ITEM C

# CITY OF LA VISTA
## EMERGENCY MEETING
### MAYOR AND CITY COUNCIL REPORT
### NOVEMBER 24, 2020 AGENDA

| Subject: | Type: | Submitted By: |
|---|---|---|
| COVID-19<br>RULES/REGULATIONS<br>FACE COVERINGS | RESOLUTION<br>◆ORDINANCE<br>RECEIVE/FILE | <br>BRENDA S. GUNN<br>CITY ADMINISTRATOR |

#### SYNOPSIS

Rules and regulations are set forth in a proposed ordinance for immediate action at this emergency meeting in response to the emergency presented by the Novel Coronavirus (COVID-19) pandemic, continued community transmission and increased number of confirmed COVID-19 cases within the City, and resulting dangers to the public health, safety, and welfare. The ordinance, among other matters, requires face coverings while indoors and posting notice of such requirement, and provides for exceptions, enforcement, penalties, abatement, periodic updates, and sunset.

#### FISCAL IMPACT

N/A.

#### RECOMMENDATION

Approval.

#### BACKGROUND

The latest data indicates that positivity levels in La Vista and adjacent parts of the metropolitan area are unprecedented. Over the past four weeks, the positivity rate for the Sarpy/Cass Health Department jurisdiction has doubled from 15.25% (week ending 10/17/20) to 31.51% (week ending 11/14/20). Over the same four-week period the seven-day rolling average of cases/day/100,000 residents has increased from 41.6 cases per day to 96.9. Currently, there are 1,032 active cases in Sarpy County, with 108 active cases in the 68128 zip code area and 65 in 68138 (La Vista's ETJ).

The White House Coronavirus Task Force report identified that Nebraska is in the red zone for cases, indicating 101 or more new cases per 100,000 population, with the sixth highest rate in the Country. Over the past three weeks, Douglas County, Lancaster County and Sarpy County have had the highest number of new cases, representing nearly half of the new cases in the state. Hospitalizations are also on the rise which is placing a tremendous burden on the hospital systems. The task force report called current mitigation efforts "inadequate".

As of November 22, 2020, there are 22.8% of staffed beds in NE being occupied by COVID-19 patients – causing hospitals to be at or near capacity. In the Metro Omaha Healthcare Coalition (all hospitals in our region) the number of inpatients diagnosed with COVID-19 has increased dramatically over the last month (average of 137/patients/day for week of 10/17 vs. 378 for week ending 11/14). For the week ending 11/21 the daily average of inpatients with COVID is up to 421.

In response to unprecedented coronavirus case numbers, positivity rates, seven day rolling average per 100,000 residents and hospitalizations in La Vista and adjacent parts of Sarpy County and the Omaha metropolitan area, staff was directed to prepare for immediate consideration proposed rules and regulations to require face coverings while indoors in the City ("Rules and Regulations") and to make necessary arrangements for emergency consideration.

Rules and Regulations are presented in proposed ordinance included with the agendas for emergency meetings of the Board of Health and City Council. A proposed resolution also is presented for consideration at the Board of Health meeting which provides that Board of Health approval of the Rules and Regulations set forth in the proposed ordinance shall be subject to City Council approval, or modification and approval. The proposed ordinance, among other matters requires face coverings while indoors and posting notice of such requirement, and provides for exceptions, enforcement, penalties, abatement, periodic updates, and sunset; and if passed as an emergency ordinance would take effect upon the Mayor's proclamation immediately upon its first publication on November 27, 2020.

**Attachments:**

- JAMA (November 17, 2020) -Preventing the Spread of SARS-CoV-2 with Masks and Other "Low-tech" Interventions
- News Channel Nebraska (November 17, 2020) — White House COVID-19 Task Force calls Nebraska virus spread 'exponential and unyielding'
- CDC Scientific Brief: Community Use of Cloth Masks to Control the Spread of SARS-CoV-2 — (Updated November 10, 2020)
- Scientific Brief: Community Use of Cloth Masks to Control the Spread of SARS-CoV-2 — Nebraska Medicine Global Center for Health Security (November 17, 2020)
- Nebraska Medicine (November 17, 2020) — 1700+ Nebraska health care workers signed a letter asking for your help
- Health Affairs (August 2020) — Community Use of Face Masks and COVID-19: Evidence from a Natural Experiment of State Mandates in the US
- Physics of Fluids (June 2020) — Visualizing the effectiveness of face masks in obstructing respiratory jets

**ORDINANCE NO. ________**

AN ORDINANCE TO AMEND CHAPTER 92 OF THE LA VISTA MUNICIPAL CODE TO ADD SUBCHAPTER 92.30 ENTITLED “PREVENTION OF COVID-19”; TO PROVIDE LEGISLATIVE FINDINGS AND INTENT; TO REQUIRE FACE COVERINGS WHILE INDOORS WITHIN THE CITY, NOTICE OF SUCH REQUIREMENT, AND EXCEPTIONS; TO DECLARE PUBLIC NUISANCE AND PROVIDE FOR PENALTIES, ABATEMENT, SUNSET AND REQUIRED REPORTING; TO REPEAL CONFLICTING PROVISIONS; AND TO PROVIDE FOR SEVERABILITY, PUBLICATION AND EFFECTIVE DATE

BE IT ORDAINED BY THE MAYOR AND CITY COUNCIL OF THE CITY OF LA VISTA, NEBRASKA, as follows:

I. As result of the Novel Coronavirus (COVID-19) pandemic, continued community transmission and increased number of confirmed COVID-19 cases within the City limits of the City of La Vista, and resulting dangers to the public health, safety, and welfare, an emergency exists within the City of La Vista requiring immediate action of the City as provided in this ordinance. This ordinance shall amend Chapter 92 of the La Vista Municipal Code to adopt rules and regulations for a non-pharmaceutical intervention to combat and halt the spread and progression of COVID-19.

II. Chapter 92 of the La Vista Municipal Code is hereby amended by adding subchapter 92.30 as follows:

“§92.30. — PREVENTION OF COVID-19

Sec. 92.30.1. — Legislative Findings and Intent.

(1) The City Council hereby finds and declares, based upon the scientific and medical evidence before it, that:

(a) the Novel Coronavirus (COVID-19) has impacted and continues to dramatically impact the citizens of the City of La Vista, Nebraska; and

(b) exposure to COVID-19 presents a risk of death or serious long-term disability; the exposure is widespread and poses significant risk of harm, including death, to people in the general population of the City of La Vista; there is a particular subset of the population that is more vulnerable to the threat and thus at an increased risk; and the threat is from a novel infectious disease; and

(c) information from the World Health Organization, the United States Centers for Disease Control and Prevention (CDC), Nebraska Department of Health and Human Services, the Sarpy/Cass Health Department, local public health departments throughout Nebraska, and members of the Sarpy County and metropolitan area medical community indicate that citizens of the metropolitan area, including the City of La Vista, have been and will continue to be exposed due to community transmissions of COVID-19; and

(d) the manner in which the spread of COVID-19 cases in the City of La Vista has occurred creates an unacceptable risk to the health, safety, and welfare of the citizens of the City of La Vista; and

(e) the number of COVID-19 infections within the City of La Vista continues to increase; and

(f) COVID-19 constitutes a public nuisance and a threat to the health, safety, and welfare of the City of La Vista and its residents; and

(g) The Director of the CDC, the Director the Sarpy/Cass Health Department, doctors and infectious disease experts from the University of Nebraska Medical Center and Nebraska Medicine, as well as others in the medical profession, have concluded that the wearing of face coverings by every individual while in public, particularly while indoors, is one of the best methods to slow and stop the spread of COVID-19; and

(h) the wearing of face coverings by every individual while indoors in public places in the City of La Vista will reduce community transmissions of COVID-19, resulting in fewer deaths and serious health complications, and will ease the strain on hospitals and other medical offices and facilities; and

(1) the wearing of face coverings by every individual while indoors in public places in the City of La Vista will increase the chances of keeping businesses open and operating, encouraging economic growth and preventing prolonged economic harm; and

(j) it is just and proper for the City Council to exercise the authority granted to it by applicable law, including without limitation Neb. Rev. Stat. Sections 16-238, 16-240, 16-246, and 18-1720, in furtherance of protecting the public health, safety, and welfare.

Sec. 92.30.2. — Definitions.

For purposes of this subchapter, the following terms are defined as follows:

(1) **Face Covering**. — A face covering is defined as a covering which, when worn properly, must cover the nose and mouth completely and can include a paper or disposable face mask, a cloth face mask, a scarf, a bandanna, a neck gaiter, or a religious face covering. Medical-grade masks and respirators are sufficient face coverings, but to preserve adequate supplies, their purchase and use is discouraged for those who do not work in a health care setting or in other occupations that require medical-grade personal protective equipment. Masks that incorporate a valve designed to facilitate easy exhaling, mesh masks, or masks with openings, holes, visible gaps in the design or material, or vents are not sufficient face coverings because they allow exhaled droplets to be released into the air.

(2) **Premises That Is (or Are) Open to the General Public. —** Premises that is (or are) open to the general public means property upon or into which any members of the public are allowed to enter. The term is intended to be broadly defined to include without limitation real or personal property owned or operated by entities that employ or engage workers, including private-sector entities, public-sector entities, non-profit entities, regular commercial or business establishments, private clubs, religious centers or buildings, public transportation (including buses, taxis, ride-sharing vehicles, or vehicles used for business purposes), and any place which is generally open to any members of the public, including educational institutions and daycare facilities.

(3) **Subchapter. — Subchapter means the p**rovisions set forth in sections 92.30.1 through 92.30.12.

Sec. 92.30.3. — individual Face Coverings Required.

All individuals age five (5) and older shall wear a face covering over their mouth and nose while indoors in a premises that is open to the general public including, but not limited to, educational institutions, unless the individual maintains a minimum of six (6) feet of separation or social distance at all times from anyone who is not a member of the individual's household, except face coverings will not be required if the individual:

(1) is seeking federal, state, county, or city governmental services;

(2) is seated at a bar or restaurant to eat or drink, or while immediately consuming food or beverages;

(3) is engaged in an occupation preventing the wearing of a face covering;

(4) is obtaining a service or purchasing goods or services that requires the temporary removal of the face covering;

(5) is asked to remove a face covering to verify an identity for lawful purposes;

(6) is providing a speech, lecture, or broadcast to an audience so long as six (6) feet of distancing from other individuals is maintained; or

(7) cannot otherwise wear a face covering because of a medical condition, a mental health condition, or a disability that makes it unreasonable for the individual to wear a face covering.

Nothing in this section shall prohibit the owner or person in charge of a premises that is open to the general public, including without limitation the owner or person in charge of any federal, state, city, or other governmental facility, from requiring an individual to wear a face covering during any of the circumstances enumerated above or from implementing a more restrictive face covering policy.

Sec. 92.30.4. — Premises That Are Open to the Public — Duty to Require Face Coverings.

Any individual or entity which maintains premises that are open to the general public including, but not limited to, educational institutions, shall require all individuals age five (5) and older to wear a face covering over their mouth and nose while indoors in said premises, unless the individual maintains a minimum of six (6) feet of separation or social distance at all times from anyone who is not a member of the individual's household, except face coverings will not be required if the individual:

(1) is seeking federal, state, county, or city governmental services;

(2) is seated at a bar or restaurant to eat or drink, or while immediately consuming food or beverages;

(3) is engaged in an occupation preventing the wearing of a face covering;

(4) is obtaining a service or purchasing goods or services that requires the temporary removal of the face covering;

(5) is asked to remove a face covering to verify an identity for lawful purposes;

(6) is providing a speech, lecture, or broadcast to an audience so long as six (6) feet of distancing from other individuals is maintained; or

(7) cannot otherwise wear a face covering because of a medical condition, a mental health condition, or a disability that makes it unreasonable for the individual to wear a face covering.

Nothing in this section shall prohibit the owner or person in charge of a premises that is open to the general public, including without limitation the owner or person in charge of any federal, state, city, or other governmental facility, from requiring an individual to wear a face covering during any of the circumstances enumerated above or from implementing a more restrictive face covering policy.

Sec. 92.30.5. — Notice of Face Covering Requirements.

Any individual or entity which maintains premises that are open to the general public, including but not limited to educational institutions, must post one or more signs that are visible to all persons — including workers, customers, and visitors — instructing them to wear face coverings as required by this subchapter. The signs required by this section must be printed on a poster or paper that is a minimum size of 8.5 inches by 11 inches, and be written or typed in a legible font or typeface that is no smaller than 12 points of leading or 12-point type.

Sec. 92.30.6. — Exceptions.

The provisions of this subchapter shall not apply to:

(1) Courts of law; public utilities or federal, state, county, or city operations; medical providers, facilities, or pharmacies; congregate living centers or facilities; group homes and residential drug and/or mental health treatment facilities; shelters; airport travel; election offices; polling places on an election day; or to residential dwelling units.

(2) Children under the age of five (5). While children ages three (3) and four (4) may wear a face covering if that child can remove the face covering without assistance, guidance from the CDC states that children two (2) years old and under should never wear a face covering due to the risk of suffocation.

(3) Federal and state activities. Nothing in this subchapter shall be construed to limit, prohibit, or restrict in any way the operations of the federal or state government or the movement of federal or state officials in the City while acting in their official capacity, including federal and state judicial, legislative, and executive staff and personnel.

(4) Individuals at their workplace when wearing a face covering would create a job hazard for the individual or others, as determined by federal, state, or local regulators or workplace safety and health standards and guidelines.

(5) Individuals who are alone in an office, room, a vehicle, the cab of heavy equipment or machinery, or an enclosed work area. In such situations, the individual should still carry a face covering to be prepared for person-to-person interactions and to be used when the individual is no longer alone.

(6) Individuals who are seated at a desk or standing at a stationary work station, provided that the desk or work station has a solid Plexiglas or plastic barrier installed upon it which cannot be moved.

(7) Individuals who are officiating at a religious service.

