National Collaborating Centre for Environmental Health
Centre de collaboration nationale en santé environnementale

Masking During the COVID-19 Pandemic

Last updated Oct. 21, 2020

Prepared by
Juliette O'Keeffe

Introduction

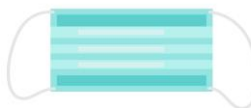
Extensive debate over when, where, and what types of masks should be worn, and by whom, has persisted during the COVID-19 pandemic with questions arising over the efficacy of different types of face covering in different settings. Since the beginning of the pandemic, agencies such as the World Health Organization (WHO)[1] have updated their guidance on the use of non-medical masks in community settings, recommending mask wearing where there is a high level of community spread of the virus and in crowded locations where it is difficult to maintain physical distancing. The Public Health Agency of Canada (PHAC) similarly updated recommendations for wearing of non-medical masks or face covering in settings such as crowded shopping areas, public transportation, and other settings where it is difficult to maintain physical distancing. PHAC has provided additional advice on wearing and making of non-medical masks.[2]

The purpose of this document is to outline the most commonly used types of masks, their effectiveness in providing protection against pathogenic hazards based on a rapid review of the literature, and to list key considerations for the safe use. Given the changes to guidance from public health agencies and emergence of newly published literature, this document has been updated from the previous version published in April 2020 to reflect these changes and address additional questions arising about the use of masks to reduce transmission of SARS-CoV-2.

Types of masks

There are now a wide variety of masks used for medical and non-medical purposes. In simple terms these can be grouped as medical masks, which include **respirators** (commonly referred to as N95, or filtering facepieces [FFP] masks) **and surgical masks**, and non-medical masks including homemade **cloth masks and other face covering not intended for healthcare settings**. Differences between these are summarized in **Table 1.**

Table 1 Overview of mask types

	Respirator	Surgical or procedure mask	Non-medical cloth mask
			
Types	N95, 99, 100 (US, Canada), FFP2 or FFP3 (EU). Various styles including cup, flat-fold and duckbill. May also include an exhalation valve.	Typically a 3-layer laminate structure that can include a combination of non-woven air-laid paper and polypropylene.[3]	Wide variability in fabric, number of layers and design with 2-layer cotton being a common design.
Use	For use in environments where exposure to aerosols is likely. Protect against most particles (e.g., N95 block 95% of particles and provide some splash and spray protection). Medical grade N95s are tested for resistance to fluids including blood, but commercial grade are not.	For use in routine care to reduce inward and outward transfer of respiratory droplets. Filter particles > 20 µm diameter and some finer droplet nuclei.[4] Block blood and infectious materials from contact with oral, nasal and skin area. Effective against splash and sprays.	For use by the public in non-healthcare settings as source control to reduce respiratory emissions from the wearer and to reduce exposure to respiratory emissions of others.[3,5]
Approval	U.S. National Institute for Occupational Safety and Health (NIOSH) for N95 or similar and EU standards for FFP equivalents.[6] The Government of Canada lists other approved alternatives to N95s.	FDA with grading based on the level of resistance to splashing (e.g., ASTM 1 – venous pressure; ASTM 2 – arterial pressure; ASTM 3 – high velocity splash).	Not approved for use in any healthcare setting; not tested to any standard of effectiveness. **Note:** Many procedure-type masks found in retail outlets may not be assessed to any approval standards, and would also be considered non-medical masks.
Advantages	Medical grade respirators can be effective against aerosol penetration. Can be reused and disinfected with precautions.	Some protection against contact transmission, are disposable and inexpensive. Fit testing is not required.	Inexpensive and can be made from household materials. Can act as a reminder to not touch face.[5] Can be reused and laundered.[7]
Disadvantages	Filtration efficiency for aerosols is only effective if properly fit tested. Some users may experience some reduction in comfort/breathability. Expensive and may be in short supply.	Less effective against smaller particles (e.g., 0.4-1.3 µm), looser fit than N95 respirators, and therefore more penetration via leaks.[8] Not recommended for reuse or disinfection for use in healthcare environments.	Variable performance for respiratory protection and breathability depending on the material and design.[9] They do not replace other protective measures (e.g., hand hygiene and distancing).[5,10]

Evaluating the effectiveness of masks

Masks are worn by individuals either to provide a barrier to the inhalation of particles (**protection of the wearer**), or to act as source control to prevent the exhalation or release of particles due to coughing, sneezing or other respiratory activities (**protection of others**). Many studies have assessed the performance of mask types for both purposes. For example:

- Studies that assess **protection of the wearer.**[5,9-22]
    - **Penetration studies** to measure the movement of particles from the external environment through mask material into the breathing zone of the wearer.
    - **Protective effect studies** that compare clinical outcomes for mask wearers. Examples include those assessing the reduced incidence of clinical respiratory illness (CRI), influenza-like illness (ILI) or laboratory-confirmed viral infection among healthcare workers (HCWs) wearing masks versus no masks.
- Studies that assess **protection of others** from an infected individual.[9,12,14,21,23-30]
    - **Penetration studies** such as coughing tests that measure the movement of particles through a mask to the external environment.
    - **Secondary attack rate (SAR) studies** to evaluate the effect of mask wearing by an infected individual to prevent transmission to others in close contact (e.g., household members).

Respirators (e.g., N95, KN95, FFP2):

Respirators approved to performance standards in different countries such as N95 (USA), KN95 (China), P2 (Australia/New Zealand), FFP2 (Europe) and others provide a superior level of filtration and fit for protection against particles including aerosols compared to surgical and non-medical masks.[6,13,21] Respirators approved by agencies such as NIOSH, are guaranteed to perform to a minimal level of particle penetration (e.g., 95% blockage or better for N95 respirators). Respirators have also been found to be effective in reducing release of respiratory particles from the wearer.[31] In protective effect studies, respirators are found to provide a greater level of protection as compared to surgical masks, with incidence of CRI found to be lower in N95 wearers compared to surgical mask wearers.[16,17,19,22] A protective effect has also been observed in the COVID-19 pandemic. A retrospective study of a group of 493 HCWs in Wuhan, China, found that none of those wearing N95 respirators (278) working in a high-risk environment and observing regular hand hygiene were infected with SARS-CoV-2 compared to 10 of 213 staff working in a much lower-risk environment and not wearing masks and only washing hands occasionally.[22] The protective effect of respirators for HCWs exposed to SARS-CoV-2 during an aerosol generating procedure has also been observed.[32]

Surgical/procedure masks

Surgical masks are found to provide a higher level of protection to the wearer compared to most cloth masks.[5,9,10,13,21,33,34] In penetration studies for protection of the wearer, surgical masks have been found to block about 60% of particles but may allow penetration by virus particles in high concentration environments.[13,18] Penetration studies for protection of others find that surgical masks block the release of some large droplets but are less effective at blocking the release of infectious aerosols from exhaled breath and coughs.[9,14,23,28]

