferably wash with soap and water. (28,30-32) Table 1 summarizes characteristics and the use of different types of masks in different situations during the COVID-19 pandemic. (33, 34)

Table 1. Characteristics and use of different types of masks during the COVID-19 pandemic

Parameters	Multilayer reusable mask	Medical masks	N95 respirators
Layers	fabric/cloth masks (not standardized) multiple layers	Made of 3 layers with pleats	3 layers of Microfibers of polypropylene layered on top of each other and electrostatically charged
Fitting	Fitted, simple	Non fitted	Fitted uncomfortable
Cost, availability	Cheap, available	Less expensive	Expensive, less available
Reuse	Reusable	Single use	Single use
Reprocessing	Can be washed with soap and reused	No evidence	Little evidence, hydrogen peroxide, ultraviolet, moist heat

Effectiveness	Not to be used in medical settings. No sufficient evidence of effectiveness for use in general public.	Equally effective to N95 if associated with proper hygiene	minimum 95% of Viruses <0.3µm
Recommended for	Only for general public	<ul style="list-style-type: none"> • Healthcare workers • Family care giver of a suspect or a confirmed COVID-19 patient • COVID-19 patients • Non-COVID-19 patients • During a visit to a healthcare facility. 	<ul style="list-style-type: none"> • Healthcare workers • Non-COVID-19 patients

3. Effectiveness of facemasks

There are conflicting evidences about effectiveness of facemask. Effectiveness differs from study to study according to type of mask, population studied and setting of use. To be effective facemasks must be correctly worn, frequently changed, properly removed and disposed of safely. (35-37) Gandhi et al. stated that masks, depending on type, filter out the majority of viral particles, but not all. They hypothesized that universal masking reduces the “inoculum” or dose of the virus for the mask wearer, leading to more mild and asymptomatic infection. (38) Howard et al. in their review concluded that the preponderance of evidence indicates that mask wearing reduces the transmissibility per contact by reducing transmission of infected droplets in both laboratory and clinical contexts. (39) Strizova et al. postulated that the use of face masks in public presumptively decreases the viral load and contributes to a favorable clinical outcome in COVID-19 disease. They added that obligatory face mask wearing in public favors the virus transmission through oral mucosa and/or conjunctival epithelium, which enables the adaptive immune responses to evolve. (40)

Clinical settings

Up to date evidences on the effectiveness of the use of masks to prevent respiratory viral spread in clinical settings contradicts each other. Face masks significantly decreased bacterial dispersal initially but became almost ineffective after two hours of use. (41) It was found that wearing either facemask or N95 masks is effective in reducing the spread of respiratory infection. Systematic reviews reported that wearing medical/surgical masks or N95 respirators throughout the entire work shift provided greater protection against clinical respiratory illness and laboratory-confirmed upper respiratory tract bacterial colonization. (24) But the protection against laboratory-confirmed viral infections including SARSCoV was non-significant. (10,12) Other systematic reviews reported a non-significant difference between medical/surgical masks and N95 respirators in prevention of influenza. (11,42-46) Salunke et al mentioned that surgical masks are equally effective to N95 respirators if worn regularly, combined with commitment to adequate hygienic measures. Extended use and reuse of N95 respirators may cause hand contamination. If given the choice, extended use is preferable to reuse. In case of shortage, the hazard can be reduced with covering the N95 respirator with surgical

mask or face shield, avoiding touching the outside or the inside of the mask, adherence to hand hygiene before and after removal, discarding the N95 respirators if visibly contaminated, appropriate storage between uses in designated areas (clean air, away from direct sunlight, and suitable humidity, and temperature), where no distortion or crushing can take place. Some methods for disinfection N95 respirator have some promising results, but need further studies such as Ultraviolet radiation lamp, hydrogen peroxide vapors, and moist heat. (34)

