Cloth Face Coverings Worn by Public to Reduce Transmission of Viral Respiratory Infection

Cloth face coverings, combined with good hand hygiene and social distancing, are intended to reduce the transmission risk of viral respiratory infection in the general population during an outbreak. In light of the COVID-19 outbreak, the U.S. Centers for Disease Control and Prevention (CDC) recommend the general population wear cloth face coverings in public spaces where social distancing is difficult (e.g., grocery stores, pharmacies). Cloth face coverings include any reusable, washable garments, such as hand-sewn masks, scarves, bandanas, and commercially available biking and pollution masks. This report focuses on the general public’s use of these face coverings for reducing the transmission risk of viral respiratory infection.

The Evidence Bar™

Evidence is inconclusive: Too few data on outcomes of interest

In the absence of published clinical or epidemiologic studies, we assessed laboratory studies. Data from two small laboratory studies (Bae et al. 2020; Ma et al. 2020) suggest that cloth face covers may filter avian influenza virus (a COVID-19 surrogate) particles, but not COVID-19 particle spread by patients with COVID-19 who coughed while wearing cloth face masks. More studies are needed to validate and expand these findings. Surveys reporting on cloth face cover acceptance and compliance in concerned communities would also be useful. CDC guidelines have recommended wearing cloth face coverings in public in response to the COVID-19 outbreak, but the World Health Organization (WHO) has not endorsed the practice, citing insufficient evidence of effectiveness.

Evidence limitations. Laboratory studies reported on surrogate outcomes (e.g., viral load) that cannot be translated into infection risks. Also, the cloth face covers used in the studies were made of different materials (e.g., cotton, polyester cloth, polyester cloth and paper towel), and findings cannot be generalized across all cloth face covers. Ma et al. (2020) used a nebulizer model that may not reflect the dynamic nature of breathing, sneezing, and coughing.

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Executive Summary

Findings

2 published laboratory studies were available to assess.

- A laboratory study (Bae et al. 2020) found similar and high viral loads in samples collected from 4 patients with COVID-19 who coughed on a Petri dish through a cotton cloth face cover, a surgical-grade mask, or no mask at all (viral loads: no mask, 2.56 log viral copies/mL; surgical mask, 2.42 log copies/mL; cotton mask, 1.85 log copies/mL).

- A breath simulator study using a nebulizer through masks (Ma et al. 2020) reported that the percentage of avian influenza virus particle blocked by 2 homemade polyester cloth masks (95.15%, 95% CI: 90.97% to 97.39%) was lower than that blocked by N95 respirators (99.98%, 95% CI: 99.98% to 99.99%) but similar to that blocked by surgical masks (97.14%, 95% CI: 94.36% to 98.55%). Authors used avian influenza as a surrogate for COVID-19.

Evidence

Search dates: January 1, 2015, to April 6, 2020. No clinical or real-world published studies were available. We identified and reviewed full text of 2 laboratory studies.

- We did not identify any studies reporting on clinical or epidemiologic outcomes in populations that adopted cloth face coverings use in public settings. Because of the lack of clinical evidence, we reviewed laboratory studies reporting on viral loads and viral particle spread. We excluded studies of medical-grade face masks because CDC recommended that U.S. communities use cloth face covers so that N95 respirators and surgical masks could be reserved only for healthcare worker use.

- 1 study (Bae et al. 2020; n = 4) compared median viral loads in samples collected from patients with COVID-19 who coughed through a surgical mask, cotton face covers, or no mask at all.

- 1 study (Ma et al. 2020) compared avian influenza virus particle dispersion using a nebulizer through 2 homemade masks (single-layer polyester with or without 4-layered paper towel), a medical mask, and an N95 respirator.

Guidelines, Position and Consensus Statements


- 1 CDC guideline and 1 U.S. Department of Defense (DOD) guidance document recommend the general population wear cloth face covers in public spaces.

