



The effectiveness of face masks to prevent SARS CoV-2 transmission: A summary of the peer-review science.

Executive Summary: The peer-reviewed scientific evidence for the protective effect of face masks and respiratory virus infection in healthcare and community settings is overwhelming. The following studies, all published in 2020, focus on the usefulness of wearing facemasks during the COVID-19 pandemic. Nearly all these studies conclude that, outside of the healthcare setting, wearing a face mask reduces one's risk of being exposed to SARS CoV2 virus, and transmitting the virus to others, if infected. Controlled experiments similarly showed that mask wearing reduced the amount of exposure to virus particles. Importantly, countries, states and jurisdictions that imposed mask wearing mandates and encouraged adherence were generally associated with lower disease transmission and overall decreases in disease trends. Despite political controversies surrounding mask wearing, the published scientific evidence strongly supports mask wearing, coupled with hand hygiene and social distancing to reduce the risk of COVID-19 transmission in the community.

Reviews and Meta-analyses:

Chu 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](#). Lancet (2020).

The authors identified 172 observational coronavirus studies across 16 countries; 38 of these studies specifically studied face masks and the risk of COVID-19 illness. The authors found that the use of either an N95 respirator or face mask (e.g., disposable surgical masks or similar reusable 12–16-layer cotton masks) by those exposed to infected individuals was associated with a large reduction in risk of infection (up to an 85% reduced risk). The use of face masks was protective for both health-care workers and people in the community exposed to infection.

MacIntyre et al. [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](#). International Journal of Nursing Studies (2020).

The authors describe 8 clinical trials evaluating the effectiveness of face masks to reduce respiratory viruses and SARS CoV2 transmission. Their analysis suggests that community mask use by well people could be beneficial, particularly for COVID-19, where transmission may be pre-symptomatic. The studies of masks as source control (where sick persons use masks to reduce spread) also suggest a benefit and may be important during the COVID-19 pandemic in both community and health care settings.

Wang J, Pan L, Tang S, Ji JS, Shi X. [Mask use during COVID-19: A risk adjusted strategy](#). Environ Pollut. (2020). 266(Pt 1):115099.

Prior to COVID-19, the authors highlight a large systematic review from 67 studies that showed that wearing masks is one of the important barriers to controlling respiratory viruses transmission; and evidences indicates that N95 respirators were similarly effective to surgical masks ([Jefferson et al., 2011](#)). Additionally, the authors summarized that the main transmission routes of SARS-

CoV-2 include droplet, contact transmissions, and airborne transmissions, which is characterized by high proportion of cases with mild symptom or asymptomatic cases, and the necessity of wearing masks by the public during COVID-19 pandemic has been under-emphasized.

Brainard et al. [Facemasks and similar barriers to prevent respiratory illness such as COVID-19: A rapid systematic review](#). medRxiv (2020).

The authors reviewed 31 clinical trials and observational studies to better understand the value of wearing facemasks in community settings to prevent respiratory illness. The authors report that when both housemates and an infected household member wore facemasks the likelihood of additional household members becoming ill may be modestly reduced by around 19%. The authors go on to conclude that, based on clinical trials, wearing facemasks can be slightly protective against primary infection from casual community contact, and modestly protective against household infections when both infected and uninfected members wear facemasks.

Gandhi et al. [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.

The authors suggest that although universal public masking can certainly protect others, the “inoculum” theory (the amount of virus particles one could be exposed to) argues for a major protective effect for the individual. Masks, depending on the material and design, filter out a majority of viral particles and decrease the overall ‘dose’ of virus particles one could be exposed to. This perspective commentary puts forth another advantage of population-level facial masking for pandemic control with SARS-CoV-2 based on an old but enduring theory regarding viral inoculum.

Howard et al. [Face Masks Against COVID-19: An Evidence Review](#). Proceedings National Academy Sciences (2020).

This review of the literature offers evidence in favor of widespread mask use to reduce community transmission: masks use materials that obstruct droplets of the necessary size; people are most infectious in the initial period post-infection masks have been effective in reducing transmission of influenza; non-medical masks have been shown to be effective at blocking transmission of coronavirus; and places and time periods where mask usage is required or widespread have shown substantially lower community transmission. The available evidence suggests that near-universal adoption of non-medical masks when out in public, in combination with complementary public health measures could successfully reduce effective-R to below 1.0, thereby stopping community spread.

Matuschek et al. [Face masks: benefits and risks during the COVID-19 crisis](#). Eur J Med Res. 2020 Aug 12;25(1):32.