Community settings

Scientific data on effectiveness of facemasks in reducing infections in the community are extremely limited and even inconsistent. There are no high-quality studies evaluating the impact of mask wearing by large segments of the population in public settings. There have been several studies on the use of medical masks outside of the hospital setting. These studies have evaluated the effectiveness of masking household members and individuals in other confined spaces (e.g. university residences, airplanes) to prevent acquisition of respiratory infections. In the majority of studies, no significant benefit from wearing masks was identified. Studies that demonstrated a benefit were associated with enhanced hand hygiene measures. (47)

Many systematic reviews and meta-analyses concluded that there is little evidence of the effectiveness of facemasks to decrease the risk of transmission of influenza virus in community settings. (48-50) Recent studies provided some indirect evidence of the benefits of facemask when combined with social distancing, but no isolated effect. (49, 51) However, there is enough evidence to support the use of facemasks for short periods of time by particularly vulnerable individuals when in transient higher risk situations. (52) Furthermore, van der Sande et al. concluded that any type of general mask use is likely to decrease viral exposure and infection risk on a population level. (53) Sunjaya and Jenkins postulated that universal masking may help in reducing droplet-based transmission of COVID-19 and contribute to flattening and shortening the curve. (54) The decreased transmissibility could substantially reduce the death toll and economic impact while the cost of the intervention is low. (39)

Non-medical masks

Disposable, cotton and paper masks (compared with medical masks) were not recommended for protection

against respiratory infection spread. (10) However, Konda et al. found that combinations of various commonly available fabrics used in cloth masks can potentially provide significant protection against the transmission of aerosol particles. (55) Furthermore, it was found that the bacterial efficiency is similar for cotton fabric and two-ply disposable masks. (41) The evidence from laboratory filtration studies suggests that such fabric masks may reduce the transmission of larger respiratory droplets. There is little evidence regarding the transmission of small aerosolized particulates of the size potentially exhaled by asymptomatic or pre-symptomatic individuals with COVID-19. (56) Shakya et al. found that cloth masks are only marginally beneficial in protecting individuals from particles 02.5 µ m. (18)

4. Hazards of facemasks

Literature highlighted many potential hazards of wearing facemasks in the public to mitigate COVID-19. These include: (14-17, 19)

- False sense of security (32): The World Health Organization warned that this false sense of security can lead to neglecting other essential protective measures. (5) This is known as Peltzman's effect or risk compensation that is introducing one safety measure may lead to other compensatory risk behaviors. (57) This is important with the incorrect use of medical masks e.g. poorly fitted or the use of substandard masks. Also, filtration can be extremely poor (almost none in cloth masks). (58)
- Increased risk to wearer due to inappropriate use e.g. infrequent or non-changing single-use masks, touch their masks and incorrect disposal. (32, 59)
- Decreases both quality and volume of speech between people wearing masks and they may unconsciously come closer.
- The exhaled air goes into the eyes with uncomfortable feeling and wearer touch eyes with contaminated hands.
- Difficult breathing for people with asthma and chronic obstructive pulmonary diseases. (60) Facemask wearers re-inhale the exhaled carbon dioxide that worsens the burden of COVID-19. The infected people wearing masks push the viral load down into their lungs.
- The high viral load in the humid air together with viruses captured by the fabrics of masks can cause a defeat of the innate immunity and an increase in infections.
- The increased demand on medical PPE may endanger frontline workers with limited access to the equipment they need. It also increases the risk for members of the public who may purchase a low-quality mask due to fear of not doing the right thing.
- Wearing facemasks when not necessary may increase cost and procurement burden
- Much harm were identified during the SARS epidemic and included respiratory fatigue, increased work of breathing, poor work capability, increased nasal resistance of organisms, fatigue with minimal workloads, facial dermatitis, acne and potential self-contamination events. (61-66)

- N95 and surgical facemasks induce significantly different temperature and humidity in the microclimates of the facemasks, which have profound influences on heart rate and thermal stress and subjective perception of discomfort. (67)
- Prolonged use of PPE, specially the N-95 respirator, can lead to the development of device-related pressure ulcers (DRPU) over the face of HCWs. High incidences (83.1% and 78.7%) of skin damage over the nasal bridge and cheek were reported. (68)
- Physical and psychological stresses were common among HCWs with prolonged wearing of PPE. (68)
- Workplace hazards including heat stress, psychological stress, impaired vision (due to fogged eyeglasses), difficulties with verbal communication and lapse in attention to a task.