- 1 WHO document states: “The use of masks made of other materials (e.g., cotton fabric), also known as nonmedical masks, in the community setting has not been well evaluated. There is no current evidence to make a recommendation for or against their use in this setting.”

- 1 FDA position statement expresses no objection to face mask use or distribution to the public during the outbreak.
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Background

Viral Respiratory Infections

Viral respiratory infections are caused by a virus, a small infectious agent that enters the respiratory system through the nose, mouth, or eyes. Viruses causing such infections include respiratory syncytial viruses, influenza viruses, parainfluenza viruses, adenoviruses, rhinoviruses, and coronaviruses. Symptoms common to viral respiratory infections include coughing, sneezing, runny nose, sore throat, fever, trouble breathing, muscle pain, and tiredness. Most viral respiratory infections cause mild disease that resolves without treatment, but some, such as the H1N1 influenza or the SARS-CoV-2 coronavirus, can precipitate acute respiratory distress syndrome, a serious and life-threatening complication. No specific treatments exist for many viral respiratory infections, and treatment is typically based on symptom relief and respiratory support in critically ill patients. (For more information, see Infections of the Respiratory System, the article Viral Respiratory Infection, and Overview of Viral Infections.)

Viral respiratory infections can spread to healthy people in several ways, including when the virus contacts mucus in the nose or mouth, by touching used tissues or surfaces touched by an infected person, or by touching an infected person’s unwashed hands. Other ways for viral respiratory infection spread include the inhalation of droplets by healthy individuals in close proximity to an infected person who coughs, sneezes, or talks.

A pandemic occurs when a new virus emerges and spreads among people sustainably and across multiple continents. Nonpharmaceutical interventions are implemented to reduce virus spread and transmission during an outbreak. Interventions include staying home when ill, covering coughs and sneezes, washing hands often, and wearing face masks in community settings when ill. (For more information, see Overview of Viral Infections and Community Mitigation Guidelines to Prevent Pandemic Influenza-United States, 2017.)

Use of Face Masks and Respirators in Healthcare Settings

Face masks and respirators are widely used in healthcare settings (e.g., hospitals, ambulatory care units) as part of personal protective equipment to reduce viral respiratory infection risks. The most common face masks and respirators used in healthcare settings include disposable surgical masks and N95 respirators. FDA defines surgical masks as “a loose-fitting, disposable device that creates a physical barrier between the mouth and nose of the wearer and potential contaminants in the immediate environment.” Surgical masks (also known as medical masks) cover the user’s nose and mouth and are designed to block large-particle droplets, splashes, and sprays that may contain viruses or bacteria. Some surgical masks include a clear shield that provides an additional barrier for the eyes, cheeks, and forehead. N95 respirators have better filtration properties than surgical masks and can block ≥95% of very small particles (0.3 microns). N95 masks are designed for a tight facial fit. FDA regulates both surgical masks and N95 respirators, which are intended for medical purposes. A subset of N95 respirators are intended for use in construction and other industrial jobs that expose workers to small particles. This subset of N95 respirators are not intended for medical use but are still regulated by the National Institute for Occupational Safety and Health. (For more information, see FDA’s articles N95 Respirators and Surgical Masks (Face Masks) and Surgical Masks – Premarket Notification [510(k)] Submissions.)

Use of Cloth Face Coverings in Public Settings

Cloth face coverings or masks, combined with good hand hygiene and social distancing (six feet or more), are intended to reduce disease spread in the general population during the COVID-19 outbreak. Cloth face coverings typically are reusable, washable items, and include common household items, such as scarves, bandanas, handkerchiefs, hand-sewn masks, and commercially available masks, such as biking masks and pollution masks. Cloth face coverings are less effective than N95 respirators, but experts propose they reduce infection risks by containing coughs and sneezes and reducing the amount of infectious droplets in the air. (For more information on homemade cloth face masks, see the New York Times article A User’s Guide to Face Masks, the Pennsylvania Department of Health document Guidance on Homemade Masks during COVID-19, and the Consumer Reports article What to Know Now About Masks and Coronavirus.)