The protective effect of surgical masks has been demonstrated in healthcare studies. A retrospective study of SARS-CoV-2 infection among HCW in a US hospital before and after the implementation of universal masking with surgical masks for HCWs and patients found that masking was associated with a lower rate of infection.[20,35] A systematic review by Bartoszko et al. (2020) found that surgical masks offered a similar level of protection against respiratory viruses as N95 respirators in non-aerosol-generating healthcare settings.[36] In a case report from China, 41 HCWs were exposed to aerosol-generating procedures for a patient who subsequently tested positive for SARS-CoV-2. None of the HCWs, of whom 85% wore surgical masks and 15% wore respirators, tested positive for SARS-CoV-2.[32] Secondary attack rate (SAR) studies in healthcare settings have found that the use of surgical masks by visitors and HCW has been shown to reduce the incidence of respiratory viral infections among patients.[29]

In non-healthcare settings, several studies in France, Germany, Hong Kong, China and Australia have assessed the effectiveness of wearing surgical masks in the home by patients with influenza or ILI to reduce secondary transmission to other members of the household. Some of these studies have found a lower SAR, but did not show statistically significant reductions[12,24,27] including one study that assessed the protective effect of both surgical masks and N95 equivalent masks.[15] The greatest reductions in SAR have been observed in studies where mask wearing was implemented early after the onset of symptoms in the sick patient, or where mask wearing was combined with other measures such as hand hygiene.[11,25,30]

Cloth masks or face coverings

The range of styles, materials, and design of cloth masks vary significantly as does performance. Studies assessing the protective effect of cloth masks in healthcare settings find that the incidence of CRI, ILI and viral infections was higher among cloth mask wearers compared to surgical mask wearers.[16,19] Cloth masks are not recommended for healthcare, or high-risk settings, but may be effective in community settings where there is a high level of adherence to mask wearing.[37]

Penetration studies of cloth masks for protection of the wearer find that performance is affected by the fit and the type of material used. Loose-fitting cloth masks (e.g., handkerchiefs) provide only minimal protection from inhalation and release of particles.[5,13,33] Particle removal efficiency has been found to vary from 28-90%, with most removing less than 60% when worn as loose-fitting masks.[9,38,39] Penetration studies measuring release of droplets or aerosols from wearers find that cloth masks can block the release of some large droplets but are generally less effective at blocking the release of infectious aerosols, particularly loose-fitting designs and porous fabrics.[9,28,33] Adding multiple layers of the same material provides only limited additional protection, but can reduce breathability.[9,13] Hao et al. (2020) found that fabrics with very low filtration efficiency (e.g., a wool scarf and a cotton bandana) provided minimal filtration efficiency even when tested as four layers. The most effective multi-layer designs use layers of different materials, such as absorbent layers and water repellent outer barrier layers (e.g., synthetic materials such as polypropylene and polyester).[40] Fabrics that allow for electrostatic interaction such as polyester and silk can provide superior removal compared to cotton but breathability of fabrics can be a trade-off for filterability.

Face shields

There may be situations where face shields are considered for specific uses. Face shields allow for visibility of facial movements and expression, which may be beneficial for the hearing impaired. For HCWs or those caring for an infected person, the use of goggles or a face shield may be considered as complementary PPE (i.e., with a surgical mask) to prevent additional exposures due to splash and spray and some intake of particles that could occur due to loose-fitting masks.

There has been limited study of the effectiveness of face shields for reducing transmission of infectious respiratory diseases. There is some evidence that face shields may provide some additional protection when used as complementary PPE with masks. The use of an integral visor with a surgical mask has been found to reduce leakage into the breathing zone around the nose.[18] Face shields can extend the usability of respirators or masks by reducing the potential for surface deposition or accidental contact with mask surfaces.[a] There is some evidence that infection with SARS-CoV-2 via the eyes is possible and face shields may provide additional protection of the wearer by preventing self-inoculation due to touching of the face or eyes.[41-45] A study using a coughing patient simulator and a breathing worker simulator found that face shields reduced surface contamination of a respirator by up to 97% for larger aerosols and 76% for smaller aerosols (median 8.5 and 3.5 µm diameter respectively). The same study found that the face shield provided a high reduction in initial inhalation exposure (96%) for larger aerosols, and a moderate reduction in exposure (68%) for smaller aerosols. After 1-30 minutes after the cough, the face shield only reduced aerosol inhalation by 23% as aerosols dispersed throughout the room and were able to flow around the sides of the shield.[46]

The use of face shields as source control has not been widely assessed.[45] Ronen et al. (2020) demonstrated that using a face shield over a cough simulator blocked the release of droplets from the source and exposure to a nearby manikin.[47] While face shields block forward protection of droplets, they allow for leakage from seams and joints, and upward, downward, sideways and backward leakage jets, so may provide limited protection to others.[48]

Systematic reviews

There have been several systematic reviews of the effectiveness of face masks to reduce the spread of respiratory viruses.[49-58] The key findings of these reviews vary, linked to the scope and inclusion criteria of the reviews. Two reviews indicate insufficient evidence, or no significant

---

[a] Public Health Ontario. Recommended steps for donning and doffing of PPE: https://www.publichealthontario.ca/-/media/documents/rpap-recommeded-ppe-steps.pdf?la=en

reduction in transmission of influenza or ILI with the use of face masks. These studies are limited to randomized control trials (RCT) and influenza or ILI.[54,58] Other reviews indicate a range in the degree of protective effect depending on variables such as the setting (healthcare versus community), mask type (respirator, surgical mask or cloth mask), the mask wearer (infected versus susceptible), the range of respiratory viruses considered (influenza, ILI, H1N1, coronaviruses, SARS-CoV-2) and whether mask wearing is combined with another protective measure such as hand hygiene. The key findings of a selection of systematic reviews are summarized in Table 2.

Table 2 Key findings of systematic reviews evaluating the effectiveness of mask wearing for prevention of respiratory illness.