(8) Individuals communicating with other individuals who are deaf or hard of hearing or who have a disability, medical condition, or mental health condition that makes communication with that individual while wearing a face covering difficult, provided

that minimum social distancing of six (6) feet or more is maintained to the extent possible between persons who are not members of the same household.

(9) Individuals who are engaged in activities, such as swimming or showering, where the face covering will get wet.

(10) Individuals who are exercising in an indoor business or indoor space such as a gym or fitness center, while the level of exertion makes it difficult to wear a face covering, provided that minimum social distancing of six (6) feet or more is maintained at all times.

(11) Individuals in an indoor premises that is generally open to the public while playing a musical instrument that cannot be played when a face covering is worn, provided that a minimum social distancing of six (6) feet or more is maintained at all times.

(12) Individuals actively participating in a team sports activity, while the level of exertion makes it difficult to wear a face covering.

(13) Public safety workers actively engaged in a public safety role, including but not limited to law enforcement personnel, fire fighters, or emergency medical personnel, in situations where wearing a face covering would seriously interfere in the performance of the individual's public safety responsibilities.

Nothing in this section shall prohibit the owner or person in charge of a premises that is open to the general public, including without limitation the owner or person in charge of any federal, state, city, or other governmental facility, from requiring an individual to wear a face covering during any of the circumstances enumerated above or from implementing a more restrictive face covering policy.

Sec. 92.30.7. — Public Nuisance Declared.

Any individual or entity which maintains premises that are open to the general public who fails to comply with the requirements of section 92.30.4, above, is hereby declared to be a nuisance and a danger to the public health, safety, and welfare.

Sec. 92.30.8. — Application**.**

The provisions of this subchapter shall only apply to all persons and property within the corporate limits of the City of La Vista and shall not extend into the extraterritorial jurisdiction of the City.

Sec. 92.30.9. — Penalty.

Any individual or person who is found to have violated any of the provisions of this subchapter shall be guilty of an infraction as defined in Neb. Rev. Stat. Section 29-436 and shall be subjected to the fines set forth in such Section 29-436; provided, however, the fine for an initial offense shall be $25.00. Each instance of violation of this subchapter may be considered a separate offense.

Sec. 92.30.10. — Civil Abatement.

In addition to any other penalty sought or obtained under this subchapter or other applicable law, the City Attorney, upon direction of the Mayor or City Administrator, may institute injunctive or other appropriate civil proceedings necessary to obtain compliance with this subchapter or to abate any nuisance resulting from violations of this subchapter.

Sec. 92.30.11. — Sunset Provision.

The requirements imposed by this subchapter shall expire and terminate at 11:59 p.m. on February 23, 2021, unless otherwise extended by ordinance of the City Council.

92.30.12**.** — Report Required.

The City Administrator of the City of La Vista, or any designee of the City Administrator, while the provisions of this subchapter remain in effect, periodically shall prepare a report or update to be delivered to the Mayor and the City Council. The report or update shall contain information from the prior report or update on the status of COVID-19 infections in the City of La Vista and such additional information as the Mayor or City Council shall specify, which may include, for example, information on the current number of cases in the City, the number of new cases diagnosed, the number of tests performed, the positivity rate of those tests, the number of new deaths that have occurred, the metropolitan area hospital occupancy rate, the ventilator utilization rate, the COVID-19 hospitalization rate, a breakdown of cases by zip code, and any such other information that the City Administrator, such designee, Mayor or City Council deems relevant to the spread of COVID-19 within the City of La Vista.”

III. Repeal of Conflicting Provisions. Any and all Ordinances or portions thereof, which are in conflict herewith are hereby repealed.

IV. Severability. The sections, subsections, paragraphs, sentences, clauses, and phrases of this Ordinance are severable, and if any section, subsection, paragraph, sentence, clause, or phrase of this Ordinance, for any reason, shall be declared invalid, unenforceable, or unconstitutional by the valid judgment or decree of a court of competent jurisdiction, such invalidity, unenforceability, or unconstitutionality shall not affect any of the remaining sections, subsections, paragraphs, sentences, clauses, or phrases of this Ordinance. The Mayor and City Council of the City of La Vista hereby declare that it would have passed this Ordinance and each section, subsection, paragraph, sentence, clause or phrase hereof, irrespective of the fact that any one or more sections, subsections, paragraphs, sentences, clauses or phrases be declared unconstitutional or invalid.

V. Publication and Effective Date. This Ordinance shall be published and in force and effect in accordance with applicable law; provided, however, this Ordinance shall constitute an emergency ordinance and take effect upon the proclamation of the Mayor immediately upon its first publication if passed by an affirmative three-fourths vote of the City Council.

PASSED AND APPROVED THIS ___TH DAY OF _________, 2020

CITY OF LA VISTA

____________________________
Douglas Kindig, Mayor

ATTEST

____________________________
Pamela A. Buethe, CMC
City Clerk

JAMA Nov 17, 2020



VIEWPOINT

# Preventing the Spread of SARS-CoV-2 With Masks and Other "Low-tech" Interventions

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Audio and Video

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the cause of coronavirus disease 2019 (COVID-19), has caused a global pandemic of historic proportions in the 10 months since cases were first reported in Wuhan, China, in December 2019, with worldwide morbidity, mortality, and disruptions to society.

Ultimately, a safe and effective vaccine will be essential to control the pandemic and allow resumption of the many activities of normal life. While results of phase 3 trials for multiple candidate vaccines are on the near horizon, "low-tech" tools to prevent the spread of SARS-CoV-2 are essential, and it must be emphasized that these interventions will still be needed after a vaccine is initially available. Even if one or more vaccines have high efficacy and uptake in the population, it will take at least several months for enough people to be vaccinated to confer herd immunity on a population basis.

Modalities in the combination prevention "toolbox" against the spread of SARS-CoV-2 include wearing masks, physical distancing, hand hygiene, prompt testing (along with isolation and contact tracing), and limits on crowds and gatherings. If a vaccine has only moderate efficacy, or if vaccine uptake is low, these other modalities will be even more critical.

> Return to normalcy will require the widespread acceptance and adoption of mask wearing and other inexpensive and effective interventions as part of the COVID-19 prevention toolbox.

Wearing face coverings—masks—in the community setting to prevent the spread of SARS-CoV-2 is a key component of this combination approach. Multiple lines of evidence support the effectiveness of masks for the prevention of SARS-CoV-2 transmission. Mandates for the wearing of masks in public have been associated with a decline in the daily growth rate of COVID-19 cases in the US. The implementation of such mandates averted more than 200 000 cases of COVID-19 by May 22, 2020, according to modeling estimates.[1]

Randomized clinical trials of community mask use are challenging to conduct because of ethical and practical considerations. Observational studies have substantial limitations but can be instructive. For example, a study of secondary SARS-CoV-2 transmission in 124 Chinese households found that mask wearing at home by 1 or more family members before the onset of symptoms in the primary case was associated with a lower odds of secondary transmission (adjusted odds ratio, 0.21 [95% CI, 0.06-0.79]).[2] In a study at a US academic medical center, after the implementation of universal mask use for all health care workers and patients, the SARS-CoV-2 positivity rate among health care workers declined from 14.65% to 11.46%, with a decline of 0.49% per day.[3]

To understand the rationale for mask wearing to prevent SARS-CoV-2 transmission, it is helpful to understand how the virus spreads from person to person. SARS-CoV-2 is primarily transmitted by respiratory droplets exhaled by infected individuals; these droplets span a spectrum of sizes. Larger droplets fall out of the air relatively quickly while close to the source, usually within a 6-foot distance. Smaller droplets, often referred to as aerosols, are also present at close range but may remain in the air over time and greater distances, decreasing in concentration as they move outward from their source.[4]

The epidemiology of SARS-CoV-2 indicates that most infections are likely spread through exposure to an infected individual at close range, within about 6 feet. However, recent reports indicate that aerosols remaining in the air over longer distances or times also have been involved in SARS-CoV-2 transmission in certain circumstances, often in poorly ventilated enclosed spaces and associated with behaviors such as singing, shouting, or breathing heavily during exercise. The Centers for Disease Control and Prevention (CDC) recently updated its guidance to acknowledge this potential for airborne spread of SARS-CoV-2.[4]

Blocking the dispersion of respiratory droplets from an individual infected with SARS-CoV-2 via use of a mask that functions as a physical barrier is a logical strategy to curb transmission. Surgical masks can reduce respiratory virus shedding in exhaled breath,[5] and the filtering efficacy of some materials used in cloth masks may approach that of surgical masks.[6]

Respiratory droplets are produced not only by coughing and sneezing, but also when speaking and simply breathing.[4] Light-scattering experiments indicate that 1 minute of loud speaking potentially can generate more than 1000 virion-containing aerosols that may linger in the air in a closed, stagnant environment.[7] These particles may accumulate in enclosed spaces with poor ventilation, especially when individuals are singing, shouting, or breathing heavily (eg, with physical exercise). Therefore, the commonly observed practice of individuals removing their mask when speaking is not advisable. With the onset of colder weather in the northern hemisphere, activities will increasingly occur inside, resulting in often-unavoidable congregating. Therefore, it is particularly important to continually

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emphasize the necessity of consistent wearing of masks, particularly in the indoor setting.

Recent evidence suggests that up to 40% to 45% of people infected with SARS-CoV-2 may never be symptomatic but still can transmit the virus.[4] Viral spread from people without symptoms may account for more than 50% of transmission events in COVID-19 outbreaks.[8] Since it has now become evident that individuals capable of transmitting SARS-CoV-2 cannot be identified solely by the presence of symptoms, universal mask wearing in the community for source control is recommended.[4]

Masks should be used in combination with other modalities to prevent the spread of SARS-CoV-2, including physical distancing, hand hygiene, adequate ventilation, and avoiding crowded spaces. Widespread testing for SARS-CoV-2 infection is also important but insufficient on its own for pandemic control. No test is perfect; all have a lower limit of detection for viral material and the potential for false negatives. In addition, the result of a test represents just one point in time and does not indicate an individual's status outside of the moment the specimen was collected. Testing, along with contact tracing and the isolation of individuals who are infected, is a key tool for curbing the spread of SARS-CoV-2. However, reliance on testing alone to prevent transmission will be ineffective without the use of additional strategies such as mask wearing and physical distancing.

As countries around the world seek to safely reopen businesses, schools, and other facets of society, mask use in the community to prevent the spread of SARS-CoV-2, in conjunction with other low-cost, low-tech, commonsense public health practices, is and will remain critical. Return to normalcy will require the widespread acceptance and adoption of mask wearing and other inexpensive and effective interventions as part of the COVID-19 prevention toolbox.

ARTICLE INFORMATION

**Published Online:** October 26, 2020. doi:10.1001/jama.2020.21946

**Conflict of Interest Disclosures:** None reported.

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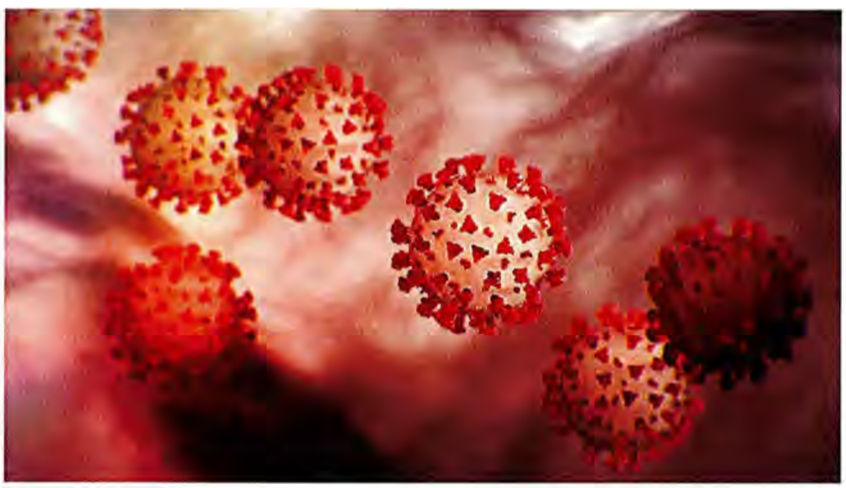
NEWS

# White House COVID-19 Task Force calls Nebraska virus spread 'exponential and unyielding'

Nebraska is also in the red zone for test positivity, indicating a rate at or above 10.1%, with the fourth highest rate in the country.

Tuesday, November 17th 2020, 3:12 PM CST

By **KETV NewsWatch 7**



Coronavirus Image

According to the newest White House Coronavirus Task Force Report, Nebraska is in the red zone for cases, indicating 101 or more new cases per 100,000 population, with the sixth highest rate in the country.

Nebraska is also in the red zone for test positivity, indicating a rate at or above 10.1%, with the fourth highest rate in the country.

Douglas County, Lancaster County and Sarpy County have had the highest number of new cases over the past three weeks, representing nearly half of the new cases in the state.

Nebraska had 735 new cases per 100,000 population, compared to a national average of 294 per 100,000.

"Between Nov. 7 and Nov. 13, on average, 124 patients with confirmed COVID-19 and 38 patients with suspected COVID-19 were reported as newly admitted each day to hospitals in Nebraska," the report states.

A total of 94% of hospitals received new COVID-19 patients in this time period.

The task force called current mitigation efforts "inadequate."

"COVID-19 spread in Nebraska is exponential and unyielding, with hospitalizations increasing week over week and reported limited bed availability. Increases from the past two weeks correlate with Halloween and related activities. With Thanksgiving and upcoming holidays, Nebraskans must understand the COVID-19 situation statewide," the report states. "Serious messaging and action are needed from state leadership; recommending Nebraskans wear masks in public settings communicates the current risk level and an action all Nebraskans need to take."