Recommendations on cloth face coverings vary across countries during the COVID-19 outbreak. In Europe, countries including the Czech Republic, Germany, Slovakia, and Bosnia-Herzegovina have mandated the compulsory use of
face masks (surgical or cloth covers) in the general population. Asian countries such as China, South Korea, and Japan have adopted use of surgical or cloth face coverings in public areas as a common hygienic practice. In Africa, Morocco made wearing face masks in public mandatory and encouraged textile factories across the country to produce cloth face masks. (For more information, see the article by Feng et al.[1] and news articles Coronavirus: Countries Where Face Masks are Mandatory in COVID-19 Fight and Morocco Makes Face Masks Compulsory Due to Coronavirus.)

In the United States, recommendations vary across states, counties, and cities. CDC recommends “wearing cloth face coverings in public settings where other social distancing measures are difficult to maintain (e.g., grocery stores and pharmacies) especially in areas of significant community-based transmission.” The recommendation is considered a voluntary precaution for the general public. Some cities, however, require the general population to wear face coverings outside the home in public, including Los Angeles, CA; Philadelphia, PA; and Miami, FL. Montgomery County, MD, also issued an order to the public to wear face coverings in grocery stores, pharmacies, and other stores. Other states, including Washington and Pennsylvania, encourage use of cloth face covers, but they are not mandatory. (For more information, see the Los Angeles website, the Washington State Department of Health’s website, the Pennsylvania Department of Health’s website, and news articles by the Miami Herald and Washington Post.)

Government agencies, hospitals systems, and social media platforms encourage the general public to make their own cloth face covers. CDC published instructions for making cloth face covers. According to CDC’s website, cloth face coverings should fit snugly and comfortably against the side of the face, be secured with ties around the ears, include multiple fabric layers, and allow for unrestricted breathing. The Pennsylvania Department of Health also offers instructions on how to construct cloth face covers. Hospitals systems, including Deaconess in Indiana, CoxHealth in Missouri, and Atlantic Health System in New Jersey, are encouraging the general population to create cloth face masks and donate them to hospitals. Fashion designers are also publishing sewing tutorials on social media platforms. (For more information, see the CDC website, the Pennsylvania Department of Health’s website, the Deaconess’ website, the CoxHealth’s website, Atlantic Health System’s website, and news articles by the Huffpost, The Philadelphia Inquirer, and The New York Times.)

Guidelines, Position and Consensus Statements

Searches of PubMed, EMBASE, ECRI Guidelines Trust®, and other web-based resources identified four relevant guidelines published between January 1, 2015, and April 6, 2020, that address use of cloth face coverings by the general public during the COVID-19 outbreak:

CDC: **Use of Cloth Face Coverings to Help Slow the Spread of COVID-19**, 2020. This guideline recommends:

- CDC recommends wearing cloth face coverings in public settings where other social distancing measures are difficult to maintain (e.g., grocery stores and pharmacies), especially in areas of significant community-based transmission.
- CDC also advises the use of simple cloth face coverings to slow the spread of the virus and help people who may have the virus and do not know it from transmitting it to others. Cloth face coverings fashioned from household items or made at home from common materials at low cost can be used as an additional, voluntary public health measure.
- Cloth face coverings should not be placed on young children under age 2, anyone who has trouble breathing, or is unconscious, incapacitated or otherwise unable to remove the mask without assistance.
- The cloth face coverings recommended are not surgical masks or N-95 respirators. Those are critical supplies that must continue to be reserved for healthcare workers and other medical first responders, as recommended by current CDC guidance.

DOD: **DOD Guidance on the Use of Cloth Face Masks**, 2020. This document recommends:

- [CDC] recommends wearing cloth face coverings in public settings where other social distancing measures are difficult to maintain, especially in areas of significant community-based transmission. Military personnel, DoD civilian employees, their family members, and DoD contractors are strongly encouraged to follow CDC guidelines on the
use of cloth face coverings in public settings or where other social distancing measures are difficult to maintain.