Reference	Key Findings
Jefferson et al. (2020,)[54] *Pre-print*	Insufficient evidence was identified for reduction in ILI or influenza in community or healthcare settings due to mask wearing based on analysis of 14 RCTs.
Xiao et al. (2020)[58] *Pre-print*	No significant reduction in influenza transmission was found to be associated with the use of face masks. Most studies were observed to be underpowered due to a small sample size, and some studies reported variable adherence to mask wearing.
Jefferson et al. (2011)[53]	Mask wearing reduced respiratory illness in healthcare and community settings, with N95s providing superior protection over surgical masks.
Wei et al. (2020)[57] *Pre-print*	Mask wearing reduced the transmission of ILI in the community, with the effect greater where masks were worn by both sick and healthy individuals.
Chu et al. (2020)[51]	Mask wearing provided a protective effect against coronaviruses based on observational studies for MERS, SARS and COVID-19. Eye protection (e.g., visor, face shield, goggles) was associated with a lower risk of infection in both healthcare and community settings.
Liang et al. (2020)[55]	Mask wearing provided a significant protective effect when worn by HCW and non-HCW in non-household settings in a review of studies including influenza, SARS, H1N1 and COVID-19.
Gupta et al. (2020)[52] *Pre-print*	The effectiveness of mask wearing to prevent respiratory viruses on a community scale was found to be greater when used early and where there was a greater degree of adherence to mask wearing.
Brainard et al. (2020)[49] *Pre-print*	Mask wearing was found to be slightly protective against respiratory infection in a community setting and modestly protective for closer contacts such as households when both infected and susceptible wear a mask based on a review of RCT and observational studies.
Chou et el. (2020)[50]	Mask wearing was found to be associated with a decreased risk of SARS and MERS infection. In healthcare settings N95 and surgical masks had a similar level of risk of ILI, but N95 may be associated with decreased risk of SARS compared to surgical masks. Better adherence to mask wearing was associated with a decreased risk of infection for SARS and MERS.
MacIntyre and Chughtai (2020)[56]	Mask wearing may provide a protective effect, which is enhanced when combined with other measures such as hand hygiene based on a review of RCTs. Continuous wearing of respirators by HCW was found to be protective, but intermittent use was not, and medical and cloth masks had less effect.

On balance, most systematic reviews on the protective effect of masks against respiratory illness transmission indicate some benefit from mask wearing. The evidence of a protective effect appears to be stronger in observational studies as compared to RCTs, which may be based upon the paucity of RCTs for mask use in community settings, and the small sample size used in some studies.[49]

Modelling studies

Modelling studies use data from various sources to estimate the effects of interventions on different health outcomes. There have been several studies that have estimated the effect that mask wearing has had on reducing the spread of COVID-19 in different geographical locations by comparing progression of the pandemic before and after mask-wearing mandates were introduced.[59-62] Leffler et al. (2020) found that average mortality due to COVID-19 was lower in the majority of countries with early adoption of mask wearing in the community compared to countries without early adoption of mask wearing.[63] Studies have estimated that universal mask-wearing mandates reduced cases or the growth rate of COVID-19 in locations such as San Francisco,[61] a selection of US states,[60,64,65] the City of Jena and other cities with high population density in Germany,[66] and Morocco.[67] Other models estimate that mask use can suppress transmission of COVID-19, but the effectiveness may be more significant where there is widespread adherence, interactions between masks wearers and non-mask wearers are minimized, and other complementary public health measures such as hand hygiene and distancing are widely used.[68,69] Modelling results from a survey of over 8000 Chinese adults found that mask wearing provided the most protective effect from COVID-19 infection among four non-pharmaceutical interventions (NPIs - hand hygiene, respiratory etiquette, social distancing and mask wearing), and the effect was increased where additional NPIs were used.[62] Emerging research is considering the effect of mask wearing on severity of infection, including the rate of asymptomatic infection. Further research is needed to understand the relationship between mask wearing, infectious dose, and severity of disease.[70,71]

Considerations for mask use

Mask fit

Where respirators are used as PPE, a **fit test**, and user **seal check** are essential for ensuring effectiveness of N95 type respirators. Fit tests are used to confirm that a specific make, model and size of respirator provides adequate respiratory protection to the user by providing a tight seal between the facepiece and the face that prevents leakage into or out of the respirator facepiece (**Box 1**). If the respirator does not pass a fit test, another make, model or size is tested until a suitable respirator is found. The wearer can then use the same make, model, and size of respirator, repeating the test once per year to confirm that fit is maintained, or reconfirming fit if physical changes to the face have occurred, such as weight loss or injury. If the user changes the make, model or size of respirator, a new fit test is required.

Box 1: How is a fit test done?

A fit test can include either a **qualitative** or **quantitative** test and usually takes about 15 to 20 minutes to complete, during which time the wearer may perform various movements (e.g., turning head side to side or moving the head up or down). If the wearer normally uses a respirator in combination with other PPE, such as goggles or a face shield, these should also be worn during the test. The wearer should also perform a seal check before starting the fit test.

- **Qualitative** fit testing assesses whether the mask wearer can detect the taste or smell of a substance introduced into a chamber placed over the mask wearer. Common substances used in qualitative fit tests include isoamyl acetate (banana smell), saccharin (sweet taste), Bitrex™ (bitter taste) or irritant smoke, which causes coughing.
- **Quantitative** fit testing uses instrumentation with a fit testing adaptor and probe that is attached to the face piece. The instrumentation can measure generated aerosol, ambient aerosol, or controlled negative pressure and will compare the conditions inside and outside the respirator to determine a fit factor.

A demonstration of fit testing by the US Occupational Safety and Health Administration can be viewed here: https://www.osha.gov/video/respiratory_protection/fittesting.html

A user seal check is different from a fit test and should be performed every time a respirator is put on. Advice on user seal checks is provided by the Canadian Centre for Occupational Health and Safety (CCOHS)[b] and can differ depending on the type of respirator. In general, the wearer identifies a good seal on inhalation by checking that there is slight collapse in the respirator and

[b] CCOHS https://www.ccohs.ca/oshanswers/prevention/ppe/wearing.html?=undefined&wbdisable=true

checks for leakage on exhalation by feeling around the edges or surface of the facepiece. Factors that can influence a poor fit or seal can include damage or deformation of the mask, and the presence of obstructions to fit such as facial hair.[72]

For other types of mask, a good fit that aligns to the contours of the face can reduce seepage of air around the edges of the mask. A tight but comfortable fit with effective coverage of the nose and mouth that does not restrict breathability can reduce the frequency that a user touches a mask for readjustment. Masks with conical or tetrahedral shapes that fit closely with face contours perform better than loose-fitting masks.[10] Where face shields are used as complementary to masks, they should be easy to don and doff, fit snugly with reduced areas for leakage, providing full face coverage around the face and below the chin.[73]

Exhalation valves in masks

Exhalation valves improve breathability of respirators while maintaining the protective effect for the wearer but may provide less protection of others from the wearer. Many health authorities, including the US CDC, advise against the use of valved respirators as source control, particularly in sterile environments due to the potential for release of an unfiltered exhalation jet from the wearer.[74] This has been demonstrated in a visualization study of the exhalation jet from a valved respirator, which indicated significantly more leakage of aerosols compared to an un-valved respirator.[75]

There is limited evidence available to assess whether the use of valved masks in community settings increases transmission risks compared to other non-medical face coverings.[76] A quantitative study by Fischer et al. (2020) found that a valved N95 respirator released more particles over time compared to an un-valved N95 and a surgical mask but performed similarly or better than some cloth masks.[33] A study comparing emission of aerosol-size particles during breathing, talking and coughing found that in comparison to a surgical mask and an un-valved KN95 respirator, a valved N95 mask demonstrated similar performance, and all were better than homemade paper and cloth masks for blocking aerosol transmission, albeit the valved mask was tested on a smaller number of study participants.[31]