# Scientific Brief: Community Use of Cloth Masks to Control the Spread of SARS-CoV-2

Updated Nov. 10, 2020    Print

## Background

SARS-CoV-2 infection is transmitted predominately by respiratory droplets generated when people cough, sneeze, sing, talk, or breathe. CDC recommends community use of masks, specifically non-valved multi-layer cloth masks, to prevent transmission of SARS-CoV-2. Masks are primarily intended to reduce the emission of virus-laden droplets ("source control"), which is especially relevant for asymptomatic or presymptomatic infected wearers who feel well and may be unaware of their infectiousness to others, and who are estimated to account for more than 50% of transmissions.[1,2] Masks also help reduce inhalation of these droplets by the wearer ("filtration for personal protection"). The community benefit of masking for SARS-CoV-2 control is due to the combination of these effects; individual prevention benefit increases with increasing numbers of people using masks consistently and correctly.

## Source Control to Block Exhaled Virus

Multi-layer cloth masks block release of exhaled respiratory particles into the environment,[3-6] along with the microorganisms these particles carry.[7,8] Cloth masks not only effectively block most large droplets (i.e., 20-30 microns and larger)[9] but they can also block the exhalation of fine droplets and particles (also often referred to as aerosols) smaller than 10 microns ;[3,5] which increase in number with the volume of speech[10-12] and specific types of phonation.[13] Multi-layer cloth masks can both block up to 50-70% of these fine droplets and particles[3,14] and limit the forward spread of those that are not captured.[5,6,15,16] Upwards of 80% blockage has been achieved in human experiments that have measured blocking of all respiratory droplets,[4] with cloth masks in some studies performing on par with surgical masks as barriers for source control.[3,9,14]

## Filtration for Personal Protection

Studies demonstrate that cloth mask materials can also reduce wearers' exposure to infectious droplets through filtration, including filtration of fine droplets and particles less than 10 microns. The relative filtration effectiveness of various masks has varied widely across studies, in large part due to variation in experimental design and particle sizes analyzed. Multiple layers of cloth with higher thread counts have demonstrated superior performance compared to single layers of cloth with lower thread counts, in some cases filtering nearly 50% of fine particles less than 1 micron .[14,17-29] Some materials (e.g., polypropylene) may enhance filtering effectiveness by generating triboelectric charge (a form of static electricity) that enhances capture of charged particles[18,30] while others (e.g., silk) may help repel moist droplets[31] and reduce fabric wetting and thus maintain breathability and comfort.

## Human Studies of Masking and SARS-CoV-2 Transmission

Data regarding the "real-world" effectiveness of community masking are limited to observational and epidemiological studies.

- An investigation of a high-exposure event, in which 2 symptomatically ill hair stylists interacted for an average of 15 minutes with each of 139 clients during an 8-day period, found that none of the 67 clients who subsequently consented to an interview and testing developed infection. The stylists and all clients universally wore masks in the salon as required by local ordinance and company policy at the time.[32]
- In a study of 124 Beijing households with ≥ 1 laboratory-confirmed case of SARS-CoV-2 infection, mask use by the index patient and family contacts before the index patient developed symptoms reduced secondary transmission within the households by 79%.[33]

households by 79%.[33]

- A retrospective case-control study from Thailand documented that, among more than 1,000 persons interviewed as part of contact tracing investigations, those who reported having always worn a mask during high-risk exposures experienced a greater than 70% reduced risk of acquiring infection compared with persons who did not wear masks under these circumstances.[34]
- A study of an outbreak aboard the USS Theodore Roosevelt, an environment notable for congregate living quarters and close working environments, found that use of face coverings on-board was associated with a 70% reduced risk.[35]
- Investigations involving infected passengers aboard flights longer than 10 hours strongly suggest that masking prevented in-flight transmissions, as demonstrated by the absence of infection developing in other passengers and crew in the 14 days following exposure.[36,37]

Seven studies have confirmed the benefit of universal masking in community level analyses: in a unified hospital system,[38] a German city,[39] a U.S. state,[40] a panel of 15 U.S. states and Washington, D.C.,[41,42] as well as both Canada[43] and the U.S.[44] nationally. Each analysis demonstrated that, following directives from organizational and political leadership for universal masking, new infections fell significantly. Two of these studies[42,44] and an additional analysis of data from 200 countries that included the U.S.[45] also demonstrated reductions in mortality. An economic analysis using U.S. data found that, given these effects, increasing universal masking by 15% could prevent the need for lockdowns and reduce associated losses of up to $1 trillion or about 5% of gross domestic product.[42]

# Conclusions

Experimental and epidemiological data support community masking to reduce the spread of SARS-CoV-2. The prevention benefit of masking is derived from the combination of source control and personal protection for the mask wearer. The relationship between source control and personal protection is likely complementary and possibly synergistic[14], so that individual benefit increases with increasing community mask use. Further research is needed to expand the evidence base for the protective effect of cloth masks and in particular to identify the combinations of materials that maximize both their blocking and filtering effectiveness, as well as fit, comfort, durability, and consumer appeal. Adopting universal masking policies can help avert future lockdowns, especially if combined with other non-pharmaceutical interventions such as social distancing, hand hygiene, and adequate ventilation.

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Last Updated Nov. 10, 2020

# 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

November 17, 2020

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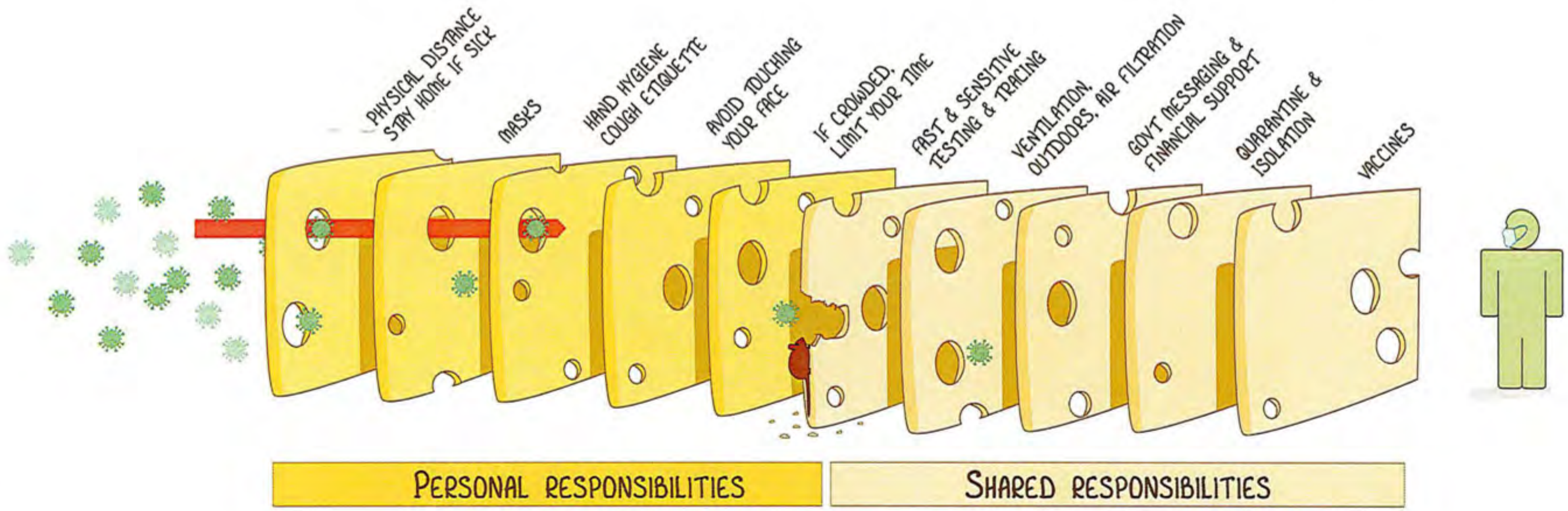
# THE SWISS CHEESE RESPIRATORY VIRUS PANDEMIC DEFENCE

RECOGNISING THAT NO SINGLE INTERVENTION IS PERFECT AT PREVENTING SPREAD




EACH INTERVENTION (LAYER) HAS IMPERFECTIONS (HOLES).
MULTIPLE LAYERS IMPROVE SUCCESS.

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IAN M MACKAY
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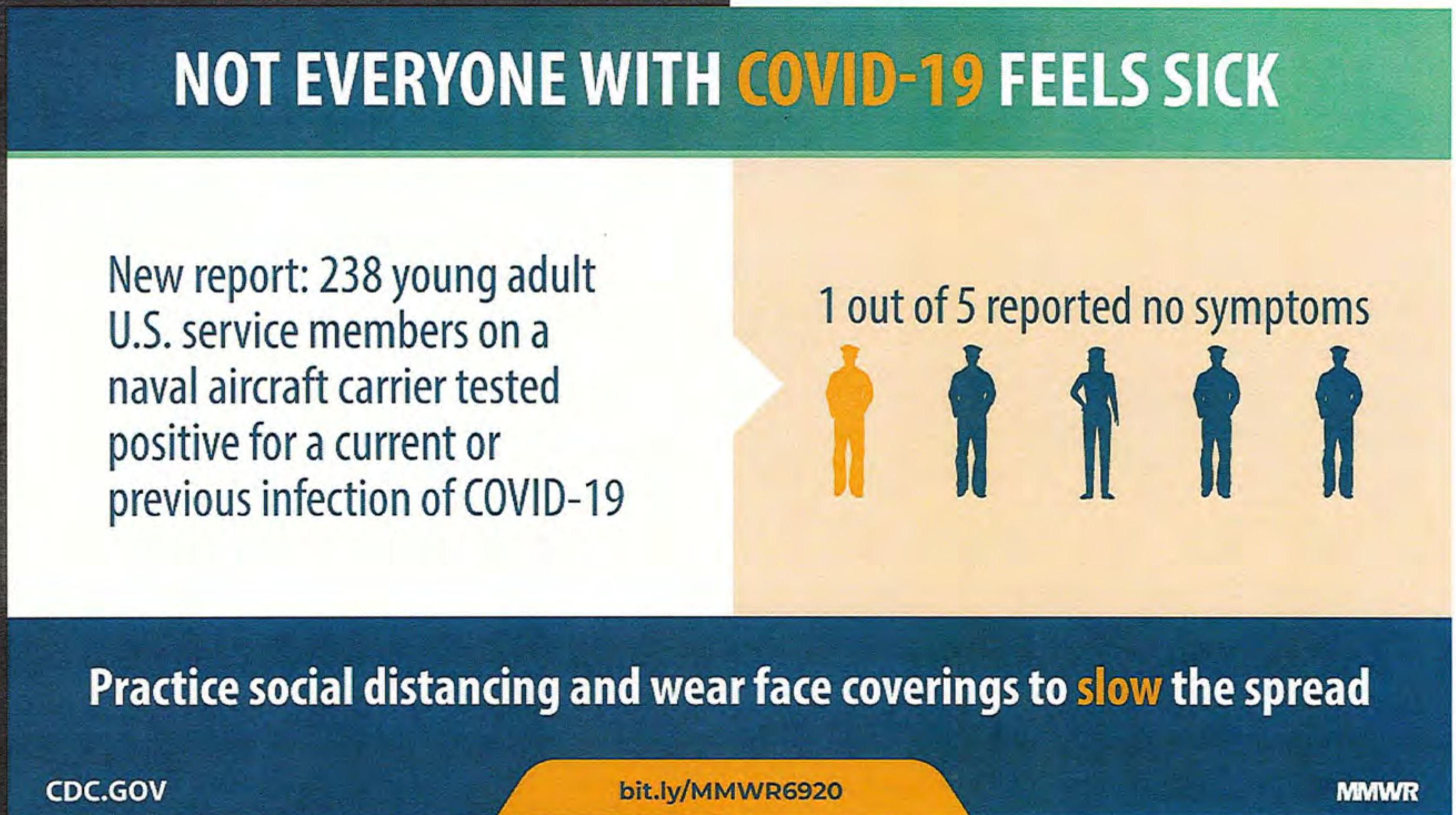
WITH THANKS TO JODY LANARD, KATHERINE ARDEN & THE UNI OF QLD
BASED ON THE SWISS CHEESE MODEL OF ACCIDENT CAUSATION, BY JAMES T REASON, 1990
VERSION 3.0
UPDATE: 24OCT2020

