

Masks: Literature Review as of January 31, 2021

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Methods

This rapid review of evidence was originally conducted to identify studies connecting mask use to clinically important outcomes. Multiple sources were searched with terms such as “masks” or “face coverings” with outcomes related to disease, infection, influenza, coronavirus, etc. The original focus was on high level evidence; however, in the months since the beginning of the COVID-19 pandemic, many studies and reviews have been completed that look at effectiveness of masks. As such, we have updated the review as needed though the review is not all-inclusive as a true systematic review on the topic would be. Additionally, the CDC published a scientific brief on masks in November 2020 that concisely summarizes current knowledge and corresponds well to our findings.¹

Masks in the General Public

Studies primarily from research conducted prior to the COVID-19 pandemic show that masks worn by the general public can be an effective intervention to help minimize the spread of disease but are likely more useful when combined with other interventions such as physical distancing and hand washing. Several reviews, including those by Jefferson et al., Xiao et al., Saunders-Hastings et al., Chu et al., Liang et al., and Brainard et al., conclude that although the quality of evidence has been low due to its observational nature, masks may reduce the risk of respiratory viral infection (not specific to the SARS CoV-2 virus), though pooled analyses were not always statistically significant.²⁻⁷ These reviews often include studies in both healthcare workers and non-healthcare workers and report pooled odds ratios ranging from 0.15 to 0.94 while relative risks ranged from 0.78 to 0.99. Two reviews found statistically significant reductions in risk of infection. Chu et al., found a large reduction in personal risk of infection from viruses including SARS, MERS, and COVID-19 when a mask is worn versus no mask (OR = 0.15, 95% CI: 0.07 – 0.34). Liang et al., included studies evaluating masks and COVID-19 in addition to other respiratory viruses also found a statistically significant reduction in risk of infection (OR = 0.35, 95% CI 0.24 – 0.51). A recent review by Li et al. synthesized randomized controlled trials of mask wearing to prevent COVID-19 infection specifically found significant reduction in risk of infection (OR = 0.38, 95% CI 0.21 to 0.69), though 5 of the 6 studies included were in healthcare workers only.⁸ While Brainard et al., state that considering all limitations with the studies in their review, their best estimate is a reduction of risk of infection between 6% and 15%, these results suggest that mask wearing can reduce overall risk of infection from COVID-19.

A recent case-control study of COVID-19 infection in Thailand residents found that wearing masks all the time, not just some of the time, significantly reduced the risk of infection (adjusted OR = 0.23, 95% CI 0.09 – 0.60).⁹ People who wore masks all the time were also more likely to limit contact to less than 15 minutes and to frequently wash their hands. In this study, the type of mask worn did not matter. A study that developed a model by utilizing survey data from over 378,000 people 13 years old and older in the United States combined with other publicly available data found that communities with high mask wearing and social distancing had the highest predicted ability to control transmission.¹⁰ Another model suggests that universal mask use (i.e. 95% of the population) could save an additional 129,574 lives, while lower user (85% of population) could save 95,814 lives from September 22, 2020 through the end of February 2021.¹¹

Mask Effectiveness by Type

Existing studies do not assess whether the type of mask worn by a member of the public is any more beneficial than another at reducing the risk of infection. There are an increasing number of studies exploring the efficacy of differing types of masks and masks materials at filtering out viral particles from breathing, and only recently have cloth masks been investigated.

A 2009 study by Johnson et al., using 9 influenza positive participants found that N95 respirators and procedure masks were similar in the amounts of influenza virus filtered by masks when participants coughed directly onto a petri dish.¹² A meta-analysis by Barycka et al., comparing N95s and surgical masks for upper respiratory infections did not find N95s to be superior for reducing risk, although N95 wearers did have less frequent respiratory illness.¹³

Several studies comparing filtration properties of masks made of different materials have been published in recent months. Though the studies do help in choosing materials for purchasing or making masks, the conditions of each study vary with respect to how particles are emitted, how filtration is measured, the size of particles used in the study, and whether the studies used disks of fabric, manikins, or actual humans. Additionally, studies nearly always compare fabrics to both N95 and surgical masks, since the reason cloth masks have been used throughout the pandemic was due to supply chain issues and working to ensure healthcare workers had appropriate masks while caring for patients. This may be less of a concern since supply chain issues for surgical/procedure masks have improved greatly since early in the pandemic.