Length of use

The longer a mask is used, the greater the risk for infectious particles to become deposited on the surface.[77] Surgical masks or respirators (e.g., N95) that become wet, damaged, torn, visibly dirty, or contaminated following close contact with an infected person will not provide adequate protection. A study of mask use by HCWs found that very low infection was observed for masks used ≤ 6 hours, however a greater virus positivity was found beyond 6 hours of use, and for HCWs who examined more than 25 patients.[77] The potential presence of viruses on the outer surface suggests a need for caution during doffing practices by avoiding contact with the mask surface (Box 2), and preventing the resuspension of deposited aerosols.[78] Frequent donning and doffing of the same mask can increase the risk of surface contamination on both the inside and the outside of masks and continuous use of respirators may reduce the potential for contamination as compared to frequent donning and doffing of the same mask.[79]

Early in the pandemic, concern was raised that adoption of universal masking in the community could reduce adherence to other public health measures such as distancing and handwashing. Doung-ngern et al. (2020) found that mask wearers in Thailand were more likely to observe distancing and handwashing measures compared to non-mask wearers, but were also more likely to have physical contact, and long duration of contact (e.g., > 60 minutes) compared to non-mask wearers.[80] Communication on mask wearing by public health authorities should emphasize the importance of continued adherence to other protective behaviours, along with mask-wearing. Masks should not be used by those who are symptomatic or may have been exposed to COVID-19, to avoid quarantine requirements.

Box 2: Tips for safe mask doffing

1. Assume that the surface of a mask or respirator is contaminated and take care not to touch the surface when removing the mask.
2. Remove the loops around the ear, or for ties or straps that go around the back of the head, untie or remove the bottom ties first followed by the top ties, without touching mask surface. Pull the mask away from the face.
3. For disposable masks, hold by the straps or ties and place directly in a garbage bin with a lid.
4. For reusable masks that may be disinfected (respirators) or laundered (cloth masks), hold the ties and place into a suitable receptacle such as a sealable bin or disposable plastic bag until the mask can be placed in the laundry or disinfection chamber.
5. Wash hands with soap and water or sanitize after discarding the mask.

Decontamination and reuse of masks

Masks can become contaminated by the user and the external environment. For cloth masks, laundering in a hot wash and thoroughly drying is recommended by PHAC, but any damage, deterioration or reduced fit will reduce the already limited protective function of cloth masks. In general, surgical masks are considered disposable and not recommended for decontamination and reuse. Laundering or disinfection processes can potentially damage the protective layers of the surgical masks, reducing their effectiveness.

Several decontamination methods have been considered for the purpose of providing additional supplies of respirators when there is high demand. The key criteria for effective decontamination methods are stated as: the ability to remove the viral threat, maintaining the integrity of mask elements, and being harmless to the user.[3,81,82] Decontamination methods include autoclaving; microwave steam sterilization; washing in soap and water; dry heat treatment; treatment with isopropyl alcohol, bleach, hydrogen peroxide vapour, gamma irradiation; ozone decontamination; UV germicidal irradiation (UVGI) and ethylene oxide treatment.[81-85] Promising results have been observed for hydrogen peroxide vapour and UVGI; however, any reuse of decontaminated respirators should include steps to inspect respirators for deterioration and damage and to include user seal testing prior to re-use.[34,81,82,84]

Expired, counterfeit and recalled masks

Surgical masks and respirators that have been certified by organizations such as NIOSH or the FDA have an expiry date, after which they are no longer considered to be certified. In times of high demand, expired masks may be considered for use following a visual inspection for any damage or degradation of the mask components, including the straps. For expired N95 respirators, the ability to form an effective face seal should also be confirmed by a fit test and user seal check.[86]

Health Canada has issued recalls for several mask and respirator products including some surgical masks and KN95 and N95 respirators. Reasons for recalls include improper or misleading packaging such as labelling as "N95" respirators without NIOSH certification, or testing by Health Canada indicating that the product does not meet the specification stated. These recalls are intended to remove products that may not provide consistent and adequate respiratory protection. Further advice from Health Canada on fraudulent and unauthorized N95 respirators is provided here. The US CDC also keeps up-to-date lists of counterfeit respirators or devices that misrepresent NIOSH-approval.

Mask use for children

The WHO has published advice on the use of masks for children.[87] The evidence on the benefits or harms of children wearing masks to limit transmission of SARS-CoV-2 is limited, although evidence from other respiratory diseases suggests mask wearing may be more effective for older children (e.g., nine years and above) than younger children. This may be due to multiple factors, such as the mechanisms of disease transmission, and the acceptability of mask wearing and level of compliance among children of different ages. The WHO recommends that masks are not worn by children aged up to five years for source control, but where a lower cut-off age is used, adult supervision is recommended. For older children up to 11 years, a risk-based approach to decision making is recommended based on the level of community transmission, socio-cultural factors, impacts on learning and development, and the settings and scenarios in which mask wearing may be more appropriate. Older children 12 and above are recommended to follow guidance on masks for adults. The WHO also recommends that children with cognitive or respiratory impairments should not be required to wear masks, and alternatives for children with developmental disorders and disabilities should be considered.

Mask use for persons with cognitive difficulties or physical disabilities

There are some people who may not be able to wear masks such as persons with cognitive difficulties or physical disabilities who are unable to safely don or doff a mask without help. For persons who are unable to wear a mask safely, those providing care and support should be aware of appropriate infection prevention and control measures and take precautions to minimize risk of transmission to the person under care, and to others.[88]

Persons with hearing impairments may find communication with others difficult where their communication partners are wearing masks. Mask wearing may also provide discomfort to those with breathing difficulties. Where safe to do so, wearing of alternative face coverings such as face shields or clear masks may be considered, recognizing the limitations of these alternatives and importance of other measures such as physical distancing and hand hygiene.[88,89]

Conclusions

Masks vary widely in their design and construction and the level of protection against respiratory viruses that they can provide to the wearer and to others as source control. The use of medical masks including approved respirators (e.g., N95 and similar) and surgical masks can reduce the transmission of respiratory infection in healthcare settings. The use of non-medical masks by the public may also reduce the risk of transmission of respiratory infection, especially when used by both infected and susceptible persons, but masking does not eliminate the risk of transmission.

Key messages

- Systematic reviews and modelling studies have indicated that mask wearing has reduced the number of cases and growth rate of COVID-19 infections where there was early uptake, widespread adherence, and where used in combination with other non-pharmaceutical interventions such as hand hygiene and physical distancing.
- Users of medical masks and respirators should be aware of appropriate fit testing (where necessary) and safe donning and doffing procedures.
- Counterfeit and recalled products may provide inadequate respiratory protection, so users should consult trusted government sources prior to procuring products.
- Cloth masks vary widely in their ability to reduce exposure to infectious droplets and aerosols and as source control for protection of others. The most effective masks are those that provide a good fit around the nose, sides, and chin, and are made of materials that provide a high level of particle filtration, while maintaining breathability.
- Exhalation valves can reduce the effectiveness of masks as source control.
- Face shields should be considered as complementary to wearing of masks, but not as an alternative, except in circumstances where mask wearing is not possible.
- Special consideration should be given to children, persons with cognitive difficulties or physical disabilities when considering appropriate mask use.