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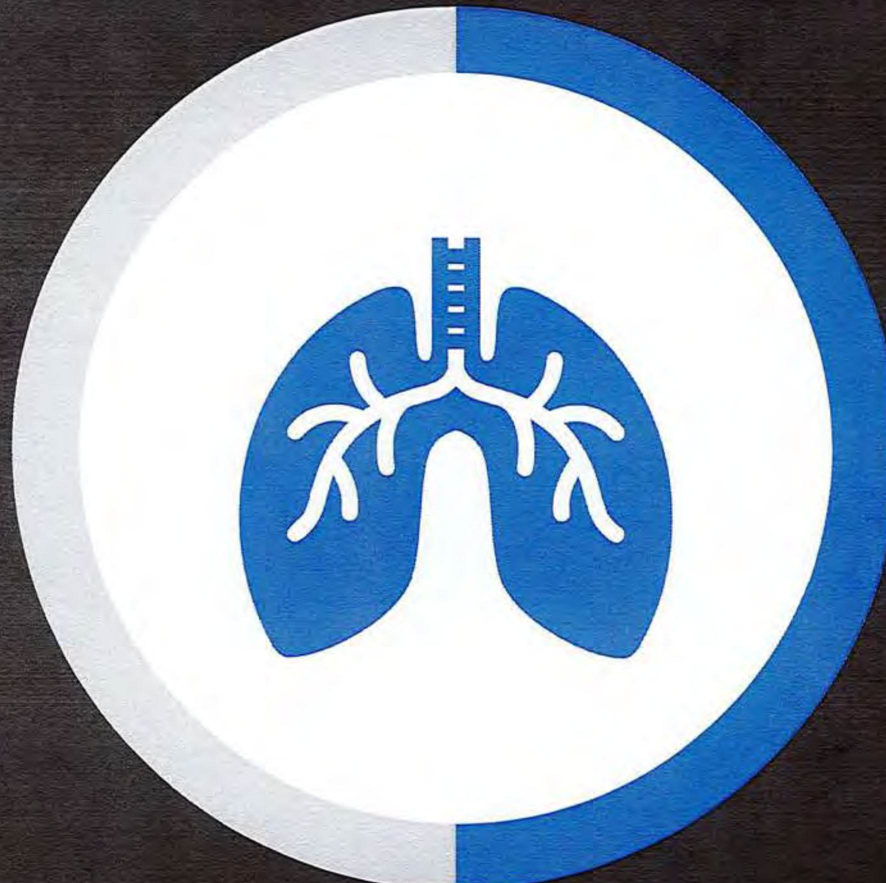
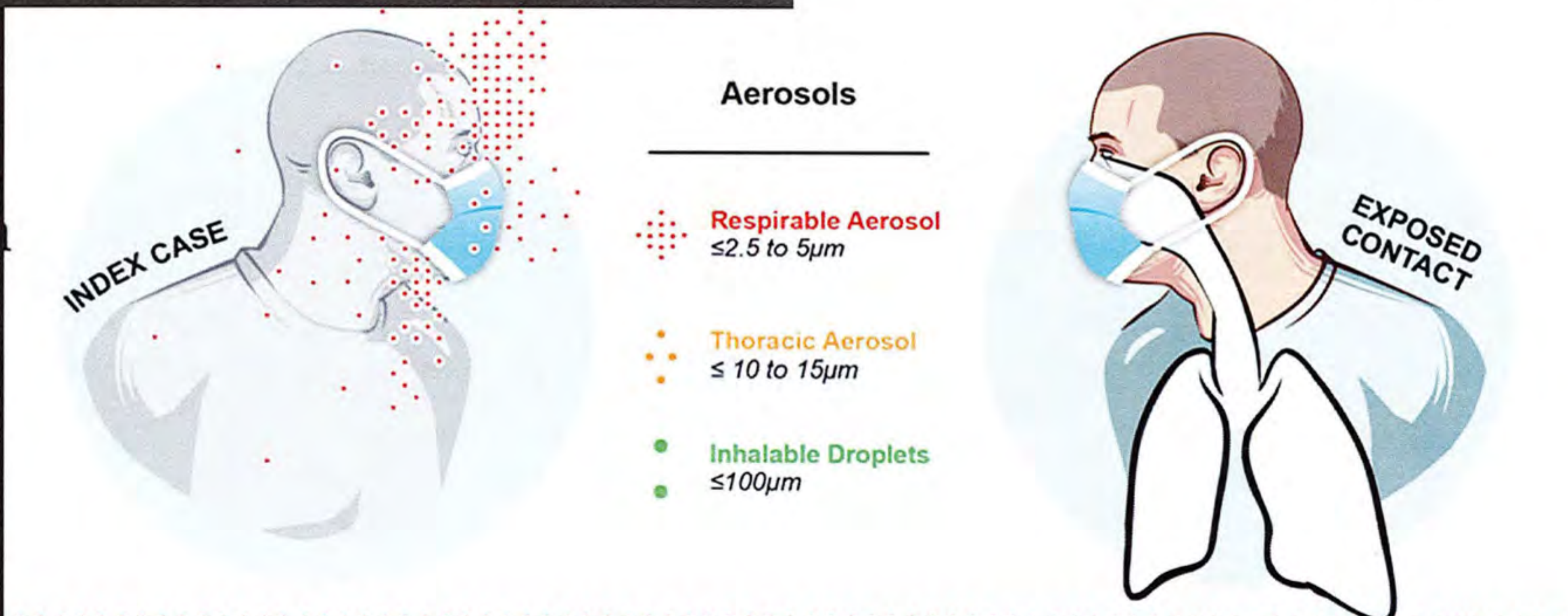
- SARS-CoV-2 infection is transmitted by respiratory droplets generated when people cough, sneeze, sing, talk, or breathe. CDC recommends community use of masks to prevent transmission of SARS-CoV-2.
- The community benefit of masking for SARS-CoV-2 control increases with increasing numbers of people using masks consistently and correctly.



Source control

Inhalation Protection




D. K. Milton, *J Pediatric Infect Dis Soc* (2020), doi:10.1093/jpids/piaa079.

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# Source Control to Block Exhaled Virus

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- Multi-layer cloth masks both block up to 50-70% of fine droplets[3,14] and limit the forward spread of those that are not captured.[5,6,15,16]


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# Source Control to Block Exhaled Virus (refs)


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# Filtration for Personal Protection

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Adopting universal masking policies can help avert future lockdowns, especially if combined with other non-pharmaceutical interventions such as social distancing, hand hygiene, adequate ventilation and community measures that limit congregate mask free activities.

# Human Studies of Masking and SARS-CoV-2 Transmission

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An investigation of a high-exposure event, in which 2 symptomatically ill hair stylists interacted for an average of 15 minutes with each of 139 clients during an 8-day period, found that none of the 67 clients who subsequently consented to an interview and testing developed infection. The stylists and all clients universally wore masks in the salon as required by local ordinance and company policy at the time.[32]

# Human Studies of Masking and SARS-CoV-2 Transmission

**Table 1** Continued

| Primary cases | Total (n (%)) (n=124) | Families without transmission (n (%)) (n=83) | Families with transmission (n (%)) (n=41) | P value | Unadjusted OR (95% CI) |
|---|---|---|---|---|---|
| Unlikely | 79 (63.7) | 48 (57.8) | 31 (75.6) | 0.06 | 2.26 (0.98 to 5.21) |
| Knowledge of their own infectiousness after illness onset | – | – | – | – | – |
| Likely | 84 (67.7) | 62 (74.7) | 22 (53.7) | – | Ref |
| Unlikely | 40 (32.3) | 21 (25.3) | 19 (46.3) | 0.02 | 2.55 (1.16 to 5.61) |
| Wear mask at home after illness onset¶ | – | – | – | – | – |
| Never | 41 (33.1) | 24 (28.9) | 17 (41.5) | – | Ref |
| Sometimes | 37 (29.8) | 21 (25.3) | 16 (39.0) | 0.76 | 1.15 (0.46 to 2.87) |
| All the time | 46 (37.1) | 38 (45.8) | 8 (19.5) | 0.02 | 0.30 (0.11 to 0.82) |

In a study of 124 Beijing households with ≥ 1 laboratory-confirmed case of SARS-CoV-2 infection, mask use by the index patient and family contacts before the index patient developed symptoms reduced secondary transmission within the households by 79%.[33]

# Human Studies of Masking and SARS-CoV-2 Transmission

**Table 1.** Factors associated with coronavirus disease among persons followed through contract tracing, Thailand, March–April 2020*

| Factors | COVID-19 cases, no. (%), N = 211† | Controls, no. (%), N = 839† | Crude odds ratio (95% CI)‡ | p value | Adjusted odds ratio (95% CI)‡ | p value |
|---|---|---|---|---|---|---|
| Sex | n = 211 | n = 838 | | | | |
| F | 65 (30.8) | 404 (48.2) | Referent | 0.52 | Referent | 0.37 |
| M | 146 (69.2) | 434 (51.8) | 0.83 (0.47–1.46) | | 0.76 (0.41–1.41) | |
| Age group, y | n =211 | n = 829 | | | | |
| ≤15 | 6 (2.8) | 49 (5.9) | 0.65 (0.17–2.48) | 0.29 | 0.57 (0.15–2.21) | 0.21 |
| >15–40 | 94 (44.5) | 435 (52.5) | Referent | | Referent | |
| >40–65 | 98 (46.4) | 302 (36.4) | 1.65 (0.91–2.97) | | 1.77 (0.94–3.32) | |
| >65 | 13 (6.2) | 43 (5.0) | 1.29 (0.33–5.07) | | 0.97 (0.22–4.24) | |
| Compliance with mask-wearing†† | n = 210 | n = 823 | | | | |
| Not wearing a mask | 102 (48.6) | 500 (60.7) | Referent | <0.001 | Referent | 0.006 |
| Wearing a mask sometimes | 79 (37.6) | 125 (15.2) | 0.75 (0.37–1.52) | | 0.87 (0.41–1.84) | |
| Always wearing a mask | 29 (13.8) | 198 (24.1) | 0.16 (0.07–0.36) | | 0.23 (0.09–0.60) | |

A retrospective case-control study from Thailand documented that, among more than 1,000 persons interviewed as part of contact tracing investigations, those who reported having always worn a mask during high-risk exposures experienced a greater than 70% reduced risk of acquiring infection compared with persons who did not wear masks under these circumstances.[34]

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# Human Studies of Masking and SARS-CoV-2 Transmission

**TABLE. (*Continued*) Comparison of U.S. Navy service members with and without previous or current SARS-CoV-2 infection (N = 382) — USS Theodore Roosevelt, April 2020**

| Characteristic | No. (%) Current or previous SARS-CoV-2 infection* (N = 238) | No. (%) No evidence of SARS-CoV-2 infection (N = 144) | Infection versus no infection OR (95% CI)† |
|---|---|---|---|
| **Number of symptoms** | | | |
| 1–3 | 51 (26.3) | 49 (54.4) | Referent |
| 4–5 | 37 (19.1) | 13 (14.4) | 2.74 (1.30–5.75)§ |
| 6–8 | 50 (25.8) | 16 (17.8) | 3.00 (1.51–5.96)§ |
| >8 | 56 (28.9) | 12 (13.3) | 4.48 (2.15–9.37)§ |
| **Still symptomatic at time of survey (n = 275)** | | | |
| Yes | 65 (34.0) | 24 (28.6) | 1.29 (0.74–2.26) |
| No | 126 (66.0) | 60 (71.4) | Referent |
| Duration >1 week (n = 186) | 70 (55.6) | 29 (48.3) | 1.34 (0.72–2.47) |
| **Reported prevention behaviors** | | | |
| Increased hand washing | 218 (62.1) | 133 (37.9) | 0.90 (0.42–1.94) |
| Hand sanitizer use | 219 (61.5) | 137 (38.5) | 0.59 (0.24–1.44) |
| Avoiding common areas | 78 (53.8) | 67 (46.2) | 0.56 (0.37–0.86)§ |
| Face covering use | 158 (55.8) | 125 (44.2) | 0.30 (0.17–0.52)§ |
| Increased workspace cleaning | 195 (63.5) | 112 (36.5) | 1.30 (0.78–2.16) |
| Increased berthing cleaning | 156 (61.9) | 96 (38.1) | 0.95 (0.61–1.47) |
| Increased distance from others | 105 (54.7) | 87 (45.3) | 0.52 (0.34–0.79)§ |

- A study of an outbreak aboard the USS Theodore Roosevelt, an environment notable for congregate living quarters and close working environments, found that use of face coverings on-board was associated with a 70% reduced risk.[35]

# Human Studies of Masking and SARS-CoV-2 Transmission

Seven studies have confirmed the benefit of universal masking in community level analyses: in a unified hospital system,[38] a German city,[39] a U.S. state,[40] a panel of 15 U.S. states and Washington, D.C.,[41,42] as well as both Canada[43] and the U.S.[44] nationally.

Each analysis demonstrated that, following directives from organizational and political leadership for universal masking, new infections fell significantly. Two of these studies[42,44] and an additional analysis of data from 200 countries that included the U.S.[45] also demonstrated reductions in mortality.

An economic analysis using U.S. data found that, given these effects, increasing universal masking by 15% could prevent the need for lockdowns and reduce associated losses of up to $1 trillion or about 5% of gross domestic product.[42]

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# Mandates increase number of people wearing masks

