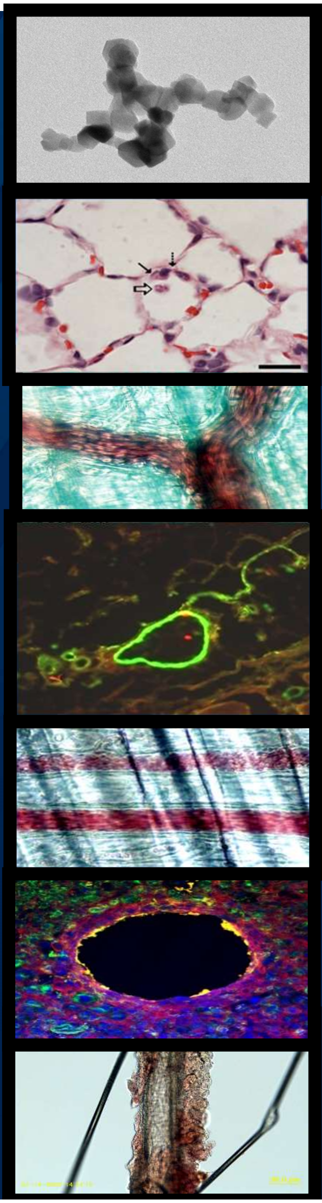
Protection against COVID-19: EFFECTIVE MASKING…

A little bit of history, and a lot of facts!



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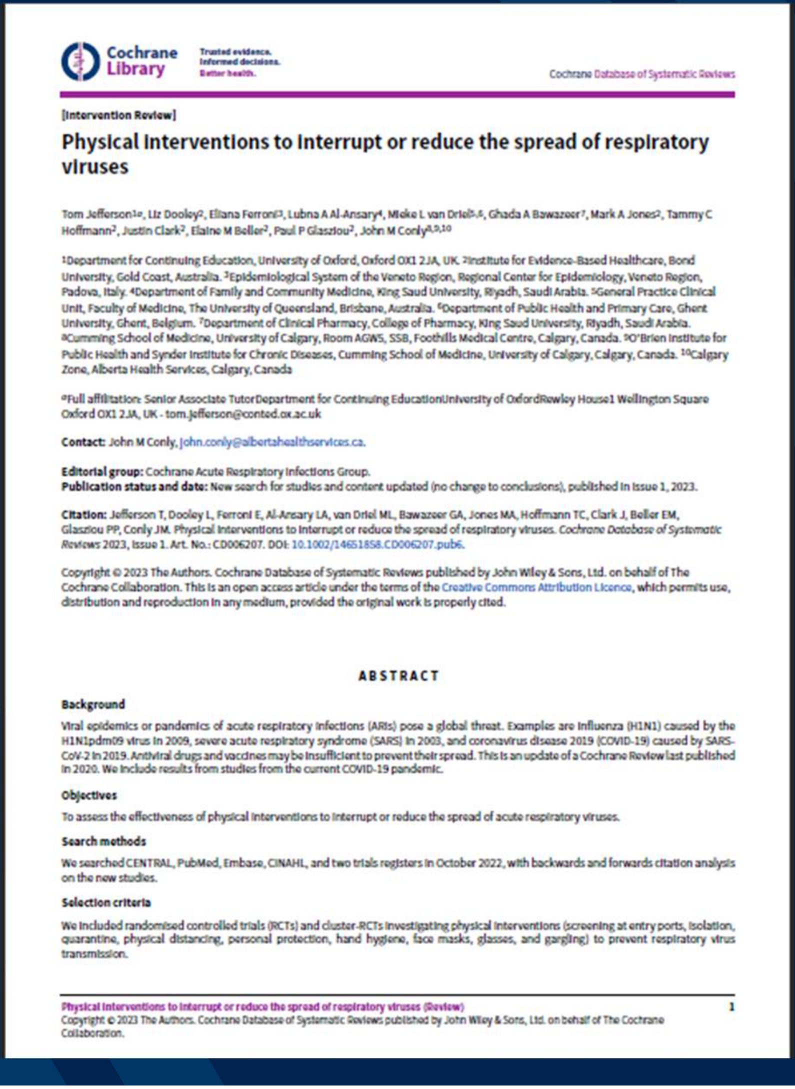
Outline

1. Background / Problem
2. Definitions / Size
3. How N-95 masks work
4. Observations / Experiences
5. Summary / Conclusions

Background – Current Problem



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[Intervention Review]

Physical interventions to interrupt or reduce the spread of respiratory viruses

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ABSTRACT

Background

Viral epidemics or pandemics of acute respiratory infections (ARIs) pose a global threat. Examples are influenza (H1N1) caused by the H1N1pdm09 virus in 2009, severe acute respiratory syndrome (SARS) in 2003, and coronavirus disease 2019 (COVID-19) caused by SARS-CoV-2 in 2019. Antiviral drugs and vaccines may be insufficient to prevent their spread. This is an update of a Cochrane Review last published in 2020. We include results from studies from the current COVID-19 pandemic.