The information provided in this document is based on current understanding and interpretation of the effectiveness of mask wearing. As new evidence and new interpretations evolve, this document will be updated.

Acknowledgements

This document benefited from the contributions of Angela Eykelbosh, Lydia Ma and Michele Wiens (NCCEH) and Tom Kosatsky (BCCDC).

References

1. World Health Organization. Coronavirus disease (COVID-19) advice for the public: when and how to use masks. Geneva, Switzerland: WHO; 2020 [updated 2020 Aug 5]; Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/when-and-how-to-use-masks.

2. Public Health Agency of Canada. Coronavirus disease (COVID-19): prevention and risks. Ottawa, ON: PHAC; 2020 [updated Sep 15]; Available from: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/prevention-risks.html.

3. Institute of Medicine. Reusability of facemasks during an influenza pandemic: facing the flu. Washington, DC: The National Academies Press; 2006. Available from: https://www.nap.edu/catalog/11637/reusability-of-facemasks-during-an-influenza-pandemic-facing-the-flu.

4. Li Y. The secret behind the mask. Indoor Air. 2011 Apr;21(2):89-91. Available from: https://doi.org/10.1111/j.1600-0668.2011.00711.x.

5. Rengasamy S, Eimer B, Shaffer RE. Simple respiratory protection—evaluation of the filtration performance of cloth masks and common fabric materials against 20–1000 nm size particles. Ann Occup Hyg. 2010;54(7):789-98. Available from: https://doi.org/10.1093/annhyg/meq044.

6. 3M. Comparison of FFP2, KN95, and N95 and other filtering facepiece respirator classes. St. Paul, MN: 3M; 2020 May. Available from: https://multimedia.3m.com/mws/media/1791500O/comparison-ffp2-kn95-n95-filtering-facepiece-respirator-classes-tb.pdf.

7. Public Health Agency of Canada. Non-medical masks and face coverings: How to put on, remove and clean. Ottawa, ON: PHAC; 2020 Jul 16. Available from: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/prevention-risks/how-put-remove-clean-non-medical-masks-face-coverings.html.

8. Lee SA, Hwang DC, Li HY, Tsai CF, Chen CW, Chen JK. Particle size-selective assessment of protection of European standard FFP respirators and surgical masks against particles-tested with human subjects. J Healthc Eng. 2016. Available from: https://doi.org/10.1155/2016/8572493.

9. Davies A, Thompson K-A, Giri K, Kafatos G, Walker J, Bennett A. Testing the efficacy of homemade masks: would they protect in an influenza pandemic? Disaster Med Public Health Prep. 2013;7(4):413-8. Available from: https://dx.doi.org/10.1017%2Fdmp.2013.43.

10. Shakya KM, Noyes A, Kallin R, Peltier RE. Evaluating the efficacy of cloth facemasks in reducing particulate matter exposure. J Expo Sci Environ Epidemiol. 2017 May 1;27(3):352-7. Available from: https://doi.org/10.1038/jes.2016.42.

11. Aiello AE, Murray GF, Perez V, Coulborn RM, Davis BM, Uddin M, et al. Mask use, hand hygiene, and seasonal influenza-like illness among young adults: a randomized intervention trial. J Infect Dis. 2010;201(4):491-8. Available from: https://doi.org/10.1086/650396.

12. Cowling BJ, Fung RO, Cheng CK, Fang VJ, Chan KH, Seto WH, et al. Preliminary findings of a randomized trial of non-pharmaceutical interventions to prevent influenza transmission in households. PLoS ONE. 2008 May 7;3(5):e2101. Available from: https://doi.org/10.1371/journal.pone.0002101.

13. Jung H, Kim JK, Lee S, Lee J, Kim J, Tsai P, et al. Comparison of filtration efficiency and pressure drop in anti-yellow sand masks, quarantine masks, medical masks, general masks, and handkerchiefs. Aerosol Air Qual Res. 2014;14(3):991-1002. Available from: https://doi.org/10.4209/aaqr.2013.06.0201.

14. Leung NHL, Chu DKW, Shiu EYC, Chan K-H, McDevitt JJ, Hau BJP, et al. Respiratory virus shedding in exhaled breath and efficacy of face masks. Nat Med. 2020 Apr 3. Available from: https://doi.org/10.1038/s41591-020-0843-2.
15. MacIntyre CR, Cauchemez S, Dwyer DE, Seale H, Cheung P, Browne G, et al. Face mask use and control of respiratory virus transmission in households. Emerg Infect Dis. 2009;15(2):233-41. Available from: https://doi.org/10.3201/eid1502.081167.
16. MacIntyre CR, Seale H, Dung TC, Hien NT, Nga PT, Chughtai AA, et al. A cluster randomised trial of cloth masks compared with medical masks in healthcare workers. BMJ Open. 2015;5(4):e006577. Available from: https://bmjopen.bmj.com/content/bmjopen/5/4/e006577.full.pdf.
17. MacIntyre CR, Wang Q, Cauchemez S, Seale H, Dwyer DE, Yang P, et al. A cluster randomized clinical trial comparing fit-tested and non-fit-tested N95 respirators to medical masks to prevent respiratory virus infection in health care workers. Influenza Other Respir Viruses. 2011 May 1;5(3):170-9. Available from: https://doi.org/10.1111/j.1750-2659.2011.00198.x.
18. Makison Booth C, Clayton M, Crook B, Gawn JM. Effectiveness of surgical masks against influenza bioaerosols. J Hosp Infect. 2013;84(1):22-6. Available from: https://doi.org/10.1016/j.jhin.2013.02.007.
19. Offeddu V, Yung CF, Low MSF, Tam CC. Effectiveness of masks and respirators against respiratory infections in healthcare workers: a systematic review and meta-analysis. Clin Infect Dis. 2017;65(11):1934-42. Available from: https://doi.org/10.1093/cid/cix681.
20. Radonovich LJ, Jr., Simberkoff MS, Bessesen MT, Brown AC, Cummings DAT, Gaydos CA, et al. N95 respirators vs medical masks for preventing influenza among health care personnel: a randomized clinical trial. JAMA. 2019 Sep 3;322(9):824-33. Available from: https://doi.org/10.1001/jama.2019.11645.
21. van der Sande M, Teunis P, Sabel R. Professional and home-made face masks reduce exposure to respiratory infections among the general population. PLoS ONE. 2008;3(7):e2618. Available from: https://doi.org/10.1371/journal.pone.0002618.
22. Wang X, Pan Z, Cheng Z. Association between 2019-nCoV transmission and N95 respirator use. J Hosp Infect. 2020;Mar 3. Available from: https://doi.org/10.1016/j.jhin.2020.02.021.
23. Bae S, Kim M-C, Kim JY, Cha H-H, Lim JS, Jung J, et al. Effectiveness of surgical and cotton masks in blocking SARS–CoV-2: a controlled comparison in 4 patients. Ann Intern Med. 2020. Available from: https://doi.org/10.7326/M20-1342.
24. Canini L, Andréoletti L, Ferrari P, D'Angelo R, Blanchon T, Lemaitre M, et al. Surgical mask to prevent influenza transmission in households: a cluster randomized trial. PLoS ONE. 2010;5(11):e13998. Available from: https://doi.org/10.1371/journal.pone.0013998.
25. Cowling BJ, Chan K-H, Fang VJ, Cheng CKY, Fung ROP, Wai W, et al. Facemasks and hand hygiene to prevent influenza transmission in households: a cluster randomized trial. Ann Intern Med. 2009;151(7):437-46. Available from: https://doi.org/10.7326/0003-4819-151-7-200910060-00142.
26. Larson EL, Ferng YH, Wong-McLoughlin J, Wang S, Haber M, Morse SS. Impact of non-pharmaceutical interventions on URIs and influenza in crowded, urban households. Public Health Rep. 2010 Mar-Apr;125(2):178-91. Available from: https://doi.org/10.1177/003335491012500206.
27. MacIntyre CR, Zhang Y, Chughtai AA, Seale H, Zhang D, Chu Y, et al. Cluster randomised controlled trial to examine medical mask use as source control for people with respiratory illness. BMJ Open. 2016;6(12):e012330. Available from: https://bmjopen.bmj.com/content/bmjopen/6/12/e012330.full.pdf.
28. Milton DK, Fabian MP, Cowling BJ, Grantham ML, McDevitt JJ. Influenza virus aerosols in human exhaled breath: particle size, culturability, and effect of surgical masks. PLoS Pathog. 2013;9(3):e1003205. Available from: https://doi.org/10.1371/journal.ppat.1003205.
29. Sokol KA, De la Vega-Diaz I, Edmondson-Martin K, Kim S, Tindle S, Wallach F, et al. Masks for prevention of respiratory viruses on the BMT unit: results of a quality initiative. Transpl Infect Dis. 2016;18(6):965-7. Available from: https://doi.org/10.1111/tid.12608.
30. Suess T, Remschmidt C, Schink SB, Schweiger B, Nitsche A, Schroeder K, et al. The role of facemasks and hand hygiene in the prevention of influenza transmission in households: results from a