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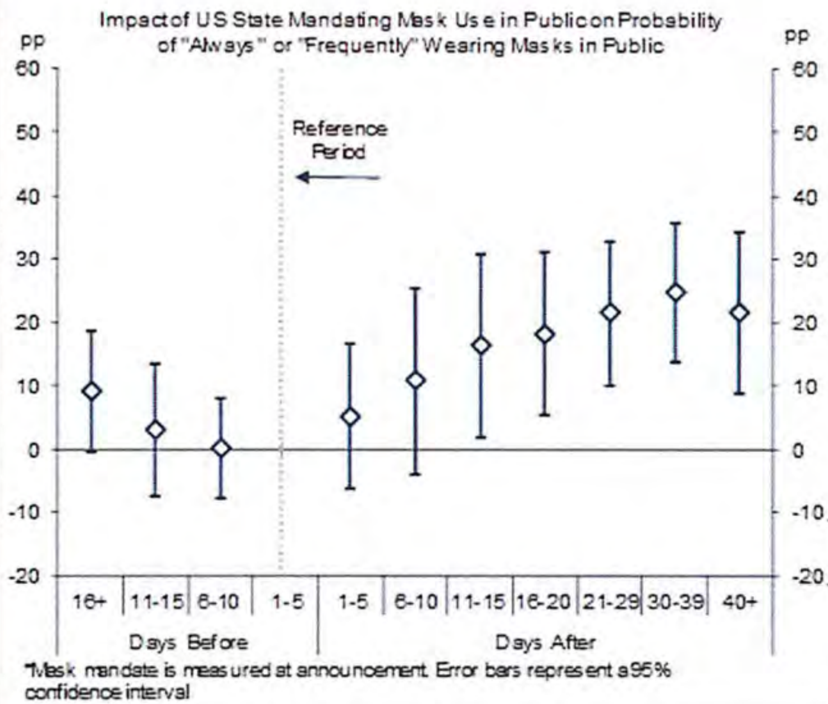
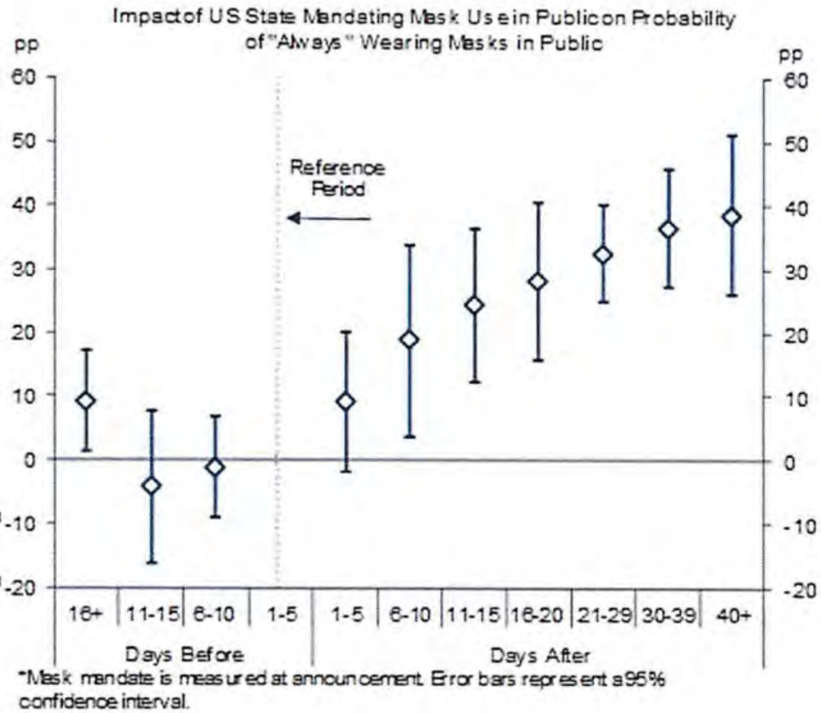
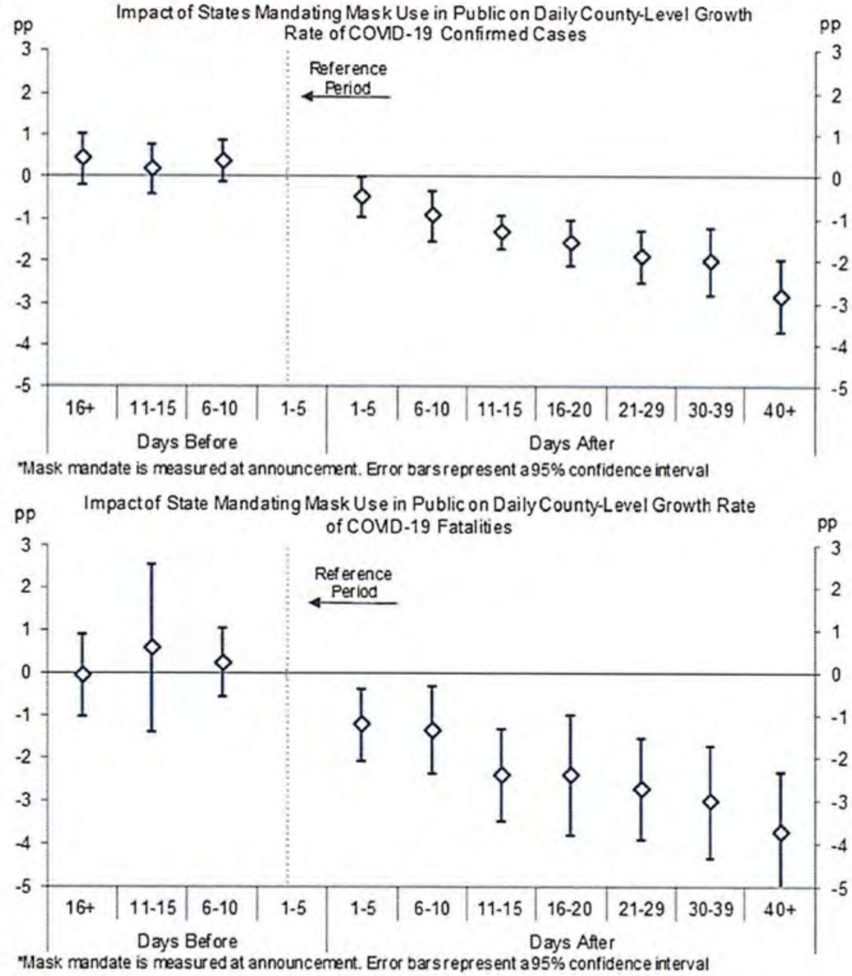
**Exhibit 4: Mask Mandates Raise the Percentage of People Who "Always" or "Frequently" Wear Masks by Around 25pp in the 30+ Days After Signing**



# Mandates result in reduction of cases and fatalities

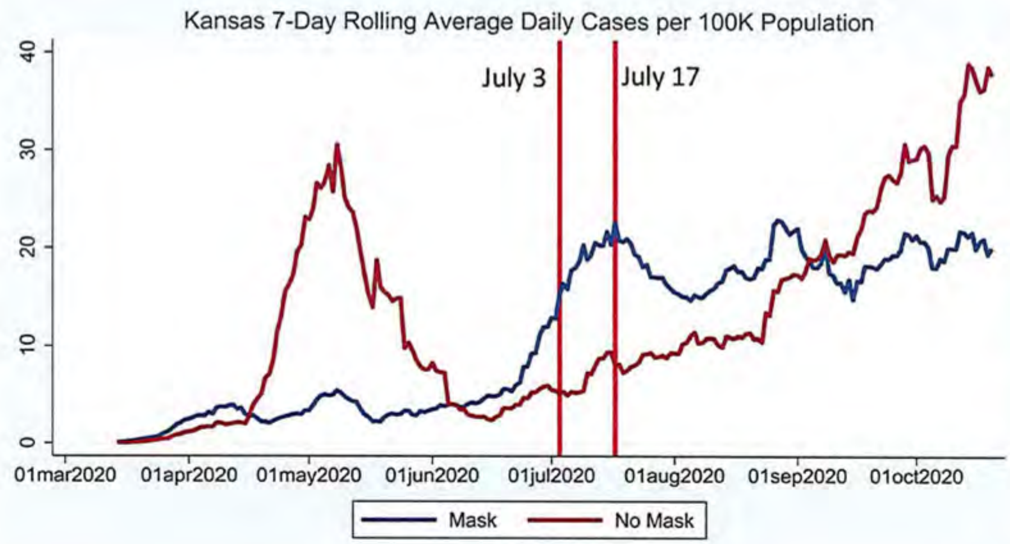
**Exhibit 5: Mask Mandates Are Associated with Large Declines in COVID-19 Case and Fatality (**




Source: YouGov, Goldman Sachs Global Investment Research

## Kansas 7-Day Rolling Average Daily Cases per 100K Population

- Counties with a mask mandate saw a decrease starting 14 days after the mandate
- New spikes afterwards despite mandate
- Mask counties "stationary"
- No-Mask counties steadily increasing




From: U of Kansas Insititute for Policy and Social Research

Carlos Zambrana, PhD & Donna K. Ginther PhD

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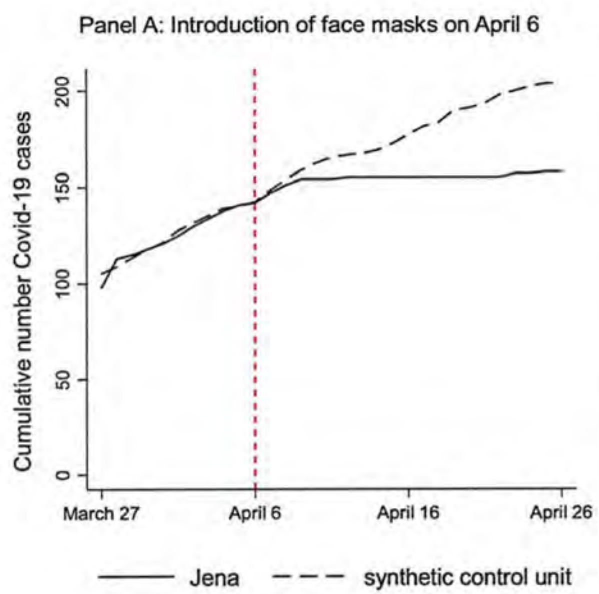
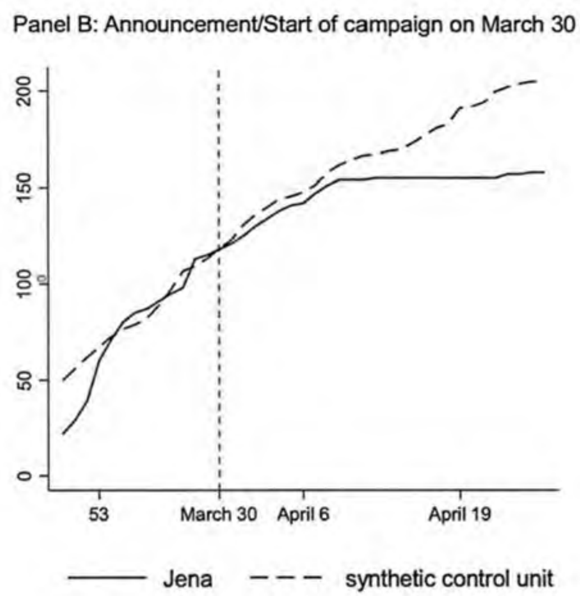
# German community mask ordinance comparison




Face masks reduced the cumulative number of registered Covid-19 cases between 2.3% and 13% over a period of 10 days after they became compulsory. Assessing the credibility of the various estimates, we conclude that face masks reduce the daily growth rate of reported infections by around 40%.

Mitze, Kosfeld, Rode, Wälde. Face *Masks Considerably Reduce COVID-19 Cases in Germany: A Synthetic Control Method Approach*. IZA – Institute of Labor Economics Bonn, Germany. JUNE 2020

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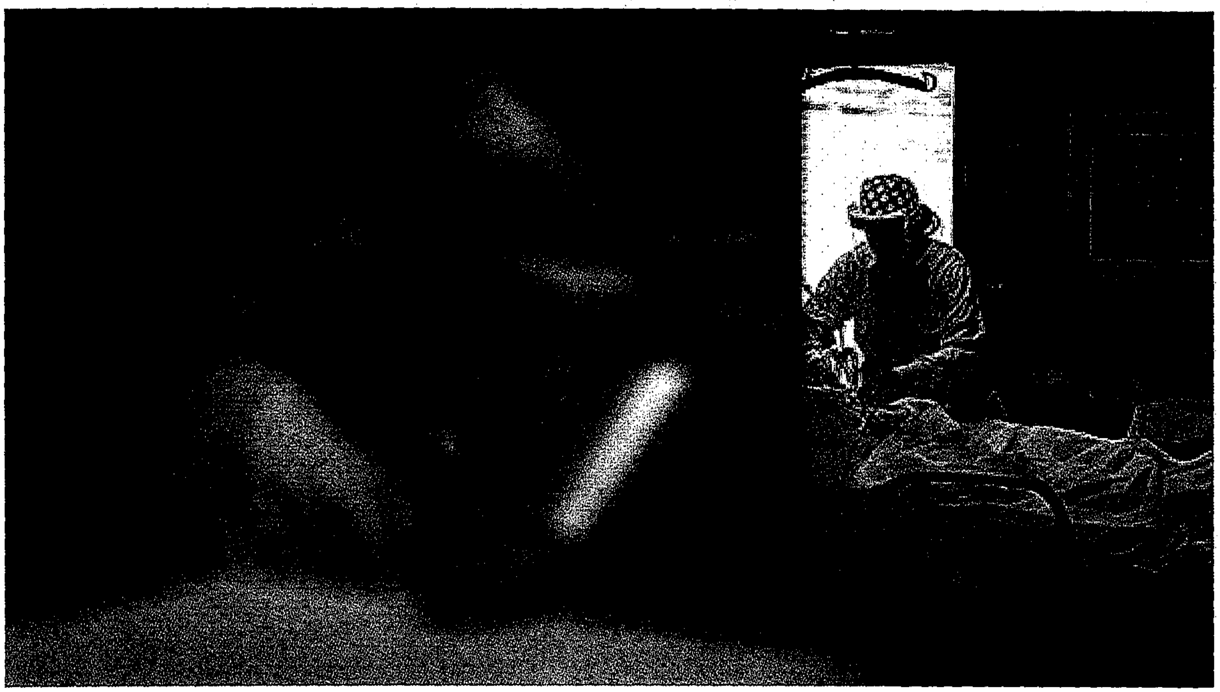
# + Nebraska health care workers signed ͺ letter asking for your help

Published November 17, 2020



Ultrasound technician Amber Olstad, left, and nurse Dani Christiansen take care of patients in 7UT, one of the 10 COVID-19 units at Nebraska Medical Center.

*University of Nebraska Medical Center (UNMC) pulmonary and critical care medicine fellows Christopher Miller, DO, Thomas Marston, MD, and Nebraska Medicine critical care physician Daniel Hershberger, MD, drafted the letter below. They distributed it to some colleagues, hoping to add signatures alongside their own. The letter quickly gained attention,* *and as of this publication, it has been signed by 1,700+ doctors and nurses.*

Fellow Nebraskans,

In our lifetime, hospitals in Nebraska have always answered the call to provide high-quality health care to our patients. We have never had to imagine a time when hospitals could not provide lifesaving care for the patients who come through our doors. We, the health care providers of Nebraska, are concerned that this unimaginable time is fast approaching. We are nearing a dangerous period of this pandemic and fear that many more lives will be lost without action from all Nebraskans.

Nebraska currently has one of the fastest-growing outbreaks of COVID-19 in the United States. We continue to add capacity to the hospitals. Currently, Nebraska Medicine has 10 units full of COVID-19 patients. We are not able to add more space and will soon not have the workforce to care for more patients. However, this dramatic climb in cases can be slowed. You can help us flatten the curve.

Wearing a mask is an effective way to help stop the spread of COVID-19. The Centers for Disease Control and Prevention (CDC) recently again showed that masks reduce the risk of spread to those around us and protect us from getting the virus. The data on mask use is clear – masks slow the transmission of COVID-19. We call on all Nebraskans to wear a mask anytime you leave your home, especially anytime you cannot socially distance from others.

We ask all Nebraskans to cut back on any unnecessary trips outside their homes. We need to socially distance to prevent the continued spread of COVID-19. Even people that do not show symptoms can still spread the virus. Social distancing can break this chain of transmission. We need to limit all gatherings to those just within our immediate households. Social distancing has economic impacts in our community, and we ask that Nebraskans support local businesses in any way you can through these challenging times.