Objectives

To assess the effectiveness of physical interventions to interrupt or reduce the spread of acute respiratory viruses.

Search methods

We searched CENTRAL, PubMed, Embase, CINAHL, and two trials registers in October 2022, with backwards and forwards citation analysis on the new studies.

Selection criteria

We included randomised controlled trials (RCTs) and cluster-RCTs investigating physical interventions (screening at entry ports, isolation, quarantine, physical distancing, personal protection, hand hygiene, face masks, glasses, and gargling) to prevent respiratory virus transmission.

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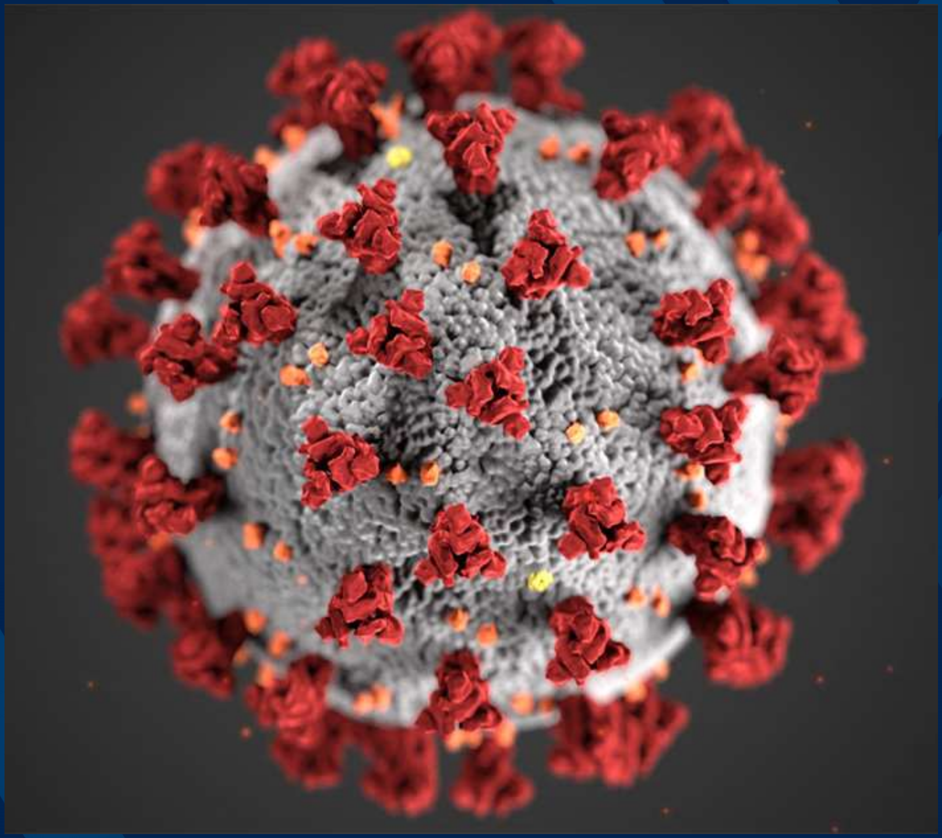
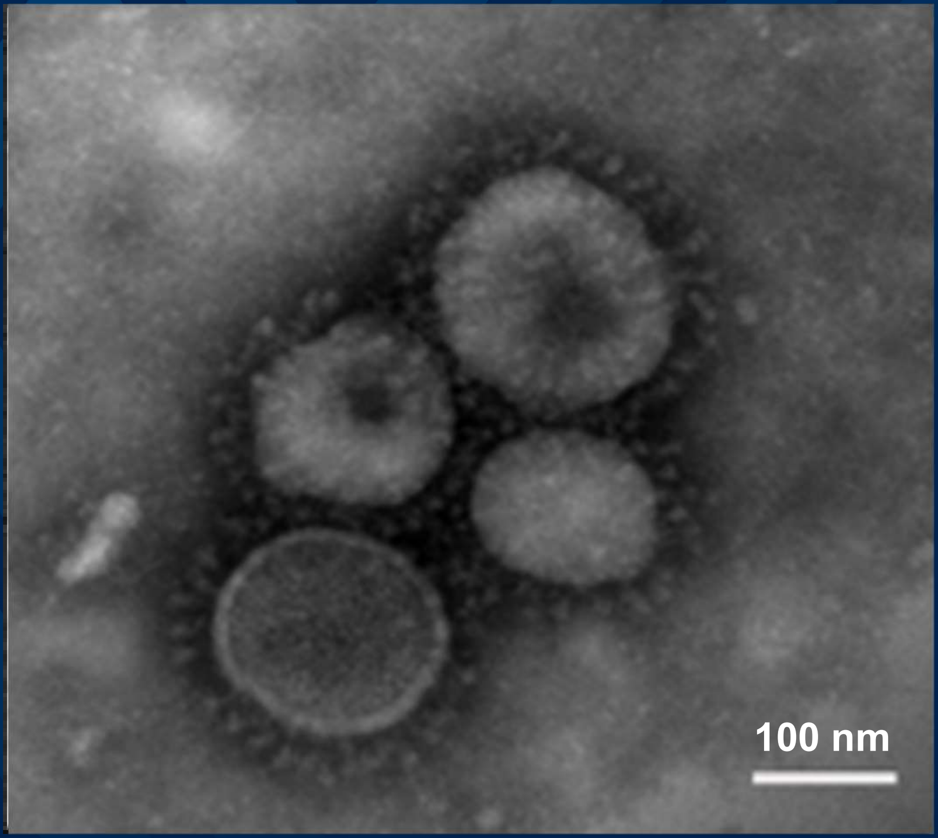
1. **30 January 2023**
2. **Meta-review**
    - **Masks**
    - **Antiviral drugs**
    - **Vaccines**
3. **Included**
    - **COVID-19**
    - **H1N1 (2009 influenza)**
    - **SARS (2003)**

