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February 10, 2021

Effectiveness of Mask Wearing to Control Community Spread of SARS-CoV-2

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Prior to the coronavirus disease 2019 (COVID-19) pandemic, the efficacy of community mask wearing to reduce the spread of respiratory infections was controversial because there were no solid relevant data to support their use. During the pandemic, the scientific evidence has increased. Compelling data now demonstrate that community mask wearing is an effective nonpharmacologic intervention to reduce the spread of this infection, especially as source control to prevent spread from infected persons, but also as protection to reduce wearers' exposure to infection.

COVID-19 spreads primarily through respiratory droplets exhaled when infected people breathe, talk, cough, sneeze, or sing. Most of these droplets are smaller than 10 μm in diameter, often referred to as *aerosols*. The amount of small droplets and particles increases with the rate and force of airflow during exhalation (eg, shouting, vigorous exercise). Exposure is greater the closer a person is to the source of exhalations. Larger droplets fall out of the air rapidly, but small droplets and the dried particles formed from them (ie, droplet nuclei) can remain suspended in the air. In circumstances with poor ventilation, typically indoor enclosed spaces where an infected person is present for an extended period, the concentrations of these small droplets and particles can build sufficiently to transmit infection.

Community mask wearing substantially reduces transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in 2 ways. First, masks prevent infected persons from exposing others to SARS-CoV-2 by blocking exhalation of virus-containing droplets into the air (termed *source control*). This aspect of mask wearing is especially important because it is estimated that at least 50% or more of transmissions are from persons who never develop symptoms or those who are in the presymptomatic phase of COVID-19 illness.¹ In recent laboratory experiments, multilayer cloth masks were more effective than single-layer masks, blocking as much as 50% to 70% of exhaled small droplets and particles.^{2,3} In some cases, cloth masks have performed similar to surgical or procedure masks for source control. Second, masks protect uninfected wearers. Masks form a barrier to large respiratory droplets that could land on exposed mucous membranes of the eye, nose, and mouth. Masks can also partially filter out small droplets and particles from inhaled air. Multiple layers of fabric and fabrics with higher thread counts improve filtration. However, the observed effectiveness of cloth masks to protect the wearer is lower than their effectiveness for source control,³ and the filtration capacity of cloth masks can be highly dependent on design, fit, and materials used. Standards for cloth masks are needed to help consumers select marketed products.

Epidemiological investigations have helped quantify the benefit of mask wearing to prevent the spread of SARS-CoV-2 (**Table; Supplement**). At a hair salon in which all staff and clients were required to wear a mask under local ordinance and company policy, 2 symptomatic, infected stylists attended to 139 clients and no infections were observed in the 67 clients who were reached for interviewing and testing. During a COVID-19 outbreak on the USS Theodore Roosevelt, persons who wore masks experienced a 70% lower risk of testing positive for SARS-CoV-2 infection.⁴ Similar reductions have been reported in case contact investigations when contacts were masked⁵ and in household clusters in which household members were masked.⁶



Table. Studies of the Effect of Mask Wearing on SARS-CoV-2 Infection Risk^a

 [Studies of the Effect of Mask Wearing on SARS-CoV-2 Infection Risk^a](#)

An increasing number of ecological studies have also provided persuasive evidence that universal mandatory mask wearing policies have been associated with reductions in the number or rate of infections and deaths ([Table](#)). These studies did not distinguish the types of masks (cloth, surgical, or N95) used in the community. This association is strengthened because, in many cases, other mitigation strategies (eg, school and workplace closures, recommendations for social distancing, hand hygiene) had already been deployed before enactment of mask wearing policies, after which the reductions were observed. A study that examined changes in growth rates for infections in 15 states and the District of Columbia before and after mask mandates showed that rates were growing before the mandates were enacted and slowed significantly after, with greater benefit the longer the mandates had been in place.⁷

Wearing a mask can become uncomfortable, particularly for long periods in warm environments, and covering the nose and mouth may inhibit verbal and nonverbal communication, particularly for children and deaf individuals. However, children aged 7 to 13 years have been shown to be able to make accurate inferences about the emotions of others with partially covered faces,⁸ and the US Food and Drug Administration recently approved a transparent surgical mask that may be useful in such circumstances. Concerns about reduced oxygen saturation and carbon dioxide retention when wearing a mask have not been supported by available data.⁹

The overall community benefit of wearing masks derives from their combined ability to limit both exhalation and inhalation of infectious virus. Similar to the principle of herd immunity for vaccination, the greater the extent to which the intervention—mask wearing in this case—is adopted by the community, the larger the benefit to each individual member. The prevalence of mask use in the community may be of greater importance than the type of mask worn. It merits noting that a recent study has been improperly characterized by some sources as showing that cloth or surgical masks offer no benefit. This randomized trial in Denmark was designed to detect at least a 50% reduction in risk for persons wearing surgical masks. Findings were inconclusive,¹⁰ most likely because the actual reduction in exposure these masks provided for the wearer was lower. More importantly, the study was far too small (ie, enrolled about 0.1% of the population) to assess the community benefit achieved when wearer protection is combined with reduced source transmission from mask wearers to others.