No single health measure is 100% effective at stopping the spread of COVID. They must be used together. That is why we are asking all of you to take every action possible to limit the spread in our community and to save lives.

Your frontline health care workers are exhausted. We are scared that the hospitals won't have the space and people to meet the ever-growing demand. We are seeing many deaths and will continue to see many more. Nebraskans have always been strong and hardworking people who have never failed to help our neighbors in the most challenging times. We call on Nebraskans to rise up once again to do everything we can for our state's health and safety. We believe in the people of this state. Your actions can save lives. We need you to wear masks, practice social distancing and limit the size of social gatherings. The life you save may be your own. We need you all to help those health care workers who dedicate their lives to save yours.

Sincerely,

**The following 1,700+ Nebraska Medicine and UNMC health care providers:**

William Poulson, MD, vascular surgery fellow
Michael C. Wadman, MD, medical director, National Quarantine Unit; professor and chair, Department of Emergency Medicine
Christopher Miller, DO, MPH, MHA, pulmonary and critical care medicine fellow
Thomas Marston, MD, pulmonary and critical care medicine fellow
Maureen McElligott, MD, pulmonary and critical care medicine fellow
Grant Turner, MD, pulmonary and critical care medicine fellow
Joseph Lamar , MD, pulmonary and critical care medicine fellow
David E. Gannon, MD, FACP, FACCP, critical care medical director; associate professor of medicine
Amol Patil, MD, associate professor of medicine
Keenan Taylor, MD, associate professor of medicine
Ross Davidson, DO, MS, pulmonary and critical care medicine fellow
Meilinh Thi, DO, associate professor of medicine
Eric Asbe, DO, pulmonary and critical care medicine fellow
Kelly Cawcutt, MD, MS, associate director of infection control and hospital epidemiology; assistant professor of infectious diseases and critical care medicine
Bridget Boeckman, APRN, critical care supervisor
Bethany Tomasek, PA-C, critical care advanced practice provider
Mollie Brittan, MD, MS, pulmonary and critical care medicine fellow
Daniel Cramer, APRN, infectious diseases advanced practice provider; assistant professor of nursing
Jake West, DO, pulmonary and critical care medicine fellow
Elizabeth Beam, PhD, RN, education researcher; assistant professor
Risa Zimmerman , MBA, MPAS, PA-C, director of the Office of Advanced Practice
Lisa Hill, APRN, nephrology advanced practice provider
Kimberly Schultz, PA-C, gastroenterology and hepatology advanced practice provider

Samantha Jordan-Schaulis, APRN, CPNP, AC/PC, pediatric critical care medicine advanced practice provider supervisor
Jill M. Strahm, APRN, FNP-C, perioperative evaluation advanced practice provider
Kirsten Wertz, RN, MSN, instructor in the College of Nursing
Laura Fraynd, DNAP, CRNA, anesthesiology
T. Scott Diesing, MD, director of hospital neurology
Rachel Pawloski, APRN, pulmonology advanced practice provider
Nicolas Cortes-Penfield, MD, infectious diseases physician; assistant professor
Kate-Lynn Muir, DO , oncology and hematology fellow
Brian Benes, DO , chief resident in internal medicine
Brent Luedders, MD, chief resident in internal medicine
Gynae Bantz, CRNA, anesthesiology
Heather Strah, MD, medical director of the lung transplant program
John B Thornton, APRN-NP, critical care advanced practice provider
Rachel Johnson, MD, assistant professor of internal medicine and pediatrics
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Nate Anderson, MD, assistant professor of hospital medicine
Nicole Maschmeier , DNAP, CRNA, anesthesiology
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Jared Baxter, MD, assistant professor, College of Nursing West Division
Ellen Roberts, MD, FASA, professor and vice chair of clinical operations in the Department of Anesthesiology
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Amy J. Hargrove, MD, MPH, surgical resident
Tiffany Olson, CRNA, associate director nurse anesthetists
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By Wei Lyu and George L. Wehby

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# Community Use Of Face Masks And COVID-19: Evidence From A Natural Experiment Of State Mandates In The US

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**George L. Wehby** (george-wehby@uiowa.edu) is a professor in the Department of Health Management and Policy, College of Public Health, University of Iowa, and a research associate at the National Bureau of Economic Research.

ABSTRACT State policies mandating public or community use of face masks or covers in mitigating novel coronavirus disease (COVID-19) spread are hotly contested. This study provides evidence from a natural experiment on effects of state government mandates in the US for face mask use in public issued by 15 states plus DC between April 8 and May 15. The research design is an event study examining changes in the daily county-level COVID-19 growth rates between March 31, 2020 and May 22, 2020. Mandating face mask use in public is 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+ days after signing, respectively. Estimates suggest as many as 230,000–450,000 COVID-19 cases possibly averted By May 22, 2020 by these mandates. The findings suggest that requiring face mask use in public might help in mitigating COVID-19 spread. [*Editor's Note: This Fast Track Ahead Of Print article is the accepted version of the peer-reviewed manuscript. The final edited version will appear in an upcoming issue of* Health Affairs.]

One of the most contentious issues being debated worldwide in the response to the novel coronavirus disease (COVID-19) pandemic is the value of wearing masks or facial coverings in public settings.[1] A key factor fueling the debate is the limited direct evidence thus far on how much widespread community use would affect COVID-19 spread. However, there is now substantial evidence of asymptomatic transmission of COVID-19.[2,3] For example, a recent study of antibodies in a sample of customers in grocery stores in New York State reported an infection rate of 14% by March 29 (projected to represent nearly 2.1 million cases), which substantially exceeds the number of confirmed COVID-19 cases.[4] Moreover, all public health authorities call on symptomatic individuals to wear masks to reduce transmission risk. Even organizations that have not yet recommended widespread community use of facial masks for COVID-19 mitigation (i.e. everyone without symptoms should use a face mask outside of their home), such as the World Health Organization, strongly recommend that symptomatic individuals wear them.[5] Since mask wearing by infected individuals can reduce transmission risk, and because of the high proportion of asymptomatic infected individuals and transmissions, there appears to be a strong case for the effectiveness of widespread use of face masks in reducing the spread of COVID-19. However, there is no direct evidence thus far on the magnitude of such effects, especially at a population level.

Researchers have been reviewing evidence from previous randomized controlled trials for other respiratory illnesses examining mask use and types among individuals at higher risk of contracting infections (such as health care workers or individuals in infected households). Systematic reviews and meta-analyses of such studies have provided suggestive, although generally weak, evidence.[6] The estimates from the meta-analyses based on the randomized controlled trials suggest declines in transmission risk of influenza or influenza-like illnesses to mask wearers, although estimates are mostly statistically insignificant possibly due to small sample sizes or design limitations especially related to assessing compliance.[7–9] There is also a relationship between increased adherence to mask use specifically and effectiveness of reducing transmission to mask wearers; in one randomized study of influenza transmission in infected households in Australia, transmission risk for mask wearers was lower with greater adherence.[10] Further, the evidence is mixed from randomized studies on types of masks and risk of influenza-like illnesses transmission to mask wearers; for example, a recent systematic review and meta-analysis comparing N95 respirators versus surgical masks found a statistically insignificant decline in influenza risk with the N95-respirators.[11]

Positions on widespread facial mask use have differed worldwide but are changing over time. In the US, public health authorities did not recommend widespread facial mask use in public at the start of the pandemic. The initially limited evidence on asymptomatic transmission and concern about mask shortages for health care workforce and individuals caring for patients contributed to that initial decision. On April 3, 2020, the Centers for Disease Control and Prevention (CDC) issued new guidance advising all individuals to wear cloth facial covers in public areas where close contact with others is unavoidable, citing new evidence on virus transmission from asymptomatic or pre-symptomatic individuals.[12] Guidelines differ between countries, and some including Germany, France, Italy, Spain, China, and South Korea have mandated use of face masks in public.[13–16]

This study adds complementary evidence to the literature on impacts of widespread community use of face masks on COVID-19 spread from a natural experiment based on whether states in the US have mandated the use of face masks in public for COVID-19 mitigation or not. Specifically, we identify the effects of mandating face mask use in public on daily COVID-19 growth rates based on differences in the timing and issuance of state mandates.

In the US, 15 states plus DC have issued mandates for face mask use in public between April 8 and May 15. We examine the effects of state mandates for use of face masks in public on the daily COVID-19 growth rate using an event study that examines the effects over different periods. We also consider the impact of mandates for mask use targeted only to employees in some work settings, as opposed to community-wide mandates. This evidence is critical as states and countries worldwide begin to shift to "reopening" their economies and as foot traffic increases. Mandating public use of masks has become a socially and politically contentious issue, with multiple protests and even acts of violence directed against masked employees and those asking customers to wear face masks.[17] Face cover recommendations and mandates are part of the current set of measures, following earlier social distancing measures such as school and non-essential business closures, bans on large gatherings, and shelter-in-place orders being considered by states and local governments, especially as regions of the country reopen. For example, most recently, Virginia started its phase one reopening on May 22, 2020 and required everyone in the state to wear face masks in public where people congregate.[18] Therefore, it is critical to provide direct evidence on this question not only for public health authorities and governments but also for educating the public.

## Study Data And Methods

**DATA** We collect information on statewide face covering mandate orders from public datasets on such policies and from searching and reviewing all state orders issued between April 1 and May 21, 2020. Our study focuses on state executive orders or directives signed by state governors that mandate use. Recommendations or guidelines from state departments of public health are not included as these largely follow the CDC guideline and may not necessarily add further information or impact. See online appendix A for more detailed description of the data sources and measuring the mandates.[19]

States differ in whether they require their citizens to wear face masks (covers) to limit COVID-19 spread or not. Between April 8 and May 15, governors of 15 states and the mayor of the District of Columbia (DC) have signed orders mandating all individuals who can medically tolerate the wearing of a face mask do so in public settings (e.g., public transportation, grocery stores, pharmacies, or other retail stores) where maintaining 6-feet of "social distance" may not always be practicable; these 15 states also have specific mandates requiring employees in certain professions to wear masks at all times while working. Besides these 15 states and DC, 20 additional states have employee-only mandates (but no community-wide mandate) requiring that some employees (e.g., close-contact services providers like barber shops and nail salons) wear a face mask at all times while providing services. The face mask defined in these orders primarily refers to cloth face covering or non-medical masks. The state orders strongly discourage the use of any medical/surgical masks and N95 respirators, which should be reserved for health care workers and first responders. The orders also clearly specify that the face masks are not a replacement for any other social distancing protocols. Fifteen states have yet not issued public or employee mandates. Further information on dates is in appendix exhibit A1. Links to these state orders are in appendixes D and E.[19]

The main model uses publicly available daily county-level data of confirmed COVID-19 cases starting on March 25 through May 21.[20] The data covers all states plus DC, and the analytical sample includes 2,930 unique counties plus New York City (five boroughs combined). See appendix A for more detailed description of COVID-19 data.[19]

**STATISTICAL ANALYSIS** We employ an event study, which is generally similar to a difference-in-differences design, to examine whether statewide mandates to wear face masks in public affect the spread of COVID-19 based on the state variations noted above. This design allows us to estimate the effects in the context of a natural experiment: comparing the pre-post mandate changes in COVID-19 spread in the states with mandates to the states that did not pass these mandates over time. The model tests whether states issuing these mandates had differential pre-trends in COVID-19 rates before they were issued. This is a critical assumption of the validity of an event study that must be upheld under testing. In addition, the model allows us to control for a wide range of time-invariant differences between states and counties such as population density and socioeconomic and demographic factors, plus time-variant differences between states and counties such as other mitigation and social distancing policies in addition to state-level COVID-19 tests.

We estimate the effects of face cover mandates on the daily county-level COVID-19 growth rate, which is the difference in the natural log of cumulative COVID-19 cases on a given day minus the natural log of cumulative cases in the prior day, multiplied by 100.[21] This measure gives the daily growth rate in percentage points.

The reference period for estimating the face cover mandate effects is 1–5 days *before* signing the order. We examine how effects change over five post-periods: 1–5 days, 6–10 days, 11–15 days, 16–20 days, and 21+ days. The model also tests for pre-trends over 6–10 days, 11–15 days, and 16+ days *before* signing the mandate. For all counties in the analytical sample, the main model includes daily data from March 31 (7 days before the first state signed a face cover mandate) through May 22. The models are estimated by least squares weighted by the county 2019 population with heteroscedasticity-robust and state-clustered standard errors.

As noted above, all of the 15 states plus DC that mandate facial cover use in public also mandated employee mask use. To assess the effects of employee face cover mandates, we estimate another event-study model that focuses on the employee face cover mandate as the policy intervention. In this analysis, we exclude the 15 states plus DC with both public and employee face cover mandates and focus on the 20 states with employee only mandate and the 15 states without an employee mandate.

**LIMITATIONS** We are unable to measure facial cover use in the community (i.e. compliance with the mandate). As such, the estimates represent the intent-to-treat effects of these mandates, i.e. their effects as passed, and not the individual-level effect of wearing a face mask in public on own COVID-19 risk. Related, we do not measure enforcement of the mandates, which might affect compliance. We also do not have data on county-level mandates for wearing public-face masks. In some states without state-level mandates such as California,[22] Texas,[23] and Colorado,[24] multiple counties have enacted such mandates. These county-level mandates do not bias the intent-to-treat estimates of effects of state-level mandates as actually passed, but they do add local-level heterogeneity not directly accounted for in the model. We do examine the robustness of estimates to excluding some of these states. Finally, we are able to examine only confirmed COVID-19 cases. However, there is evidence of a higher infection rate in the community than confirmed cases.[25]

## Study Results

**EFFECTS OF MANDATES FOR FACE COVERING IN PUBLIC** Supplemental exhibit 1 in the online appendix[19] plots the event study estimates of effects of state mandates for face covering in public on the county-level daily growth rate of COVID-19 cases with their 95% CIs, obtained from the main regression model (in appendix B) using county-level daily data from March 31 through May 22;[19] appendix exhibit C1 (column 1) reports the exact estimates.[19] The effects are shown over five periods after signing the orders, relative to the five days before signing (reference period). Also shown are estimated differences in daily COVID-19 growth rates between states with and without the mandates over three periods before the reference period.