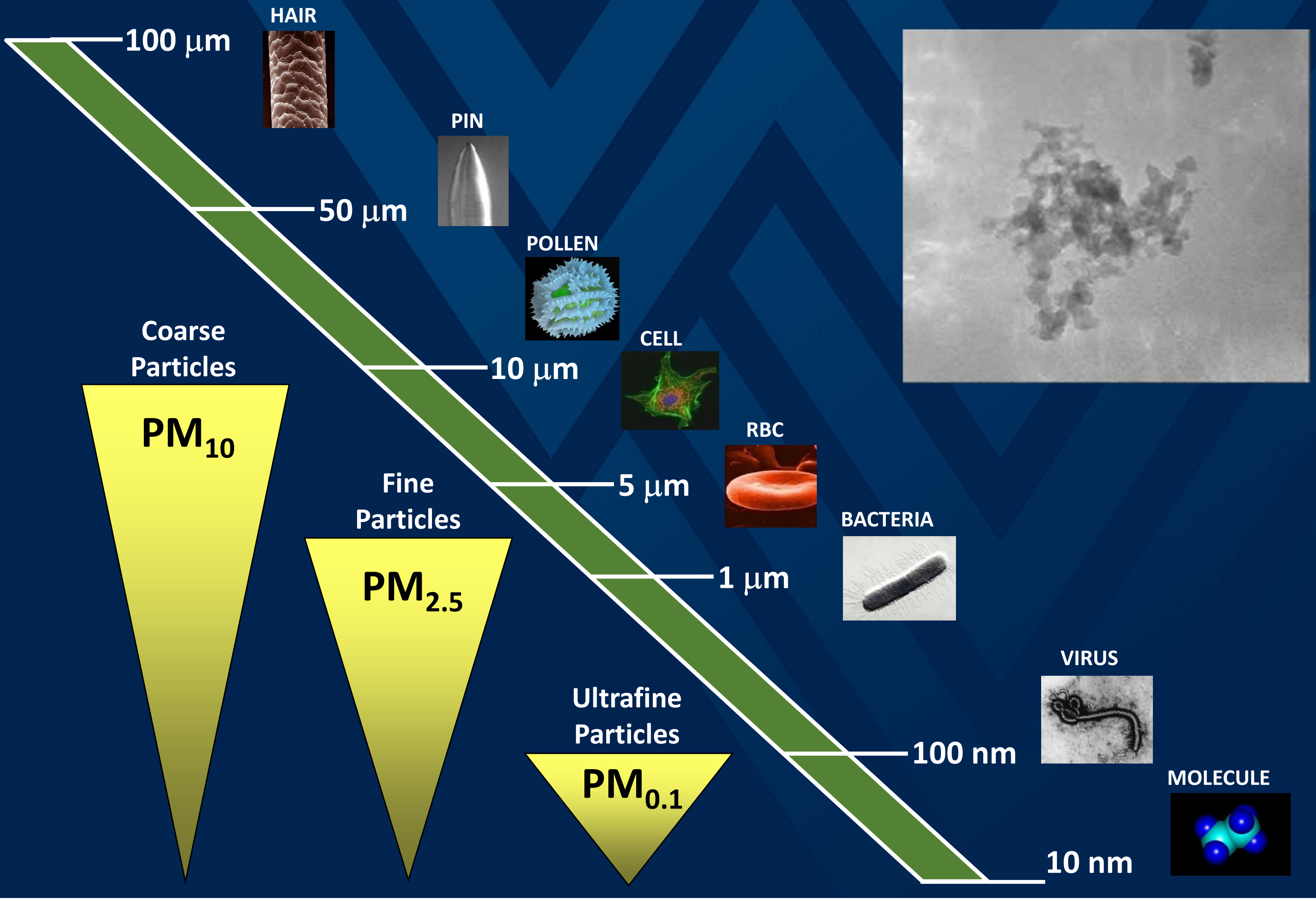
COVID Droplet(s)