As an interim measure, all individuals are encouraged to fashion face coverings from household items or common materials, such as clean T-shirts or other clean cloths that can cover the nose and mouth area. Medical personal protective equipment such as N95 respirators or surgical masks will not be issued for this purpose as these will be reserved for the appropriate personnel.

— FDA: Enforcement Policy for Face Masks and Respirators During the Coronavirus Disease (COVID-19) Public Health Emergency (Revised). 2020. This document does not mention nonmedical face masks, but states:

To help foster the availability of equipment that might offer some benefit to health care providers and the general public during the COVID-19 outbreak, for the duration of the public health emergency FDA does not intend to object to the distribution and use of face masks, with or without a face shield (not including respirators), that are intended for a medical purpose (whether used by medical personnel or the general public), without compliance with the following regulatory requirements where the face mask does not create an undue risk in light of the public health emergency.

— WHO: Advice on the Use of Masks in the Context of COVID-19. April 2020. This document states:

The use of masks made of other materials (e.g., cotton fabric), also known as nonmedical masks, in the community setting has not been well evaluated. There is no current evidence to make a recommendation for or against their use in this setting.

In the interim, decision makers may be moving ahead with advising the use of nonmedical masks. Where this is the case, the following features related to nonmedical masks should be taken into consideration:

- Numbers of layers of fabric/tissue
- Breathability of material used
- Water repellence/hydrophobic qualities
- Shape of mask
- Fit of mask

Clinical Literature

We searched PubMed, EMBASE, Google Scholar, the Cochrane Library, and selected web-based resources for clinical studies published between January 1, 2015, and April 6, 2020, and reporting on the efficacy of wearing cloth face coverings by the general public for reducing the risk of viral respiratory infection. Our search strategies included the following keywords: covid, face mask, face covering, pandemic, transmission. Please see the Selected Resources and References section for detailed search strategies. We excluded studies of medical-grade face masks because CDC recently recommended that U.S. communities primarily use cloth face covers to reserve N95 respirators and surgical masks for healthcare workers.

We did not identify any studies reporting on clinical or epidemiologic outcomes in populations that adopted cloth face covering use in public settings to reduce transmission risk. We expanded our criteria to include laboratory studies reporting on viral loads and viral particle spread. We identified and reviewed two studies, as follows:

- 1 study (n = 4) compared median viral loads in samples collected from patients with COVID-19 who coughed through a surgical mask, cotton face covers, or no mask at all.(2)
- 1 study compared avian influenza virus particle dispersion through two homemade masks (one made of single-layer polyester cloth another one made of single-layer polyester and four-layered paper towel), a medical mask, and an N95 respirator using a nebulizer model to mock human breath.(3)

Table 1 provides a summary of the studies we reviewed. We reviewed full-text articles available with open access. We excluded from review the following:

- 1 systematic review, 7 survey studies, and 1 technical study with no clear description of the face masks assessed.(4-12)
1 systematic review and 1 study assessed medical masks and cloth face covers but did not report on cloth face covers separately.(13,14)

1 RCT compared medical and cloth face covers used by healthcare workers at a hospital setting.(15)

**Evidence limitations.** No clinical studies assessed the effectiveness of cloth face coverings use by the general public to reduce the risk of viral respiratory infections. Laboratory and animal studies may at least provide a rationale for actions and recommendations for the public during critical face mask shortages. However, the available laboratory studies are too limited to support any conclusions. The studies reported on surrogate outcomes (e.g., viral load) that cannot be translated into infection risks. Also, the nonmedical face masks used in the studies were made of different materials (e.g., cotton, polyester cloth, polyester cloth and paper towels), and findings cannot be generalized to all nonmedical face masks used by the general public. One of the studies involved a nebulizer model that may not reflect the dynamic nature of breathing, sneezing, and coughing. Additional laboratory and animal studies are needed to validate and expand these findings. Survey studies and questionnaires assessing face cover use, acceptance, and compliance in concerned communities would also be useful.