There is a significant decline in daily COVID-19 growth rate after mandating facial covers in public, with the effect increasing over time after signing the order. Specifically, the daily case rate declines by 0.9, 1.1, 1.4, 1.7, and 2.0 percentage-points within 1–5, 6–10, 11–15, and 16–20, and 21+ days after signing, respectively. All of these declines are statistically significant ($p < 0.05$, or less). In contrast, the pre-trends in COVID-19 case growth rates are small and statistically insignificant.

We also project the number of averted COVID-19 cases with the mandates for face mask use in public by comparing actual cumulative daily cases to daily cases predicted by the model if none of the states had enacted the public face cover mandate at the time they did (see details in appendix B).[19] The main model estimates suggest that as many as 230,000–450,000 cases may have been averted due to these mandates by May 22. Estimates of averted cases should be viewed cautiously and only as general approximations.

**ROBUSTNESS CHECKS** We estimate multiple extensions of the main event study model to assess the robustness of estimates to different model specifications and sample choices. These checks start the event study on March 26, add flexible controls for social distancing and state reopening measures, employee face mask use mandates, and county-specific time trends, and allow time trends to vary by sociodemographic indicators. Other checks use the mandate effective date instead of signing date; use hyperbolic sine transformation to account for 0 cases; include states as the unit instead of counties; include only urban counties; exclude some states without state-level mandates but multiple counties having local mandates. The detailed description and results of these robustness checks are listed in appendix C.[19] The results are robust across these checks; effects are smaller when using the effective date instead of the signing date, which differ by about 2–3 days on average suggesting earlier compliance, and when using states as the unit of analysis. But the estimates remain meaningful and statistically significant in all checks.

**EFFECTS OF EMPLOYEE ONLY FACE COVERING MANDATES** As noted above, we also directly assess the effects of states mandating only that certain employees wear face masks. Twenty states issued employee only mandates but did not issue public use mandates. We re-estimate the event-study model described above for this employee-only mandate including those 20 states (issued between April 17 and May 9) and the 15 states without mandates and excluding the 15 states plus DC that issued the public use mandates (plus the employee use mandates). Supplemental exhibit 2[19] plots the event study estimates of changes in county-level daily COVID-19 growth rates with the employee only face cover mandates and their 95% CIs. All pre- and post-mandate estimates are small and insignificant. Overall, these results indicate no evidence of declines in daily COVID-19 growth rates with the employee-only mandates.

## Discussion

Around the world, governments have been fighting COVID-19 spread through a mix of policies and mitigation measures such as school and nonessential business closures and shelter-in-place orders. Some countries have also recommended or mandated widespread community use of facial masks as a mitigation measure. However, the effectiveness of this measure is highly debated. The debate and uncertainty are fueled by the limited direct empirical evidence on the magnitude of effects of widespread face mask use in public on COVID-19 mitigation. There is a critical need for empirical evidence on the magnitude of these effects from natural experiments.[8] This evidence is especially relevant as governments reopen their economies and loosen social distancing restrictions at times while new infections continue without a vaccine or widely accessible and effective treatments in sight.

The study provides direct evidence on the effectiveness of widespread community use of face masks from a natural experiment that evaluates effects of state government mandates in the US for face mask use in public on COVID-19 spread. Fifteen states plus DC in the US have mandated this use between April 8 and May 5. Using an event study that examines daily changes in county-level COVID-19 growth rates, the study finds that mandating public use of face masks is associated with a reduction in the COVID-19 daily growth rate. Specifically, we find that the average daily county-level growth rate decreases 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+ days after signing, respectively.

These estimates are not small and represent nearly 16–19% of the effects of other social distancing measures (school closures, bans on large gatherings, shelter-in-place orders, and closures of restaurants, bars, and entertainment venues) after similar periods from their enactment.[21] The estimates suggest increasing effectiveness and benefits from these mandates over time. By May 22, the estimates suggest that as many as 230,000–450,000 COVID-19 cases may have been averted based on when states passed these mandates. Again, the estimates of averted cases should be viewed cautiously as these are sensitive to assumptions and different approaches for transforming the changes in the daily growth rate estimates to cases.

The early declines in the daily growth rate over 5 days after signing the order are broadly consistent with timing of effects of other social distancing measures such as business closures.[21] While the median incubation period is estimated to be around 5 days,[26] there is a wide range from 2.2 (2.5th percentile) days to 11.5 days (97.5th percentile) suggesting that for many individuals symptoms may appear relatively early. Further, individuals may become aware of the mandates early through the governors' briefings and related media reports or may be anticipating them.

There is no evidence of differential pre-mandate COVID-19 trends with respect to issuing these mandates. The estimates represent the intent-to-treat effects of the statewide face cover mandates as passed, conditional on other national and local measures. In that way, the effects are independent of the CDC national guidance to wear facial masks issued on April 3. These effects are robust to several model checks. The study provides evidence from a natural experiment on effectiveness of mandating public use of face masks in mitigating COVID-19 spread. We find no evidence for effects of states mandating employee face mask use, perhaps because many businesses themselves have been requiring their employees to wear masks.[27,28] In that sense, mandating employee mask use may be reinforcing what many businesses are already choosing to do on their own.

While the intent-to-treat estimates are of interest for understanding the effectiveness of these policies in limiting COVID-19 spread at the community and population level, understanding how their effects change with compliance and enforcement strategies is important for designing effective policies. Our study builds the first step in estimating the overall effect of these policies as enacted. However, these policies vary in their strictness and consequences of noncompliance. The mandates generally require wearing a face mask in public whenever the social distance cannot be maintained. Some states (such as Delaware, Maryland, Massachusetts, and Maine) clarify what "public" areas are, for example indoor space in retail establishments, outdoor space in busy parking lots and waiting areas for take-out services, semi-enclosed areas, such as in public transportation stops, and enclosed space, such as in taxis and other public transportation means. The language on enforcement and penalties for non-compliance also vary. In some states such as Delaware, Hawaii, Maryland, and Massachusetts, the face mask orders state that they have the force and effect of law, with a willful violation subject to a criminal offense with penalties. For example, the order in Maryland states that "a person who knowingly and willfully violates this order is guilty of a misdemeanor and on conviction is subject to imprisonment not exceeding one year or a fine not exceeding $5,000 or both".[29] In contrast, the orders of some other states such as Connecticut, Maine, and Pennsylvania, while clearly mandating the wearing of a face mask in public, do not appear to clearly specify that violations of the order are subject to criminal offense or penalties. Future work should examine if and how differences in strictness and enforcement modify the effects of these mandates.

Compliance and enforcement may also differ across contextual factors (such as other social distancing measures, workforce distribution, population demographic, socioeconomic, and cultural factors). In that regard, it is important to clarify that the suggested benefits from mandating face mask use are not substitutes for other social distancing measures; the effects are conditional on the other enacted social distancing measures and how communities are complying with them. It is also important to extend the evidence into additional measures of exposure to the virus in the community as data become available such as from serological testing for antibodies. Finally, future work can examine effects on deaths, which lag cases and change not only with number of cases but also with case severity.

## Conclusion

The study provides evidence that states in the US mandating use of face masks in public had a greater decline in daily COVID-19 growth rates after issuing these mandates compared to states that did not issue mandates. These effects are observed conditional on other existing social distancing measures and are independent of the CDC recommendation to wear facial covers issued on April 3. As countries worldwide and states begin to relax social distancing restrictions and considering the high likelihood of a second COVID-19 wave in the fall/winter,[30] requiring use of face masks in public might help in reducing COVID-19 spread. ■

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# Visualizing the effectiveness of face masks in obstructing respiratory jets

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# Visualizing the effectiveness of face masks in obstructing respiratory jets

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The use of face masks in public settings has been widely recommended by public health officials during the current COVID-19 pandemic. The masks help mitigate the risk of cross-infection via respiratory droplets, however, there are no specific guidelines on mask materials and designs that are most effective in minimizing droplet dispersal. While there have been prior studies on the performance of medical-grade masks, there is insufficient data on cloth-based coverings which are being used by a vast majority of the general public. We use qualitative visualizations of emulated coughs and sneezes to examine how material- and design-choices impact the extent to which droplet-laden respiratory jets are blocked. Loosely folded face masks and bandana-style coverings provide minimal stopping-capability for the smallest aerosolized respiratory droplets. Well-fitted homemade masks with multiple layers of quilting fabric, and off-the-shelf cone style masks, proved to be the most effective in reducing droplet dispersal. These masks were able to curtail the speed and range of the respiratory jets significantly, albeit with some leakage through the mask material and from small gaps along the edges. Importantly, uncovered emulated coughs were able to travel noticeably farther than the currently recommended 6-foot distancing guideline. We outline the procedure for setting up simple visualization experiments using easily available materials, which may help healthcare professionals, medical researchers, and manufacturers in assessing the effectiveness of face masks and other personal protective equipment qualitatively.

Infectious respiratory illnesses can exact a heavy socio-economic toll on the most vulnerable members of our society, as has become evident from the current COVID-19 pandemic[1,2]. The disease has overwhelmed healthcare infrastructure worldwide[3], and its high contagion rate and relatively long incubation period[4,5] have made it difficult to trace and isolate infected individuals. Current estimates indicate that about 35% of infected individuals do not display overt symptoms[6], and may contribute to significant spread of the disease without their knowledge. In an effort to contain the unabated community spread of the disease, public health officials have recommended the implementation of various preventative measures, including social-distancing and the use of face masks in public settings[7].

The rationale behind the recommendation for using masks or other face coverings is to reduce the risk of cross-infection via the transmission of respiratory droplets from infected to healthy individuals[8,9]. The pathogen responsible for COVID-19 is found primarily in respiratory droplets that are expelled by infected individuals during coughing, sneezing, or even talking and breathing[10–15]. Apart from COVID-19, respiratory droplets are also the primary means of transmission for various other viral and bacterial illnesses, such as the common cold, influenza, tuberculosis, SARS (Severe Acute Respiratory Syndrome), and MERS (Middle East Respiratory Syndrome), to name a few[16–19]. These pathogens are enveloped within respiratory droplets, which may land on healthy individuals and result in direct transmission, or on inanimate objects which can lead to infection when a healthy individual comes in contact with them[10,18,20,21]. In another mode of transmission, the droplets or their evaporated contents may remain suspended in the air for long periods of time if they are sufficiently small. This can lead to airborne transmission[19,22] when they are breathed in by another person, long after the infected individual may have left the area.

Several studies have investigated respiratory droplets produced by both healthy and infected individuals when performing various activities. The transport characteristics of these droplets can vary significantly depending on their diameter[23–28]. The reported droplet diameters vary widely among studies available in the literature, and usually lie within the range $1\mu m - 500\mu m$[29], with a mean diameter of approximately $10\mu m$[30]. The larger droplets (diameter $> 100\mu m$) are observed to follow ballistic trajectories under the effects of gravity and aerodynamic drag[20,31]. Intermediate-sized droplets[20,31,32] may get carried over considerable distances within a multiphase turbulent cloud[33–35]. The smallest droplets and particles (diameter $< 5\mu m$ to $10\mu m$) may remain suspended in the air indefinitely, until they are carried away by a light breeze or ventilation airflow[20,32].

After being expelled into the ambient environment, the respiratory droplets experience varying degrees of evaporation depending on their size, the ambient humidity, and temperature. The smallest droplets may undergo complete evaporation, leaving behind a dried-out spherical mass consisting of the particulate contents (e.g., pathogens), which are referred to as 'droplet nuclei'[36]. These desiccated nuclei, in combination with the smallest droplets, are potent transmission sources on account of two factors: 1) they can remain suspended in the air for hours after the infected individual has left the area, potentially infecting unsuspecting individuals who come into contact with them; and 2) they can penetrate deep into the airways of individuals who breathe them in, which increases the likelihood of infection even for low pathogen loads. At present, the role of droplet nuclei in the transmission of COVID-19 is not known with certainty, and the matter is the subject of ongoing studies[37–39]. In addition to generating microscopic droplets,

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the action of sneezing can expel sheet-like layers of respiratory fluids[40], which may break apart into smaller droplets through a series of instabilities. The majority of the fluid contained within the sheet falls to the ground quickly within a short distance.

Regardless of their size, all droplets and nuclei expelled by infected individuals are potential carriers of pathogens. Various studies have investigated the effectiveness of medical-grade face masks and other personal protective equipment (PPE) in reducing the possibility of cross-infection via these droplets[13,33,41–47]. Notably, such respiratory barriers do not prove to be completely effective against extremely fine aerosolized particles, droplets, and nuclei. The main issue tends to be air leakage, which can result in aerosolized pathogens being dispersed and suspended in the ambient environment for long periods of time after a coughing/sneezing event has occurred. A few studies have considered the filtration efficiency of homemade masks made with different types of fabric[48–51], however there is no broad consensus regarding their effectiveness in minimizing disease transmission[52,53]. Nonetheless, the evidence suggests that masks and other face coverings are effective in stopping larger droplets, which although fewer in number compared to the smaller droplets and nuclei, constitute a large fraction of the total volume of the ejected respiratory fluid.

While detailed quantitative measurements are necessary for comprehensive characterization of PPE, qualitative visualizations can be invaluable for rapid iteration in early design stages, as well as for demonstrating the proper use of such equipment. Thus, one of the aims of this letter is to describe a simple setup for visualization experiments, which can be assembled using easily available materials. Such setups may be helpful to healthcare professionals, medical researchers, and to industrial manufacturers, for assessing the effectiveness of face masks and other protective equipment qualitatively. Testing designs quickly and early on can prove to be crucial, especially in the current pandemic scenario where one of the central objectives is to reduce the severity of the anticipated resurgence of infections in the upcoming months.