https://www.cdc.gov/dotw/covid-19/index.html

Particle Size Distribution



100 µm
HAIR
50 µm
PIN
POLLEN
10 µm
CELL
5 µm
RBC
1 µm
BACTERIA
100 nm
VIRUS
10 nm
MOLECULE

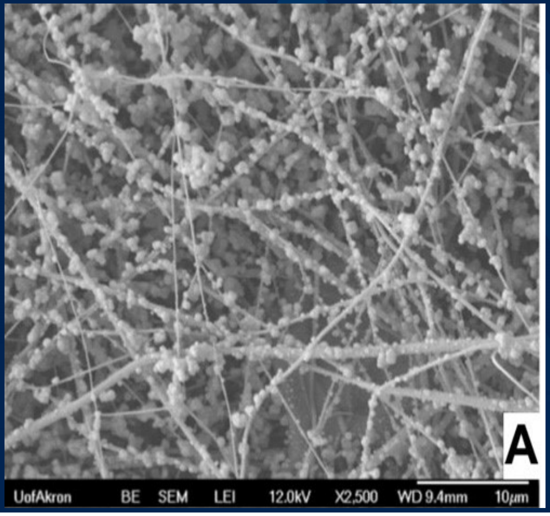
Coarse Particles
PM_{10}

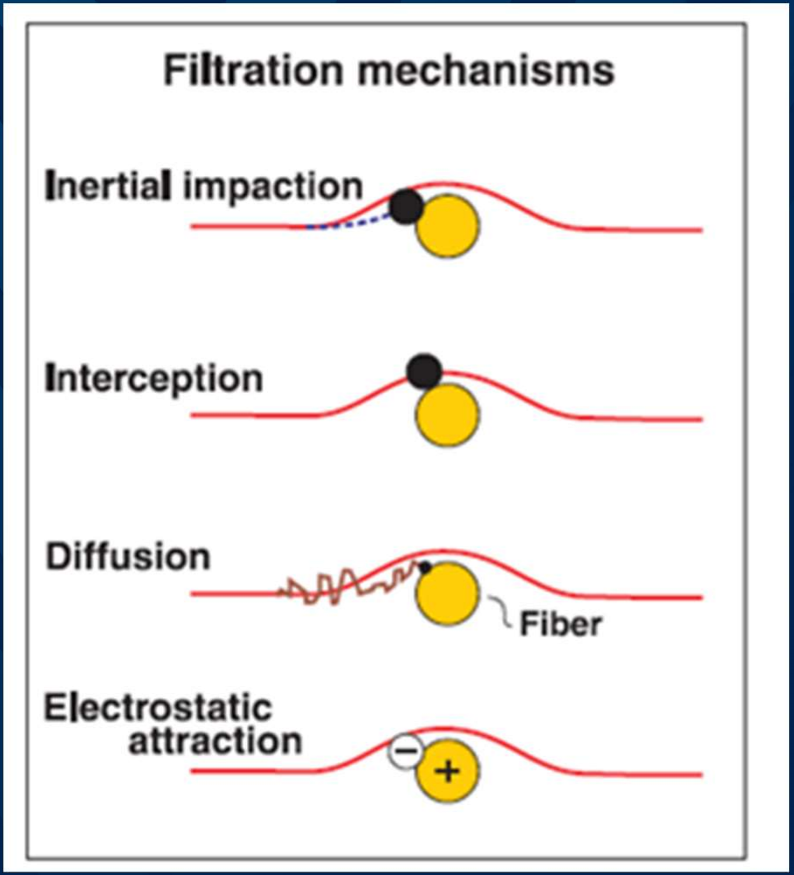
Fine Particles
$PM_{2.5}$

Ultrafine Particles
$PM_{0.1}$

N-95 Electret Filter Media (U.S. Patent 6119691A)

“Nonwoven web of thermoplastic microfibers. The thermoplastic microfibers are of substantially the same composition, are nonconductive, and have an effective fiber diameter less than about 15 micrometers. The nonwoven web also has sufficient unpolarized trapped charge”



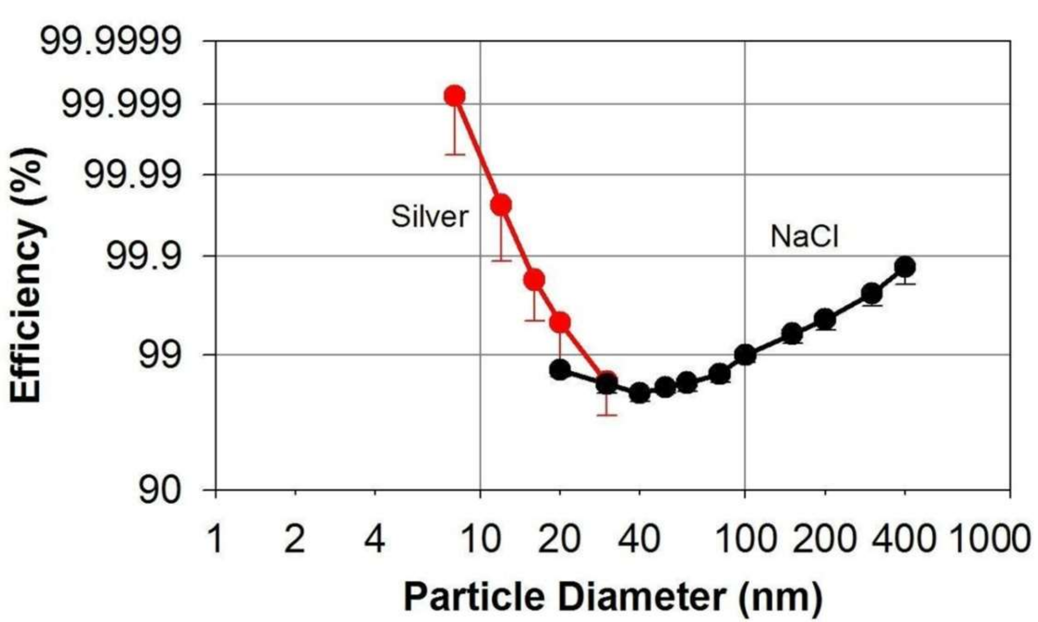


NIOSH Evaluation of Respirator Filters

1) As predicted by single fiber filtration theory, 4 to 20 nanometer particles were captured very efficiently by respirator filter media.

2)The most penetrating particle size (MPPS) range for electret filter media (the most common type of filter used in respirators on the market today) was between 30 and 100 nanometers, with 100-class respirators having higher levels of laboratory filtration performance compared to 95-class respirators.

3) Leak size (FIT) was the largest factor affecting the number of nanoparticles inside the facepiece. *Not the mask-media type*.



https://blogs.cdc.gov/niosh-science-blog/2011/12/07/resp-nano/

Do Masks Work? YES!!!

Coughing, sneezing, or even speaking

can send droplets flying everywhere

N-95 Alternatives

https://wvutoday.wvu.edu/stories/2020/04/13/wvu-team-unmasks-effective-n95-alternatives

Gaitor-Gate 2020

SCIENCE ADVANCES | RESEARCH ARTICLE

CORONAVIRUS

Low-cost measurement of face mask efficacy for filtering expelled droplets during speech

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Mandates for mask use in public during the recent coronavirus disease 2019 (COVID-19) pandemic, worsened by global shortage of commercial supplies, have led to widespread use of homemade masks and mask alternatives. It is assumed that wearing such masks reduces the likelihood for an infected person to spread the disease, but many of these mask designs have not been tested in practice. We have demonstrated a simple optical measurement method to evaluate the efficacy of masks to reduce the transmission of respiratory droplets during regular speech. In proof-of-principle studies, we compared a variety of commonly available mask types and observed that some mask types approach the performance of standard surgical masks, while some mask alternatives, such as neck gaiters or bandanas, offer very little protection. Our measurement setup is inexpensive and can be built and operated by nonexperts, allowing for rapid evaluation of mask performance during speech, sneezing, or coughing.