cluster randomised trial; Berlin, Germany, 2009-2011. BMC Infect Dis. 2012 2012/01/26;12(1):26. Available from: https://doi.org/10.1186/1471-2334-12-26.
31. Asadi S, Cappa CD, Barreda S, Wexler AS, Bouvier NM, Ristenpart WD. Efficacy of masks and face coverings in controlling outward aerosol particle emission from expiratory activities. Sci Rep. 2020;10(1):15665-. Available from: https://doi.org/10.1038/s41598-020-72798-7.
32. Ng K, Poon BH, Kiat Puar TH, Shan Quah JL, Loh WJ, Wong YJ, et al. Covid-19 and the risk to health care workers: a case report. Ann Intern Med. 2020. Available from: https://doi.org/10.7326/L20-0175.
33. Fischer EP, Fischer MC, Grass D, Henrion I, Warren WS, Westman E. Low-cost measurement of face mask efficacy for filtering expelled droplets during speech. Sci Adv. 2020 Sep;6(36). Available from: https://doi.org/10.1126/sciadv.abd3083.
34. Public Health Ontario. COVID-19 – what we know so far about… reuse of personal protective equipment Toronto, ON: PHO; 2020 Apr 4. Available from: https://www.publichealthontario.ca/-/media/documents/ncov/covid-wwksf/what-we-know-reuse-of-personal-protective-equipment.pdf?la=en.
35. Wang X, Ferro EG, Zhou G, Hashimoto D, Bhatt DL. Association between universal masking in a health care system and SARS-CoV-2 positivity among health care workers. JAMA. 2020;324(7):703-4. Available from: https://doi.org/10.1001/jama.2020.12897.
36. Bartoszko JJ, Farooqi MAM, Alhazzani W, Loeb M. Medical masks vs N95 respirators for preventing COVID-19 in healthcare workers: A systematic review and meta-analysis of randomized trials. Influenza Other Respi Viruses. 2020 Jul;14(4):365-73. Available from: https://doi.org/10.1111/irv.12745.
37. Hendrix M, Walde C, Findley K, Trotman R. Absence of apparent transmission of SARS-CoV-2 from two stylists after exposure at a hair salon with a universal face covering policy — Springfield, Missouri, May 2020. MMWR. 2020;69(28):930-2. Available from: http://dx.doi.org/10.15585/mmwr.mm6928e2external.
38. Hao W, Parasch A, Williams S, Li J, Ma H, Burken J, et al. Filtration performances of non-medical materials as candidates for manufacturing facemasks and respirators. Int J Hyg Environ Health. 2020 Aug;229:113582. Available from: https://doi.org/10.1016/j.ijheh.2020.113582.
39. Mueller AV, Eden MJ, Oakes JJ, Bellini C, Fernandez LA. Quantitative method for comparative assessment of particle filtration efficiency of fabric masks as alternatives to standard surgical masks for PPE. medRxiv. 2020 May. Available from: https://doi.org/10.1101/2020.04.17.20069567.
40. Lustig SR, Biswakarma JJH, Rana D, Tilford SH, Hu W, Su M, et al. Effectiveness of common fabrics to block aqueous aerosols of virus-like nanoparticles. ACS Nano. 2020 Jun 23;14(6):7651-8. Available from: https://doi.org/10.1021/acsnano.0c03972.
41. Deng W, Bao L, Gao H, Xiang Z, Qu Y, Song Z, et al. Ocular conjunctival inoculation of SARS-CoV-2 can cause mild COVID-19 in rhesus macaques. Nat Commun. 2020;11(1):4400. Available from: https://doi.org/10.1038/s41467-020-18149-6.
42. Li X, Wang M, Dai J, Wang W, Yang Y, Jin W. Novel coronavirus disease with conjunctivitis and conjunctivitis as first symptom: two cases report. Chin J Exp Opthalmol. 2020;April(4). Available from: https://cjeo-journal.org/novel-coronavirus-disease-with-conjunctivitis-and-conjunctivitis-as-first-symptom-two-cases-report/.
43. Qing H, Yang Z, Shi M, Zhang Z. New evidence of SARS-CoV-2 transmission through the ocular surface. Graefes Arch Clin Exp Ophthalmol. 2020 2020/05/04. Available from: https://doi.org/10.1007/s00417-020-04726-4.
44. Xia J, Tong J, Liu M, Shen Y, Guo D. Evaluation of coronavirus in tears and conjunctival secretions of patients with SARS-CoV-2 infection. J Med Virol. 2020 Jun;92(6):589-94. Available from: https://doi.org/10.1002/jmv.25725.
45. Perencevich EN, Diekema DJ, Edmond MB. Moving personal protective equipment into the community: face shields and containment of COVID-19. JAMA. 2020;323(22):2252-3. Available from: https://doi.org/10.1001/jama.2020.7477.
46. Lindsley WG, Noti JD, Blachere FM, Szalajda JV, Beezhold DH. Efficacy of face shields against cough aerosol droplets from a cough simulator. J Occup Environ Hyg. 2014 Aug;11(8):509-18. Available from: https://doi.org/10.1080/15459624.2013.877591.