### Table 1. Laboratory Studies

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study Aims</th>
<th>Setup and Outcomes</th>
<th>Results</th>
<th>Author's Conclusions</th>
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<tbody>
<tr>
<td>Bae et al. 2020(2) South Korea Reviewed full text</td>
<td>“To evaluate the effectiveness of surgical and cotton masks in filtering SARS-CoV-2.”</td>
<td>4 patients with COVID-19 coughed 5 times each onto separate Petri dishes while wearing the following sequence of masks: no mask, surgical mask, cotton mask, no mask. The outer and inner mask surfaces were swabbed. Median viral loads were quantified.</td>
<td>“The median viral loads after coughs without a mask, with a surgical mask, and with a cotton mask were 2.56 log copies/mL, 2.42 log copies/mL, and 1.85 log copies/mL, respectively. All swabs from the outer mask surfaces of the masks were positive for SARS-CoV-2, whereas most swabs from the inner mask surfaces were negative.”</td>
<td>“Neither surgical nor cotton masks effectively filtered SARS-CoV-2 during coughs by infected patients.”</td>
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</table>
# CLINICAL EVIDENCE ASSESSMENT

## Cloth Face Coverings in Public for Reducing Transmission of Viral Respiratory Infection

<table>
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<tr>
<td>Ma et al. 2020(3)</td>
<td>“In this study, the efficacy of three types of masks and instant hand wiping was evaluated using the avian influenza virus [AIV] to mock the coronavirus.”</td>
<td>A system consisting of a nebulizer and a plastic bag connected to four 60 mL syringes was used to simulate human breathing. The top of each syringe was covered with different masks: 2 homemade masks (single-layer polyester cloth and single-layer polyester plus 4-layered paper towel), a medical mask, or a N95 mask. A sponge was placed inside each syringe to collect the virus passing through the masks. RNA from the sponges was extracted, and viral load was quantified with reverse transcriptase polymerase chain reaction.</td>
<td>“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.”</td>
<td>“With these data, we propose the approach of mask-wearing plus instant hand hygiene (MIH) to slow the exponential spread of the virus. This MIH approach has been supported by the experiences of seven countries in fighting against COVID-19.”</td>
</tr>
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## Selected Resources and Reference

### Search Summaries

The following databases were used to identify the literature and related materials.

**ECRI Institute Resources [searched January 1, 2015, through April 6, 2020]**

Search Strategy:

- Covid; face masks; infection control

Results: We identified six related reports.

CLINICAL EVIDENCE ASSESSMENT

Cloth Face Coverings in Public for Reducing Transmission of Viral Respiratory Infection


Search Strategy:
- #1 (“Masks”[Mesh:NoExp] OR mask* OR (mask AND (effect* OR efficacy))
- #2 “handmade” OR “hand made” OR “homemade” OR “home made”
- #3 cloth OR fabric OR bandana* OR hankerchief* OR scarf OR scarves
- #4 “mask wearing” OR “face covering” OR (face[ti] AND cover*[ti])
- #5 public OR community OR communities OR city OR cities OR town OR towns OR household OR dwelling OR home OR neighborhood* OR store* OR outside* OR outdoor* OR non-hospital OR non-healthcare
- #6 ((#1 AND (#2 OR #3)) OR #4) AND #5
- #7 #6 AND (sars* OR avian* OR covid* OR ebola OR h1n1 OR flu OR pandemic OR pneumonia* OR infect* OR virus OR illness* OR spread)
- #8 #7 AND (humans[mh] OR inprocess[sb] OR publisher[sb] OR pubmednotmedline[sb])
- #9 #8 NOT (animal* OR mouse OR mice OR rat OR rats)
- #10 #9 AND english[Filter] AND 2015:2020[pdat]

Results: We identified 68 records.