INTRODUCTION

The global spread of coronavirus disease 2019 (COVID-19) in early 2020 has substantially increased the demand for face masks around the world while stimulating research about their efficacy. Here, we adapt a recently demonstrated optical imaging approach (*1*, *2*) and highlight stark differences in the effectiveness of different masks and mask alternatives to suppress the spread of respiratory droplets during regular speech.

In general, the term "face mask" governs a wide range of protective equipment with the primary function of reducing the transmission of particles or droplets. The most common application in modern medicine is to provide protection to the wearer (e.g., first responders), but surgical face masks were originally introduced to protect surrounding persons from the wearer, such as protecting patients with open wounds against infectious agents from the surgical team (*3*) or the persons surrounding a tuberculosis patient from contracting the disease via airborne droplets (*4*). This latter role has been embraced by multiple governments and regulatory agencies (*5*), since patients with COVID-19 can be asymptomatic but contagious for many days (*6*). The premise of protection from infected persons wearing a mask is simple: Wearing a face mask will reduce the spread of respiratory droplets containing viruses. Recent studies suggest that wearing face masks reduces the spread of COVID-19 on a population level and consequently blunts the growth of the epidemic curve (*7*, *8*). Still, determining mask efficacy is a complex topic that is still an active field of research [see, for example, (*9*)], made even more complicated because the infection pathways for COVID-19 are not yet fully understood and are complicated by many factors such as the route of transmission, correct fit and usage of masks, and environmental variables. From a public policy perspective, shortages in supply for surgical face masks and N95 respirators, as well as concerns about their side effects and the discomfort of prolonged use (*10*), have led to public use of a variety of solutions that are generally less restrictive (such as homemade cotton masks or bandanas) but usually of unknown efficacy. While some textiles used for mask fabrication have been characterized (*11*), the performance of actual masks in a practical setting needs to be considered. The work we report here describes a measurement method that can be used to improve evaluation to guide mask selection and purchase decisions.

A schematic and demonstration image are shown in Fig. 1. In brief, an operator wears a face mask and speaks into the direction of an expanded laser beam inside a dark enclosure. Droplets that propagate through the laser beam scatter light, which is recorded with a cell phone camera. A simple computer algorithm is used to count the droplets in the video. The required hardware for these measurements is commonly available; suitable lasers and optical components are accessible in hundreds of research laboratories or can be purchased for less than $200, and a standard cell phone camera can serve as a recording device. The experimental setup is simple and can easily be built and operated by nonexperts.

Below, we describe the measurement method and demonstrate its capabilities for mask testing. In this application, we do not attempt a comprehensive survey of all possible mask designs or a systematic study of all use cases. We merely demonstrated our method on a variety of commonly available masks and mask alternatives with one speaker, and a subset of these masks were tested with four speakers. Even from these limited demonstration studies, important general characteristics can be extracted by performing a relative comparison between different face masks and their transmission of droplets.

RESULTS

We tested 14 commonly available masks or mask alternatives, one patch of mask material, and a professionally fit tested N95 mask (see Fig. 2 and Table 1 for details). For reference, we recorded control trials where the speaker wore no protective mask or covering. Each test was performed with the same protocol. The camera was used to record a video of approximately 40 s length to record droplets emitted while speaking. The first 10 s of the video serve as baseline. In the next 10 s, the mask wearer repeated the sentence "Stay healthy, people" five times (speech), after which the camera

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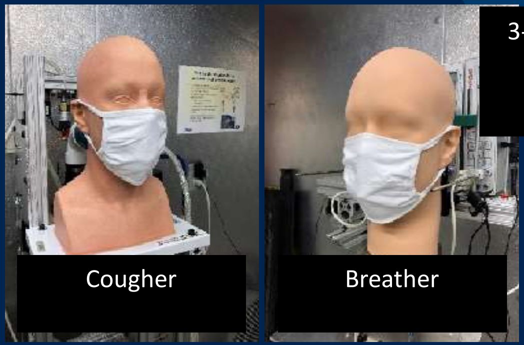
Fischer et al., Sci. Adv. 2020; 6 : eabd3083 2 September 2020

https://wvutoday.wvu.edu/stories/2020/08/14/gaiters-do-no-harm-wvu-toxicologists-find-coverings-help-contain-the-spread-of-exhaled-droplets