Most masks function well at larger particle sizes associated with droplets. Aydin et al. demonstrated this and recent analyses at Colorado State University (see <http://jv.colostate.edu/masktesting/>) also demonstrate this for a variety of fabrics and fabrics plus filter material.¹⁴ Konda et al. tested differing types of cotton and cotton combined with other fabrics to determine the efficacy of blocking particles of differing sizes.¹⁵ They found that cotton with ≥ 600 threads per inch filtered 80% or more of particles less than 300 nm and over 98% of particles greater than 300 nm in size. The cotton masks tested were similarly efficient when compared to procedural masks but less effective than an N95 respirator that fit properly though air flow rate in the study was lower than that of normal respiration which could have impacted the results. Zangmeister et al., also examined filtration efficiency and breathability of 32 cloth samples plus 7 polypropylene materials and other paper materials.¹⁶ This study also found that cottons with high to moderate yarn counts performed well compared to surgical masks, especially in at least two layers.

Four studies compared filtration for commercially available masks or masks made from common materials as compared to surgical masks and/or KN95. Maurer et al. examined several masks from primarily German manufacturers and found those that performed best had fabric content and numbers of layers similar to surgical masks (two or three layers of polypropylene/polyester/polyamide materials).¹⁷ Clapp et al. compared several consumer grade masks to medical masks and also examined fit of those masks for their protective effects (inhalation of submicron particles).¹⁸ In this study, a 2-layer nylon mask with a filter insert performed the best, while a procedure mask with ear loops twisted and pleats tucked at the side also performed well. Hao et al. evaluated filtration for several homemade masks in single layers.¹⁹ Surgical masks performed the best in this study with the best cloth being microfiber and a shop towel (disposable paper towel) mask also performing well. In this study, single layers of cotton did not fare well. Lastly, Asadi et al. compared surgical masks and KN95s to homemade masks of paper towel and t-shirt fabric (both single and double layers) for source control.²⁰ Here the

surgical masks and KN95 did the best as usual, followed by the single layer paper towel mask. The single layer and double layer t-shirt material did not perform well in this study.

The optimal design of the mask is less obvious through the literature and no specific construction design has been shown to be the best. The CDC has released a simple mask design for the general public (<https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-to-make-cloth-face-covering.html>) as well as guidance about wearing masks (<https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cloth-face-cover-guidance.html>). Based upon studies that looked at the fit of masks, the key design component is the mask fits tight to the face with no gaps. Across studies in which gaps were present, the efficacy of source control was reduced.

Some studies have looked at the addition of filter media to cloth masks. Many studies have used household items such as coffee filters or vacuum bags cut into pieces, and the work by Colorado State linked above used MERV 13 and melt blown filter media. A recent study by Akhtar et al. showed that the addition of a PM 2.5 filter to a two layer cloth masks greatly improved its ability to block aerosol particles from a sneeze or cough but it did not improve it as much as a standard surgical masks in this experiment.²¹ Interestingly, wetting the filter insert improved its performance even more, exceeding that of the surgical mask. At the time of this update, other studies using the PM 2.5 insert have not been identified.

Of note, the World Health Organization now recommends a three-layer construction for non-medical masks. They recommend an innermost layer (closest to skin) that is hydrophilic, such as cotton; a middle layer that is a breathable hydrophobic synthetic material; and an outer layer that is hydrophobic of hydrophobic synthetic materials such as polypropylene or polyester. They acknowledge that some high performing materials may be acceptable in fewer than three layers. They also recommend individuals check breathability when wearing.²²

Case Studies Where Masks Reduced Transmission of SARS-Cov-2

There have been numerous documented cases where masks have been attributed to a decrease in the spread of SARS-Cov-2. The most telling example comes from Springfield, Missouri, where two hairstylists were symptomatic with COVID-19. Between the two of them, they had 139 clients that spent at least 15 minutes with them.²³ Of 104 of the contacted clients, all reported wearing a mask for at least some of the appointment and none of clients tested positive for COVID-19. The absence of infection of SARS-Cov-2 has been attributed to mask wearing. In Beijing, a retrospective cohort of families with at least one laboratory confirmed COVID-19 case found that mask use by the primary case and family members was associated with a large decrease in the risk of transmission.²⁴ And finally, a study comparing states that mandated face mask use with those that did not found that requiring a face mask while in public averted hundreds of thousands of new cases of COVID-19.²⁵ All of these demonstrate that while face masks are not 100% effective, they are highly effective at preventing the spread of COVID-19.

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