In this review of the available literature, the authors found that the use of masks that include mouth and nose covering were linked to relevant protection during close contact scenarios by limiting pathogen-containing aerosol and liquid droplet dissemination. Wearing a mask in areas where sufficient distance is not feasible, such as public transportation, most likely reduces the spread of virus-loaded droplets and therefore the risk of transferring SARS-CoV-2. However, the authors note that if masks are not exchanged regularly (or washed properly when made of cloth), pathogens can accumulate in the mask. When improperly used, the risk of spreading the pathogen—including SARS-CoV-2—might be critically increased.

Epidemiologic Studies:

Stutt et al. [A modelling framework to assess the likely effectiveness of facemasks in combination with 'lock-down' in managing the COVID-19 pandemic](#). Proc. R. Soc.

The authors use two complementary mathematical modelling approaches to test the effectiveness of facemask wearing by sections of the population in reducing the transmission rate of SARS-Cov-2. Their models show that, when facemasks are used by the public all the time (not just from when symptoms first appear), the effective reproduction number can be decreased below 1, leading to the overall reduction of disease spread.

Mitze et al. [Face Masks Considerably Reduce COVID-19 Cases in Germany: A Synthetic Control Method Approach](#). Institute of Labor Economics (2020).

The authors assessed the impact of mandatory face mask policies in Germany on national case counts reported to federal health authorities. Depending on the region they analyzed, the authors found that face masks reduced the cumulative number of reported COVID-19 cases between 2.3% and 13% over a period of 10 days after they became compulsory. The authors go on to conclude that the introduction of face masks on 6 April reduced the number of new infections over the next 20 days by almost 25%.

Rader B et al. [Mask Wearing and Control of SARS-CoV-2 Transmission in the United States](#). medRxiv (2020).

The authors conducted cross-sectional surveys and used a multivariate logistic model to predict community transmission using state- and week-specific estimates for mask wearing. The authors, controlling for social distancing and other variables, found that a 10% increase in mask wearing was associated with a 3.5-fold increased likelihood of controlling disease transmission. Specifically, communities with high mask wearing adherence and social distancing have the highest predicted probability of a controlled epidemic.

Zhang et al. [Identifying airborne transmission as the dominant route for the spread of COVID-19](#). Proceedings of the National Academy of Sciences (2020), 117 (26) 14857-4863.

The authors quantified the impact of face coverings by projecting the number of new infections based on the data prior to implementing the use of face masks in Italy on April 6 and NYC on April 17. Their analysis indicated that face coverings reduced the number of infections by over 75,000 in Italy from April 6 to May 9 and by over 66,000 in NYC from April 17 to May 9. The authors concluded that wearing of face masks in public corresponds to the most effective means to prevent interhuman transmission, and this inexpensive practice, in conjunction with extensive testing, quarantine, and contact tracing, poses the most probable opportunity to stop the COVID-19 pandemic, prior to the development of a vaccine.

Wang et al. [Reduction of secondary transmission of SARS-CoV-2 in households by face mask use, disinfection and social distancing: a cohort study in Beijing, China](#). BMJ Glob Health (2020).

In this retrospective cohort study, the authors analyzed factors that prevented secondary transmission of COVID-19 among household contacts. The authors found that face mask use by the primary case and family contacts before the primary case developed symptoms was 79% effective in reducing secondary transmission.

Doung-ngern et al. [Case-control study of use of personal protective measures and risk for SARS-CoV-2 infection, Thailand](#). Emerg Infect Dis (2020).

In this case-control study in Thailand of 211 cases and 839 controls, the authors found that wearing masks all the time during contact was independently associated with a 77% reduced risk of SARS-CoV-2 infection compared with not wearing masks. The authors also found the type of mask worn was not independently associated with infection.

Wilson et al. [Factors Influencing Risk for COVID-19 Exposure Among Young Adults Aged 18–23 Years — Winnebago County, Wisconsin, March–July 2020](#). MMWR Morb Mortal Wkly Rep (2020); 69:1497–1502.

During an outbreak of COVID-19 among young adults in Wisconsin, the authors conducted 30 key informant interviews. Most interviewees reported exposure to misinformation, conflicting messages, or opposing views about the need for and effectiveness of masks. The authors concluded that exposure to misinformation and unclear messages may have been a driver of the outbreak, underscoring the importance of providing clear and consistent messages about the need for and effectiveness of masks.

Leffler et al. [Association of country-wide coronavirus mortality with demographics, testing, lockdowns, and public wearing of masks](#). medRxiv (2020).