Contraindications

Facemasks should not be used by young children under age 2, anyone who has trouble breathing (pre-existing heart or lung disease), or is unconscious, incapacitated or otherwise unable to remove the mask without assistance. (16, 69)

Availability/shortage

Facemasks should be available at a reasonable cost, adequately supplied and distributed to the public so as not interfere with their availability in health care settings. Facemask wearing has become a social concern due to the global facemask shortage with the increased demand. A universal facemask wearing policy put an enormous burden on the facemask supply. However, governments deny this shortage. (70) It was concluded that there is a shortage of PPE all over the world. (71) A major challenging ethical issue during COVID-19 pandemic is the lack of adequate PPE in most countries and many high-risk situations, with the consequent risk of catching the virus. (72) It is important to respond to the global shortage of PPE by minimizing the need, promoting the rational use, coordinating the supply chain mechanism and more production of the PPE on an emergency basis. (73)

5. Disposal of facemasks

Mask garbage has been increased and must be disposed of in a sanitary way. Many used masks have been discarded indiscriminately in different places e.g. public transportations, hospitals, streets, etc. These discarded masks may cause secondary infections. (63)

Medical wastes, including used masks known or suspected to be contaminated with COVID-19 should be considered and handled as hazardous medical waste. Fold, tie and wrap are the triad of proper disposal of facemasks after use. Fold the mask half inwards, then fold into another half to be a roll like, wrap with its ear loops, wrap in a piece of tissue and put into a plastic bag then throw into the garbage bin. (74) Place all used disposable gloves, facemasks, and other contaminated items in a lined container before disposing of them with other household waste or preferably in special recycling bins. (63)

6. Conclusion

The basic preventive measure of COVID-19 is social distancing and avoiding crowded places. Wearing a facemask is not a standalone preventative practice against disease transmission. Till date, there is a lack of direct evidence that the use of facemasks prevents spread of infection in the ongoing COVID-19 pandemic. Facemasks have an important role in health care settings, but there is little evidence of benefit from their use in community. Proper donning and doffing technique are critical for the effectiveness of facemasks. The quality and specifications of commercially available and homemade masks for personal use in nonclinical settings need to be monitored regularly to ensure their effectiveness. It is necessary to quantify the complex interactions that may well be operating between positive and negative effects of wearing surgical masks at population level.

Commonly use mask are Surgical mask, N95 Respirator mask, Cloth mask. Use of face mask is a common practice around the world, especially in countries. The general public uses a face mask as a measure to prevent breathing in dust or airborne particles. In Covid-19 Pandemic, there has been a debate going on the different type of mask usage or to whether all people should wear mask considering the mask shortage for Health care workers. Public health agencies have advised the general public to use homemade cloth mask when in public and World Health Organization (WHO) have released guidelines on when and which mask to use when taking care of suspected or confirm coronavirus patient. Business and communities have stepped up in providing resources to the health care system to help fight in this pandemic. Many country governments have regulated warning face mask or covering up mouth and nose when in public. Overwhelming Health care system around the world has come up with ways to manage with limited resources. Shortage of mask has led to black marketing and price gouging of this life-saving Personal Protective Equipment (PPE). (75, 76)

Evaluation of effectiveness studies of facemasks in preventing COVID-19 should include both internal and external validity of these studies. Internal validity is concerned with risk of bias, adequacy of samples and data analysis. External validity is concerned with generalizing findings of primary studies in a different population. Further large multinational clinical and field (community-based) trials are needed to evaluate the efficacy of face masks in preventing respiratory virus transmission in both clinical and community settings. There is a need to develop validated tool to measure the acceptance of and adherence to facemasks as a pre-request for their effectiveness. Many researches are ongoing and new evidences are evolving so readers should update their knowledge regularly.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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