Double Masking

https://wvutoday.wvu.edu/stories/2021/03/04/doubling-up-on-masks-doubles-down-on-protection-wvu-experiment-confirms

Two-headed coughing-breathing simulator system developed by NIOSH

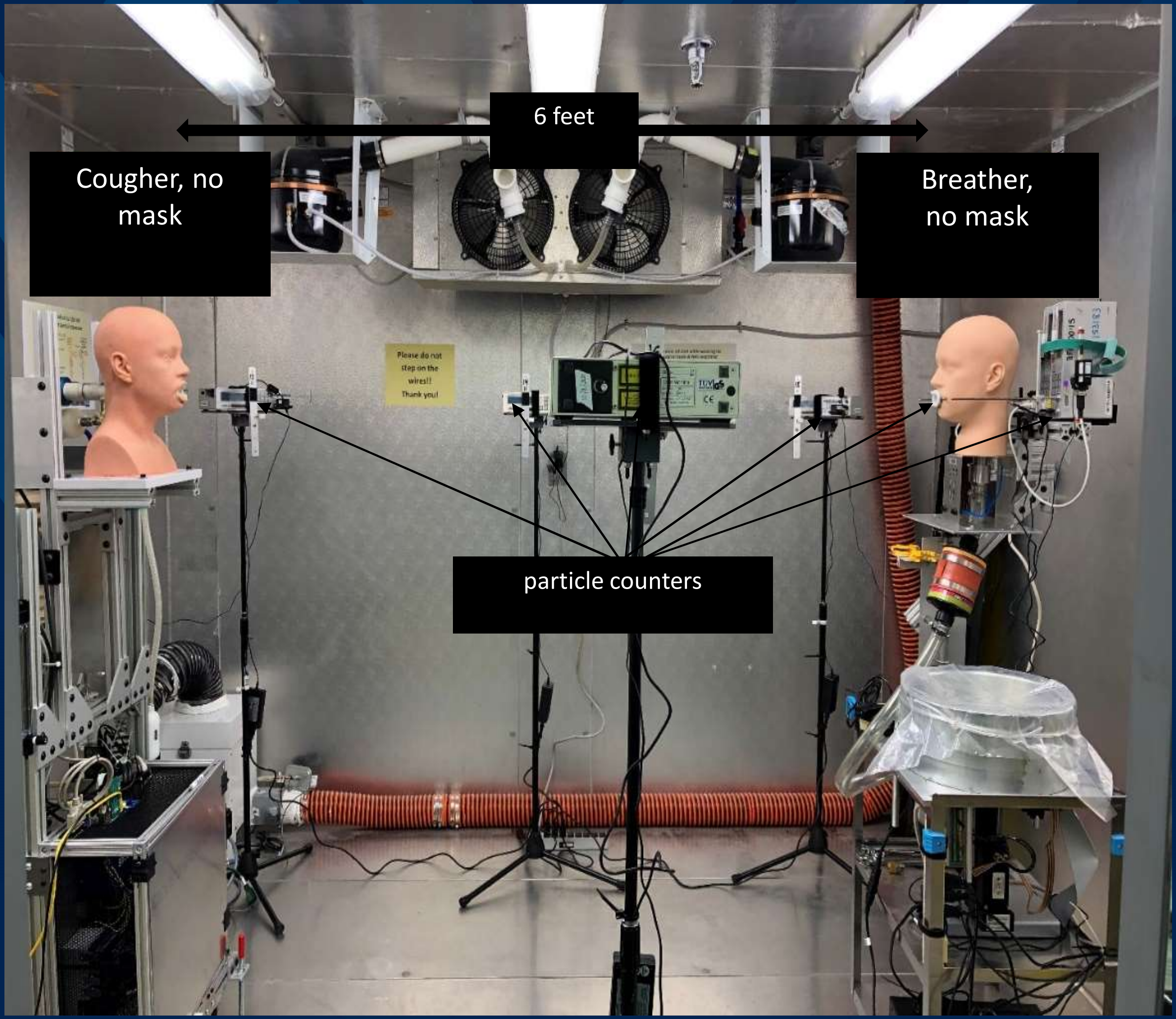


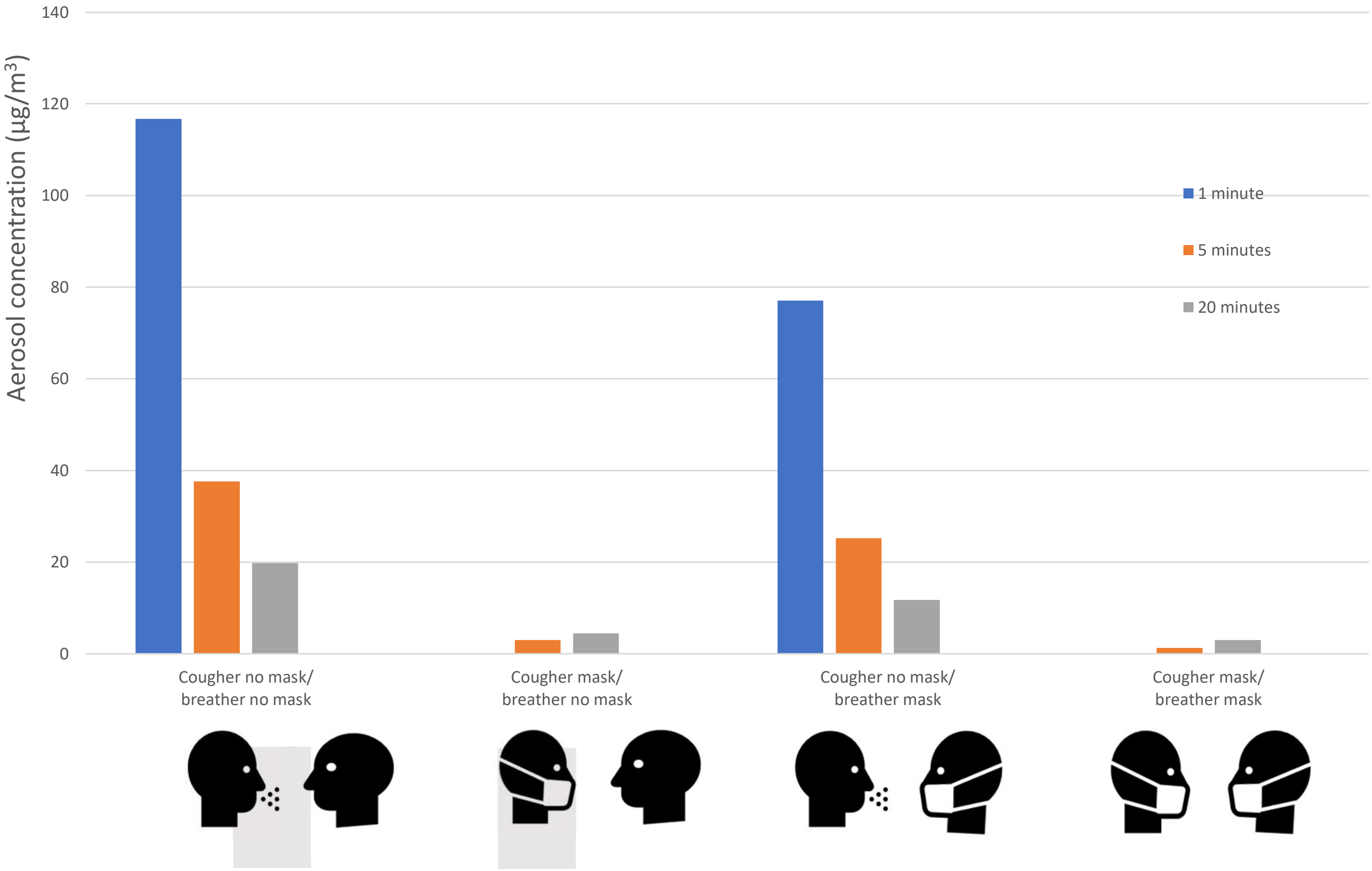
3-ply Hanes cloth mask tested

- Cougher: a single cough of 0.1—7 micron particles (small aerosol particles)
- Breather: 27 L/min breathing rate

- Four particle counters sampled aerosols around the room
- Two particle counters sampled aerosols at and to the side of the breather’s mouth

- Room was not ventilated during the experiment





Mean concentration at breathing simulator mouth
6 feet from cougher to breather

Mask Considerations and Limitations

1. **Mask type**
2. **Protect**
3. **Contain**
4. **Distance between people**
5. **Number of people**
6. **Type of room**
7. **Size of room**
8. **Time in room**