Search Strategy:
- #1 (“Masks”[Mesh:NoExp] OR mask* OR “Respiratory Protective Devices”[Mesh] OR (mask AND (effect* OR efficacy))
- #2 “handmade” OR “hand made” OR “homemade” OR “home made”
- #3 cloth OR fabric OR bandana* OR hankerchief* OR scarf OR scarves
- #4 “mask wearing” OR “face covering” OR (face[ti] AND cover*[ti])
- #5 public OR community OR communities OR city OR cities OR town OR towns OR household OR dwelling OR home OR neighborhood* OR store* OR outside* OR outdoor* non-hospital OR non-healthcare
- #6 ((#1 AND (#2 OR #3)) OR #4) AND #5
- #7 #6 AND (sars* OR avian* OR covid* OR ebola OR h1n1 OR flu OR pandemic OR pneumonia* OR infect* OR virus OR illness* OR spread)
- #8 #7 AND (humans[mh] OR inprocess[sb] OR publisher[sb] OR pubmednotmedline[sb])
- #9 #8 NOT (animal* OR mouse OR mice OR rat OR rats)
- #10 #9 AND english[Filter] AND 2015:2020[pdat]

Results: We identified 16 unique records.


Search Strategy:
- #1 (mask OR masks OR “face covering”):ti,ab,kw
- #2 prevent* OR inhibit* OR reduce OR reduction OR lower
- #3 sars* OR avian* OR covid* OR ebola OR h1n1* OR flu OR influenza OR pandemic OR pneumonia* OR infect* OR virus OR illness*
- #4 #1 AND #2 AND #3

Results: We did not identify any unique publications.
CLINICAL EVIDENCE ASSESSMENT

Cloth Face Coverings in Public for Reducing Transmission of Viral Respiratory Infection

Guidelines and Standards [searched January 1, 2015, through April 6, 2020]

Search Strategy:
“face masks”; (face AND (mask OR masks OR covering*)) AND (infection OR spread* OR community OR public OR transmit* OR transmission)

Results: We identified six relevant documents.

Selected Standards and Guidelines

─ Centers for Disease Control and Prevention. Recommendation Regarding the Use of Cloth Face Coverings, Especially in Areas of Significant Community-Based Transmission. [cited 2020 Apr 6].

─ United States Department of Defense. DOD guidance on the use of cloth face masks. 2020 Apr 5.


Selected Web Resources. [searched April 5, 2020]


─ CBS News. Should the public wear face masks? Experts are weighing new guidance. [last updated 2020 Apr 3].

─ Centers for Disease Control and Prevention.


References Reviewed (PubMed and EMBASE search dates were January 1, 2015, through April 6, 2020)


Cloth Face Coverings in Public for Reducing Transmission of Viral Respiratory Infection


The Evidence Bar™

ECRI developed The Evidence Bar™ to provide a visualization of our judgment about the balance of benefits and harms of the technology after assessing the available published clinical evidence in light of key outcomes and comparisons of interest. The Evidence Bar™ rubric shows five possible choices for our expert judgment. After review and analysis of evidence identified through literature searches conducted by master’s-level medical librarians, ECRI research analysts, extensively trained in methods of evidence assessment, weigh potential benefits and harms of a technology to arrive at their expert judgment.

| Balance of evidence unfavorable | - | - | - | - | + |
| Balance of evidence raises concerns | - | - | - | - | + |
| Balance of evidence inconclusive because of no available evidence, mixed results, or too few data | - | - | - | - | + |
| Balance of evidence somewhat favorable | - | - | - | - | + |
| Balance of evidence very favorable | - | - | - | - | + |

Policy Statement

The information presented in this Clinical Evidence Assessment is highly perishable and reflects the state of the literature on this topic at the time at which searches were conducted and the Clinical Evidence Assessment was prepared. Clinical Evidence Assessments provide a guide to the published clinical literature and other information about a topic on which we received a client inquiry. The scope is customized to address the specific information needs of the requestor. The content reflects the information identified from searches of the available, published, peer-reviewed scientific literature, gray literature, and websites at the time the searches were conducted.

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