47. Ronen A, Rotter H, Elisha S, Sevilia S, Parizer B, Hafif N, et al. Examining the protection efficacy of face shields against cough aerosol droplets using water sensitive papers. medRxiv. 2020 Jul. Available from: https://doi.org/10.1101/2020.07.06.20147090.
48. Viola I, Peterson B, Pisetta G, Pavar G, Akhtar H, Menoloascina F, et al. Face coverings, aerosol dispersion and mitigation of virus transmission risk. arXiv. 2020 May. Available from: https://arxiv.org/abs/2005.10720.
49. Brainard JS, Jones N, Lake I, Hooper L, Hunter P. Facemasks and similar barriers to prevent respiratory illness such as COVID-19: A rapid systematic review. medRxiv. 2020 Apr. Available from: : https://doi.org/10.1101/2020.04.01.20049528.
50. Chou R, Dana T, Jungbauer R, Weeks C, McDonagh MS. Masks for prevention of respiratory virus infections, including SARS-CoV-2, in health care and community settings. Ann Intern Med. 2020 Aug 27. Available from: https://doi.org/10.7326/L20-1067.
51. Chu DK, Akl EA, Duda S, Solo K, Yaacoub S, Schünemann HJ, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. The Lancet. 2020;395(10242):1973-87. Available from: https://doi.org/10.1016/S0140-6736(20)31142-9.
52. Gupta M, Gupta K, Gupta S. The use of facemasks by the general population to prevent transmission of Covid 19 infection: a systematic review. medRxiv. 2020 May. Available from: https://doi.org/10.1101/2020.05.01.20087064.
53. Jefferson T, Del Mar CB, Dooley L, Ferroni E, Al-Ansary LA, Bawazeer GA, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses. Cochrane Database Syst Rev. 2011(7). Available from: https://doi.org//10.1002/14651858.CD006207.pub4.
54. Jefferson T, Jones M, Al Ansari LA, Bawazeer G, Beller E, Clark J, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses. Part 1 - Face masks, eye protection and person distancing: systematic review and meta-analysis. medRxiv. 2020 Apr. Available from: https://doi.org/10.1101/2020.03.30.20047217.
55. Liang M, Gao L, Cheng C, Zhou Q, Uy JP, Heiner K, et al. Efficacy of face mask in preventing respiratory virus transmission: A systematic review and meta-analysis. Travel Med Infect Dis. 2020:101751. Available from: https://doi.org/10.1016/j.tmaid.2020.101751.
56. MacIntyre CR, Chughtai AA. A rapid systematic review of the efficacy of face masks and respirators against coronaviruses and other respiratory transmissible viruses for the community, healthcare workers and sick patients. Int J Nurs Stud. 2020;108. Available from: https://dx.doi.org/10.1016%2Fj.ijnurstu.2020.103629.
57. Wei J, Doherty M, Persson MSM, Swain S, Kuo C, ZENG C, et al. Facemasks prevent influenza-like illness: implications for COVID-19. medRxiv. 2020 May. Available from: : https://doi.org/10.1101/2020.05.07.2009491.
58. Xiao M, Lin L, Hodges JS, Xu C, Chu H. Double-zero-event studies matter: a re-evaluation of physical distancing, face masks, and eye protection for preventing person-to-person transmission of COVID-19 and its policy impact. medRxiv. 2020 Aug 14. Available from: https://doi.org/10.1101/2020.08.12.20173674.
59. Cheng VCC, Wong SC, Chuang VWM, So SYC, Chen JHK, Sridhar S, et al. The role of community-wide wearing of face mask for control of coronavirus disease 2019 (COVID-19) epidemic due to SARS-CoV-2. J Infect. 2020 Apr 23. Available from: https://dx.doi.org/10.1016%2Fj.jinf.2020.04.024.
60. Lyu W, Wehby G. Community use of face masks and COVID-19: evidence from a natural experiment of state mandates in the US. Health Aff. 2020;39(8):1419-25. Available from: https://doi.org/10.1377/hlthaff.2020.00818.
61. Worden L, Wannier R, Blumberg S, Ge AY, Rutherford GW, Porco TC. Estimation of effects of contact tracing and mask adoption on COVID-19 transmission in San Francisco: a modeling study. medRxiv. 2020 Jun. Available from: https://doi.org/10.1101/2020.06.09.20125831.

