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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

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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-sciencesars-cov2.html). This website and a public slide deck will be updated periodically.

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 masked[5] and in household clusters in which household members were masked.[6]

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.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table.

Studies of the Effect of Mask Wearing on SARS-CoV-12 Infection Risk[a]

Source	Location	Population studied	Intervention	Outcome
Hendrix et al	Hair salon in Springfield, Missouri	139 Patrons at a salon with 2 infected and symptomatic stylists	Universal mask wearing in salon (by local ordinance and company policy)	No COVID-19 infections among 67 patrons who were available for follow-up
Payne et al	USS Theodore Roosevelt, Guam	382 US Navy service members	Self-reported mask wearing	Mask wearing reduced risk of infection by 70% (unadjusted odds ratio, 0.30 [95% CI, 0.17-0.52])
Wang Y et al	Households in Beijing, China	124 Households of diagnosed cases comprising 335 people	Self-reported mask wearing by index cases or ≥1 household member prior to index case's diagnosis	Mask wearing reduced risk of secondary infection by 79% (adjusted odds ratio, 0.21 [95% CI, 0.06-0.79])
Doung-ngern et al	Bangkok, Thailand	839 Close contacts of 211 index cases	Self-reported mask wearing by contact at time of high-risk exposure to case	Always having used a mask reduced infection risk by 77% (adjusted odds ratio, 0.23 [95% CI, 0.09-0.60])
Gallaway et al	Arizona	State population	Mandatory mask wearing in public	Temporal association between institution of mask wearing policy and subsequent decline in new diagnoses
Rader et al	US	374 021 Persons who completed web-based surveys	Self-reported mask wearing in grocery stores and in the homes of family or friends	A 10% increase in mask wearing tripled the likelihood of stopping community transmission (adjusted odds ratio, 3.53 [95% CI, 2.03-6.43])
Wang X et al	Boston, Massachusetts	9850 Health care workers (HCWs)	Universal masking of HCWs and patients in the Mass General Brigham health care system	Estimated weekly decline in new diagnoses among HCWs of 3.4% after full implementation of the mask wearing policy
Mitze et al	Jena (Thuringia), Germany	City population aged ≥15 y	Mandatory mask wearing in public spaces (eg, public transport, shops)	Estimated daily decline in new diagnoses of 1.32% after implementation of the mask mandate
Van Dyke et al	Kansas	State population	Mandatory mask wearing in public spaces	Estimated case rate per 100 000 persons decreased by 0.08 in counties with mask mandates but increased by 0.11 in those without
Lyu and Wehby	15 US states and Washington, DC	State populations	Mandatory mask wearing in public	Estimated overall initial daily decline in new diagnoses of 0.9% grew to 2.0% at 21 days following mandates
Karaivanov et al	Canada	Country population	Mandatory mask wearing indoors	Estimated weekly 25%-40% decline in new diagnoses following mask mandates

[a]See the Supplement for the complete table.