During past national crises, persons in the US have willingly united and endured temporary sacrifices for the common good. Recovery of the nation from the COVID-19 pandemic requires the combined efforts of families, friends, and neighbors working together in unified public health action. When masks are worn and combined with other recommended mitigation measures, they protect not only the wearer but also the greater community. Recommendations for masks will likely change as more is learned about various mask types and as the pandemic evolves. With the emergence of more transmissible SARS-CoV-2 variants, it is even more important to adopt widespread mask wearing as well as to redouble efforts with use of all other nonpharmaceutical prevention measures until effective levels of vaccination are achieved nationally.

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Correction: This article was corrected on February 22, 2021, to correct a typo indicating that there were solid relevant data to support community mask wearing to reduce the spread of respiratory infections before the pandemic. This typo has been corrected.

Conflict of Interest Disclosures: None reported.

Additional Information: The science summarized in this article is reviewed in greater detail with a full set of references on the Centers for Disease Control and Prevention's COVID-19 website Scientific Brief: Community Use of Cloth Masks to Control the Spread of SARS-CoV-2 (<https://www.cdc.gov/coronavirus/2019-ncov/more/masking-science-sars-cov2.html>). This website and a public slide deck will be updated periodically.

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6 Comments for this article

EXPAND ALL

February 11, 2021

Trial of Masking

Samuel Zagarella, FACP | University of Sydney

The authors discount the randomized Danish article (1), stating that "only" 0.1% of the population was studied. in fact the study enrolled 3030 people

Yet to support their argument they offer self reported studies with tiny amounts of participants.

The hairdresser study had 139 participants and only 63 available to follow up.

Reference

1. Henning Bundgaard, Johan Skov Bundgaard, Daniel Emil Tadeusz Raaschou-Pedersen, et al. Effectiveness of Adding a Mask Recommendation to Other Public Health Measures to Prevent SARS-CoV-2 Infection in Danish Mask Wearers: A Randomized Controlled Trial. Ann Intern Med. [Epub ahead of print 18 November 2020]. doi:10.7326/M20-6817

CONFLICT OF INTEREST: None Reported

February 15, 2021

Danish Study

Peter Flanagan-Hyde |

Dr. Zagarella,

The reason the Danish study was included is that it has been widely misinterpreted as providing evidence that there is no benefit to mask wearing.

In fact this study doesn't address the point of the article at all, which is community spread. The Danish study only looked at whether the wearers were protected, with statistically inconclusive evidence (though pointing in the right direction). This is why the study was not able to address the community spread aspect and why the small size of the participants in comparison to the population is relevant.

Reference

1. ...

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March 8, 2021

Reply to Dr. Zagarella

Ira Bloom, MD | University of Toronto, ON, Canada

In further response to Dr. Zagarella's point, the Danish study (1) has been criticized for several other limitations beyond its relatively small sample size (compared to the other referenced ecological studies).

It may have been adequately powered to test for 50% reduction in Covid-19 among those who were randomized to wear a mask outside, but this likely was the right answer to the wrong question.

The right question, arguably, is whether mask wearing significantly decreased illness within the community. The hairdresser study answers this question better, with 63/139 participants.

Regarding some limitations of the ...

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February 13, 2021

Denmark's population.

Jack Campbell, MD |

For clarity, 0.1% of Denmark's population is approximately 5,700.

CONFLICT OF INTEREST: None Reported

September 3, 2021

Why the Struggle?

Scott Mendelson, MD, PhD | University of Illinois

It is astonishing the degree to which some fight, tooth and nail, against the simple wearing of a mask. You would think they are being required to sacrifice a body part. Unlike in mathematics, nothing can be proved in medical science. There are only weak or strong indications. There is now substantial data showing that masking can slow the spread of covid. The better the mask, the better the effect. Why the fight? It's not reasonable, it is political--though for life of me I can't understand even the political motivation. The necessity and value of ...

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September 11, 2021

Retired

As you can see, I am the last person who ought to offer a critical comment on a report by two medical doctors. However, of the eleven sources listed in the left-most column in the table, four list outcomes beginning with the word, "Estimated...." Another three sources, different from the four I just mentioned, describe interventions as, "Self-reporting...." "Self-reporting" and "Estimated" are not terms I associate with objective, replicable data. Mask-wearing may indeed be effective but I'm not persuaded by this article. Meanwhile, I support vaccination and mask-wearing, but I use N95 masks because there's ...

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