62. Xu H, Gan Y, Zheng D, Wu B, Zhu X, Xu C, et al. The relationship between COVID-19 infection and risk perception, knowledge, attitude as well as four non-pharmaceutical interventions (NPIs) during the late period of yhe COVID-19 epidemic in China — an online cross-sectional survey of 8158 adults. medRxiv. 2020 Jun. Available from: https://doi.org/10.1101/2020.06.02.20120808.
63. Leffler CT, Ing EB, Lykins JD, Hogan MC, McKeown CA, Grzybowski A. Association of country-wide coronavirus mortality with demographics, testing, lockdowns, and public wearing of masks. medRxiv. 2020 Aug 4. Available from: https://doi.org/10.1101/2020.05.22.20109231.
64. Eikenberry SE, Mancuso M, Iboi E, Phan T, Eikenberry K, Kuang Y, et al. To mask or not to mask: modeling the potential for face mask use by the general public to curtail the COVID-19 pandemic. Infect Dis Model. 2020;5:293-308. Available from: https://doi.org/10.1016/j.idm.2020.04.001.
65. Ngonghala CN, Iboi E, Eikenberry S, Scotch M, MacIntyre CR, Bonds MH, et al. Mathematical assessment of the impact of non-pharmaceutical interventions on curtailing the 2019 novel Coronavirus. Math Biosci. 2020;325:108364. Available from: https://doi.org/10.1016/j.mbs.2020.108364.
66. Mitze T, Kosfeld R, Rode J, Wälde K. Face masks considerably reduce COVID-19 cases in Germany: a synthetic control method approach. Bonn, Germany: IZA Institute of Labour Economics; 2020 Jun. Available from: http://ftp.iza.org/dp13319.pdf.
67. Bouchnita A, Jebrane A. A multi-scale model quantifies the impact of limited movement of the population and mandatory wearing of face masks in containing the COVID-19 epidemic in Morocco. Math Model Nat Phenom. 2020;15:31. Available from: https://doi.org/10.1051/mmnp/2020016.
68. Catching A, Capponi S, Yeh MT, Bianco S, Andino R. Examining face-mask usage as an effective strategy to control COVID-19 spread. medRxiv. 2020 Aug. Available from: : https://doi.org/10.1101/2020.08.12.20173047.
69. Fisman DN, Greer AL, Tuite AR. Bidirectional impact of imperfect mask use on reproduction number of COVID-19: A next generation matrix approach. Infect Dis Model. 2020;5:405-8. Available from: https://doi.org/10.1016/j.idm.2020.06.004.
70. Bielecki M, Züst R, Siegrist D, Meyerhofer D, Crameri GAG, Stanga Z, et al. Social distancing alters the clinical course of COVID-19 in young adults: a comparative cohort study. Clin Infect Dis. 2020. Available from: https://doi.org/10.1093/cid/ciaa889.
71. Gandhi M, Beyrer C, Goosby E. Masks do more than protect others during COVID-19: reducing the inoculum of SARS-CoV-2 to protect the wearer. J Gen Intern Med. 2020:1-4. Available from: https://doi.org/10.1007/s11606-020-06067-8.
72. Sandaradura I, Goeman E, Pontivivo G, Fine E, Gray H, Kerr S, et al. A close shave? Performance of P2/N95 respirators in health care workers with facial hair: results of the BEARDS (Adequate Respiratory DefenceS) study. J Hosp Infect. 2020 Jan 21. Available from: https://doi.org/10.1016/j.jhin.2020.01.006.
73. Roberge RJ. Face shields for infection control: A review. J Occup Environ Hyg. 2016;13(4):235-42. Available from: https://doi.org/10.1080/15459624.2015.1095302.
74. 3M. Filtering facepiece respirators FAQ: healthcare. St. Paul MN: 3M; 2020 Sep. Available from: https://multimedia.3m.com/mws/media/1792732O/respiratory-protection-faq-healthcare.pdf.
75. Verma S, Dhanak M, Frankenfield J. Visualizing droplet dispersal for face shields and masks with exhalation valves. Phys Fluids (1994). 2020 Sep 1;32(9):091701. Available from: https://doi.org/10.1063/5.0022968.
76. Chang JC, Johnson JS, Olmsted RN. Demystifying theoretical concerns involving respirators with exhalation valves during COVID-19 pandemic. Am J Infect Control. 2020:S0196-6553(20)30815-4. Available from: https://doi.org/10.1016/j.ajic.2020.08.031.
77. Chughtai AA, Stelzer-Braid S, Rawlinson W, Pontivivo G, Wang Q, Pan Y, et al. Contamination by respiratory viruses on outer surface of medical masks used by hospital healthcare workers. BMC Infect Dis. 2019;19(1):491. Available from: https://doi.org/10.1186/s12879-019-4109-x.
78. Liu Y, Ning Z, Chen Y, Guo M, Liu Y, Gali NK, et al. Aerodynamic characteristics and RNA concentration of SARS-CoV-2 aerosol in Wuhan hospitals during COVID-19 outbreak. bioRxiv. 2020 Mar. Available from: https://doi.org/10.1101/2020.03.08.982637.

79. MacIntyre CR, Chughtai AA, Rahman B, Peng Y, Zhang Y, Seale H, et al. The efficacy of medical masks and respirators against respiratory infection in healthcare workers. Influenza Other Respir Viruses. 2017;11(6):511-7. Available from: https://doi.org/10.1111/irv.12474.
80. Doung-ngern P, Suphanchaimat R, Panjangampatthana A, Janekrongtham C, Ruampoom D, Daochaeng N, et al. Case-control study of use of personal protective measures and risk for severe acute respiratory syndrome coronavirus 2 infection, Thailand. Emerg Infect Dis. 2020;26(11):2607-16. Available from: https://wwwnc.cdc.gov/eid/article/26/11/20-3003_article.
81. European Centre for Disease Control and Prevention. Cloth masks and mask sterilisation as options in case of shortage of surgical masks and respirators Stockholm, Sweden: ECDCP; 2020 [updated 2020 Mar 26]; Available from: https://www.ecdc.europa.eu/en/publications-data/cloth-masks-sterilisation-options-shortage-surgical-masks-respirators.
82. Viscusi DJ, Bergman MS, Eimer BC, Shaffer RE. Evaluation of five decontamination methods for filtering facepiece respirators. Ann Occup Hyg. 2009;53(8):815-27. Available from: https://doi.org/10.1093/annhyg/mep070.
83. Chughtai AA, Seale H, Chi Dung T, Maher L, Nga PT, MacIntyre CR. Current practices and barriers to the use of facemasks and respirators among hospital-based health care workers in Vietnam. Am J Infect Control. 2015;43(1):72-7. Available from: https://doi.org/10.1016/j.ajic.2014.10.009.
84. Schwartz A, Stiegell M, Greeson N, Vogel A, Thomann W, Brown M, et al. Decontamination and reuse of N95 respirators with hydrogen peroxide vapor to address worldwide personal protective equipment shortages during the SARS-CoV-2 (COVID-19) pandemic. Appl Biosaf. 2020 Apr. Available from: https://absa.org/wp-content/uploads/2020/04/APB_919932.pdf.
85. US Food and Drug Administration. Investigating decontamination and reuse of respirators in public health emergencies. Silver Spring, MD: US FDA; 2020 [updated Apr 10; cited 2020]; Available from: https://www.fda.gov/emergency-preparedness-and-response/mcm-regulatory-science/investigating-decontamination-and-reuse-respirators-public-health-emergencies.
86. Health Canada. Optimizing the use of masks and respirators during the COVID-19 outbreak. Ottawa, ON: Health Canada; 2020 [updated Oct 20]; Available from: https://www.canada.ca/en/health-canada/services/drugs-health-products/medical-devices/masks-respirators-covid19.html.
87. World Health Organization. Advice on the use of masks for children in the community in the context of COVID-19. Geneva, Switzerland: WHO; 2020 Aug 21. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-IPC_Masks-Children-2020.1.
88. Public Health Agency of Canada. COVID-19 and people with disabilities in Canada. Ottawa, ON: PHAC; 2020 Aug 17. Available from: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/people-with-disabilities.html.
89. US Centers for Disease Control. Considerations for wearing masks: US Department of Health and Human Services; 2020 Aug 7. Available from: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cloth-face-cover-guidance.html.

ISBN: 978-1-988234-46-5.

To provide feedback on this document, please visit www.ncceh.ca/en/document_feedback

This document can be cited as: O'Keeffe, J. Masking During the COVID-19 Pandemic. Vancouver, BC: National Collaborating Centre for Environmental Health. 2020 Oct.

 Production of this document has been made possible through a financial contribution from the Public Health Agency of Canada through the National Collaborating Centre for Environmental Health.

National Collaborating Centre for Environmental Health
Centre de collaboration nationale en santé environnementale

655 W. 12th Ave., Vancouver, BC, V5Z 4R4
contact@ncceh.ca | www.ncceh.ca