The authors analyzed differences between countries to determine sources of variation in per-capita mortality from COVID-19. In countries with cultural norms or government policies supporting public mask-wearing, per-capita coronavirus mortality increased on average by just 15.8% each week, as compared with 62.1% each week in remaining countries. The authors concluded that societal norms and government policies supporting the wearing of masks by the public, as well as international travel controls, are independently associated with lower per-capita mortality from COVID-19.

Lyu et al. [Community Use of Face Masks And COVID-19: Evidence From A Natural Experiment Of State Mandates In The US](#). Health Affairs (2020).

This study, similar to Leffler et al, compares government mandates for face mask use in public issued by fifteen states during April 8 and May 15, 2020. The authors concluded that mandating face mask use in public was associated with a decline in the daily COVID-19 growth rate by 0.9, 1.1, 1.4, 1.7, and 2.0 percentage points in 1–5, 6–10, 11–15, 16–20, and 21 or more days after state face mask orders were signed, respectively. Estimates suggest that as a result of the implementation of these mandates, more than 200,000 COVID-19 cases were averted by May 22, 2020. The findings suggested that requiring face mask use in public could help in mitigating the spread of COVID-19.

Eikenberry 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.

The authors use a mathematical model to simulate the impact of universal mask wearing. Hypothetical mask adoption scenarios, for Washington and New York state, suggest that immediate near universal (80%) adoption of moderately (50%) effective masks could prevent on the order of 17-45% of projected deaths over two months in New York, while decreasing the peak daily death rate by 34-58%, absent other changes in epidemic dynamics. In Washington, where baseline transmission is much less intense, 80% adoption of such masks could reduce mortality by 24–65% (and peak deaths 15–69%), compared to 2–9% mortality reduction in New York (peak death reduction 9–18%).

Controlled Experiments:

Ma QX, Shan H, Zhang HL, Li GM, Yang RM, Chen JM. [Potential utilities of mask-wearing and instant hand hygiene for fighting SARS-CoV-2](#). *J Med Virol* (2020).

In this study, the efficacy of three types of masks were evaluated using the avian influenza virus to simulate the coronavirus. N95 masks, medical masks, and homemade masks made of four-layer kitchen paper and one-layer cloth could block 99.98%, 97.14%, and 95.15% of the virus in aerosols. With these data, the authors propose the approach of mask-wearing to slow the exponential spread of the virus.

Leung, N.H.L., Chu, D.K.W., Shiu, E.Y.C. et al. [Respiratory virus shedding in exhaled breath and efficacy of face masks](#). *Nat Med* **26**, 676–680 (2020).

The authors tested viral shedding (in terms of viral copies per sample) in nasal swabs, throat swabs, respiratory droplet samples and aerosol samples and compared the latter two between samples collected with or without a face mask. The study demonstrated the efficacy of surgical masks to reduce coronavirus detection and viral copies in large respiratory droplets and in aerosols.

Fischer et al. [Low-cost measurement of face mask efficacy for filtering expelled droplets during speech](#). *Science Advances* (2020).

The authors demonstrated a simple optical measurement to evaluate the efficacy of masks to reduce the transmission of respiratory droplets during regular speech. In their proof-of-concept study, they compared a variety of commonly available mask types and observed that some mask types such as cloth masks approach the performance of standard surgical masks, while some mask alternatives, such as neck gaiters or bandanas, offer very little protection.

Bae et al. [Effectiveness of Surgical and Cotton Masks in Blocking SARS-CoV-2: A Controlled Comparison in 4 Patients](#). *Annals of Internal Medicine* (2020).

In this study of only 4 patients, the authors compared disposable surgical masks with reusable 100% cotton masks to filter SARS CoV-2. Neither surgical nor cotton masks effectively filtered SARS-CoV-2 during coughs by infected patients.

Konda A, Prakash A, Moss GA, Schmoltdt M, Grant GD, Guha S. [Aerosol Filtration Efficiency of Common Fabrics Used in Respiratory Cloth Masks](#). *ACS Nano* (2020)14(5):6339-6347.

This study assessed filtration effectiveness of various mask materials. Although the filtration efficiencies for various fabrics when a single layer was used ranged from 5 to 80% and 5 to 95% for particle sizes of <300 nm and >300 nm, respectively, the efficiencies improved when multiple layers were used and when using a specific combination of different fabrics. Filtration efficiencies of the hybrids (such as cotton-silk, cotton-chiffon, cotton-flannel) was >80% (for particles <300 nm) and >90% (for particles >300 nm). Cotton, the most widely used material for cloth masks performs better at higher weave densities (i.e., thread count) and can make a significant difference in filtration efficiencies.