The visualization setup used in the current study is shown in Figure 1, and consists of a hollow manikin head which was padded on the inside to approximate the internal shape and volume of the nasal- and buccal-cavities in an adult. In case a more realistic representation is required, such a setup could include 3D-printed or silicone models of the internal airways. The manikin was mounted at a height of approximately 5 feet and 8 inches to emulate respiratory jets expelled by an average human male. The circular opening representing the mouth is 0.75 inches in diameter. The pressure impulse that emulates a cough or a sneeze may be delivered via a manual pump as shown in Figure 1, or via other sources such as an air compressor or a pressurized air canister. The air capacity of the pump is 500*ml*, which is comparable to the lower end of the total volume expelled during a cough[54]. We note that the setup here emulates a simplified representation of an actual cough, which is an extremely complex and dynamic problem[55]. We use a recreational fog/smoke machine to generate tracer particles for visualizing the expelled respiratory jets, using a liquid mixture of distilled water (4 parts) and glycerin (1 part). Both the pressure- and smoke-sources were connected to the manikin using clear vinyl tubing and NPT fittings wherever necessary.

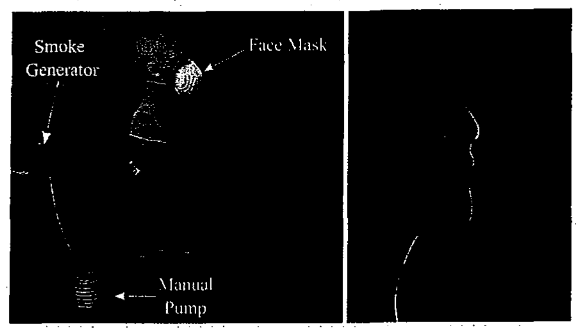


FIG. 1: Left - Experimental setup for qualitative visualization of emulated coughs and sneezes. Right - A laser sheet illuminates a puff emerging from the mouth.

The resulting 'fog' or 'smoke' is visible in the right panel of Figure 1, and is composed of microscopic droplets of the vaporized liquid mixture. These are comparable in size to the smallest droplets expelled in a cough jet (approximately $1\mu m$ to $10\mu m$). We estimate that the fog droplets are less than $10\mu m$ in diameter, based on Stokes' law and our observation that they could remain suspended for up to 3 minutes in completely still air with no perceptible settling. The laser source used to generate the visualization sheet is an off-the-shelf $5mW$ green laser pointer with a $532nm$ wavelength. A plane vertical sheet is created by passing the laser beam through a thin cylindrical rod (diameter $5mm$) made of borosilicate glass.

We first present visualization results from an emulation of an uncovered heavy cough. The spatial and temporal evolution of the resulting jet is shown in Figure 2. The aerosolized microscopic droplets visible in the laser sheet act as tracer particles, revealing a 2-dimensional cross section of the conical turbulent jet. These tracers depict the fate of the smallest ejected droplets, and any resulting nuclei that may form. We observed high variability in droplet dispersal patterns from one experimental run to another, which was caused by otherwise imperceptible changes in the ambient airflow. This highlights the importance of designing ventilation systems that specifically aim to minimize the possibility of cross-infection in a confined setting[23,56–58].

Despite high variability, we consistently observed jets that travelled farther than the 6-foot minimum distance proposed by the U.S. Centers for Disease Control and Prevention[7]. In the images shown in Figure 2, the ejected tracers were observed to travel up to 12 feet within approximately 50 seconds. Moreover, the tracer droplets remained suspended midair for up to 3 minutes in the quiescent environment. These observations, in combination with other recent studies[35,59], suggest that current social-distancing guidelines may need to be updated to account for aerosol-based transmission of pathogens.

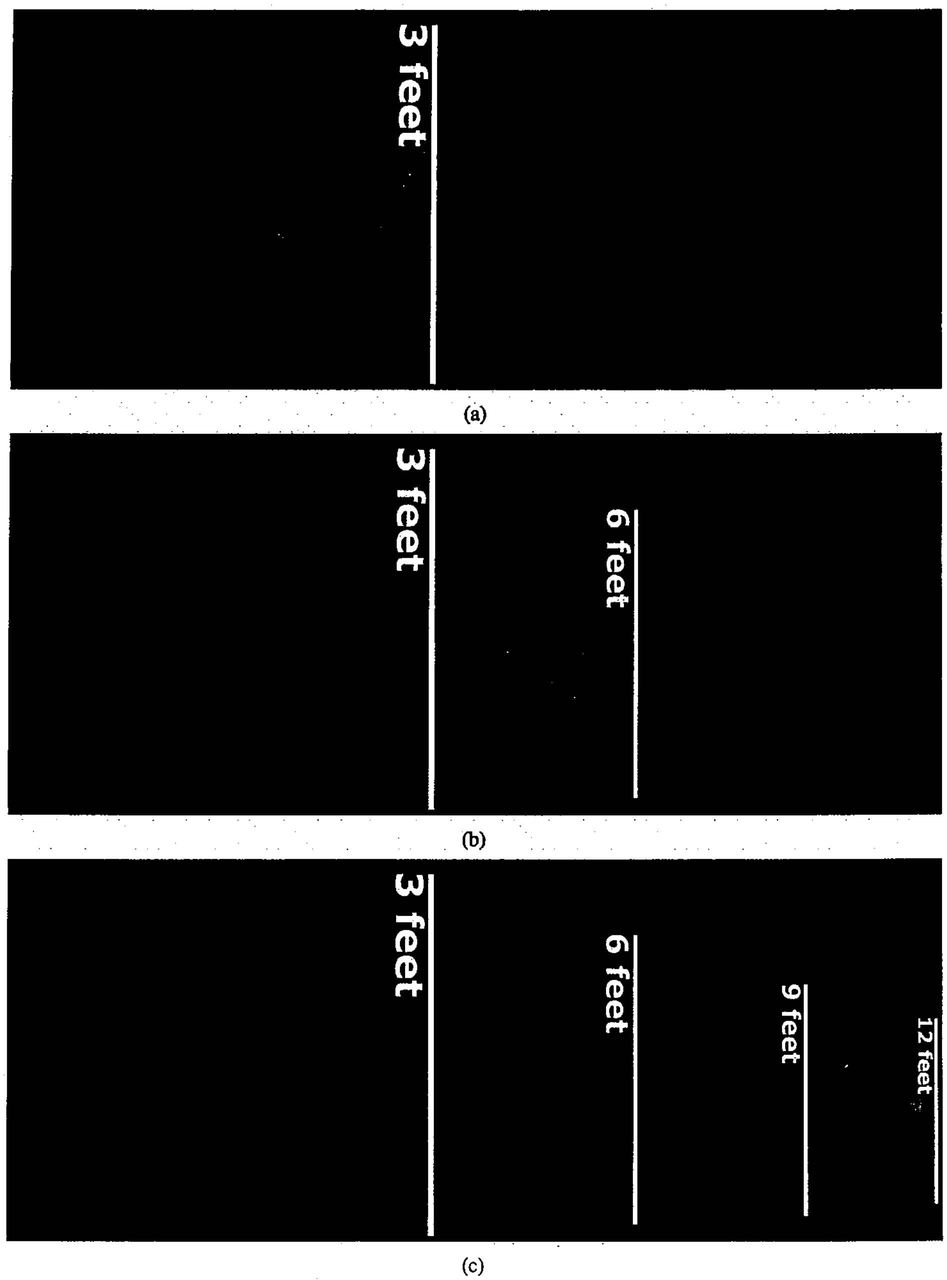


FIG. 2: An emulated heavy cough jet travels up to 12 feet in approximately 50 seconds, which is twice the CDC's recommended distancing guideline of 6 feet[7]. (a) 2.3 seconds after initiation of the emulated cough (b) 11 seconds (c) 53 seconds.

We note that although the unobstructed turbulent jets were observed to travel up to 12 feet, a large majority of the ejected droplets will fall to the ground by this point. Importantly, both the number and concentration of the droplets will decrease with increasing distance[59], which is the fundamental rationale behind social-distancing.

We now discuss dispersal patterns observed when the mouth opening was blocked using three different types of face masks. For these results, we focus on masks that are readily accessible to the general public, and which do not draw away from the supply of medical-grade masks and respirators for healthcare workers. Figure 3 shows the impact of using a folded cotton handkerchief mask on the expelled respiratory jet. The folded mask was constructed by following instructions recommended by the U.S. Surgeon General[60]. It is evident that while the forward motion of the jet is impeded significantly, there is notable leakage of tracer droplets through the mask material. We also observe a small amount of tracers escaping from the top edge of the mask, where gaps exist between the nose and the cloth material. These droplets remained suspended in the air until they were dispersed by ambient disturbances. In addition to the folded handkerchief mask discussed here, we tested a single-layer bandana-style covering (not shown) which proved to be substantially less effective in stopping the jet and the tracer droplets.

We now examine a homemade mask that was stitched using two-layers of cotton quilting fabric consisting of 70 threads per inch. The mask's impact on droplet dispersal is shown in Figure 4. We observe that the mask is able to arrest the forward motion of the tracer droplets almost completely. There is minimal forward leakage through the material, and most of the tracer-escape happens from the gap between the nose and the mask along the top edge. The forward distance covered by the leaked jet is less than 3 inches in this case. The final mask design that we tested was a non sterile cone-style mask that is available in most pharmacies. The corresponding droplet-dispersal visualizations are shown in Figure 5, which indicate that the flow is impeded significantly compared to Figure 2 and Figure 3. However, there is noticeable leakage from gaps along the top edge. The forward distance coverd by the leaked jet is approximately 6 inches from the mouth opening, which is farther than the distance for the stitched mask in Figure 4.

A summary of the various scenarios examined in this study is provided in Table I, along with details about the mask material and the average distances travelled by the respiratory jets. We observe that a single-layer bandana-style covering can reduce the range of the expelled jet to some extent, compared to an uncovered cough. Importantly, both the material and construction technique have a notable impact on the masks' stopping-capability. The stitched mask made of quilting cotton was observed to be the most effective, followed by the commercial mask, the folded handkerchief, and finally, the bandana. Importantly, our observations suggest that a higher thread count by itself is not sufficient to guarantee better stopping-capability; the bandana covering, which has the highest thread count among all the cloth masks tested, turned out to be the least effective.

We note that it is likely that healthcare professionals trained properly in the use of high-quality fitted masks will not experience leakage to the extent that we have observed in this study. However, leakage remains a likely issue for members of the general public who often rely on loose-fitting homemade masks. Additionally, the masks may get saturated after prolonged use, which might also influence their filtration capability. We reiterate that although the non-medical masks tested in this study experienced varying degrees of flow leakage, they are likely to be effective in stopping larger respiratory droplets.

In addition to providing an initial indication of the effectiveness of protective equipment, the visuals used in this study can help convey to the general public the rationale behind social-distancing guidelines and recommendations for using face masks. Promoting widespread awareness of effective preventative measures is crucial, given the high likelihood of a resurgence of COVID-19 infections in the fall and winter.

## DATA AVAILABILITY

The data that supports the findings of this study is available within the article.

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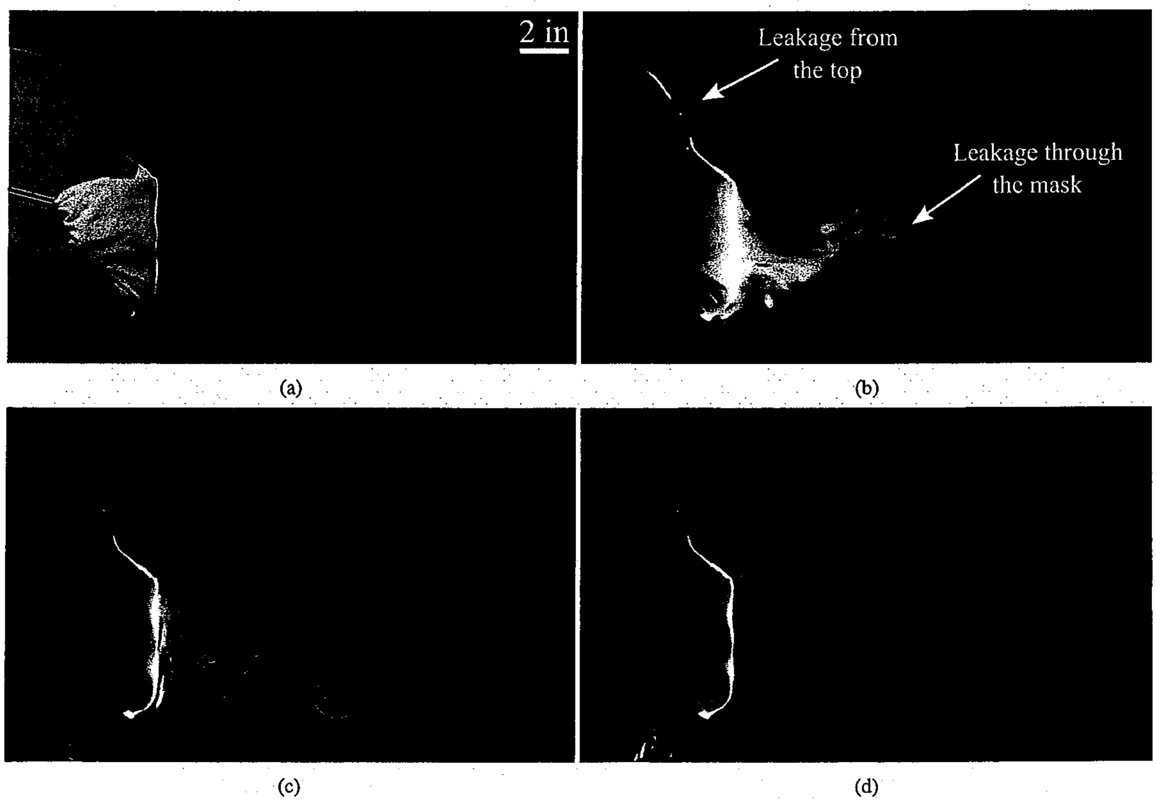


FIG. 3: (a) A face mask constructed using a folded handkerchief. (b) 0.5 seconds after initiation of the emulated cough (c) 2.27 seconds (d) 5.55 seconds.

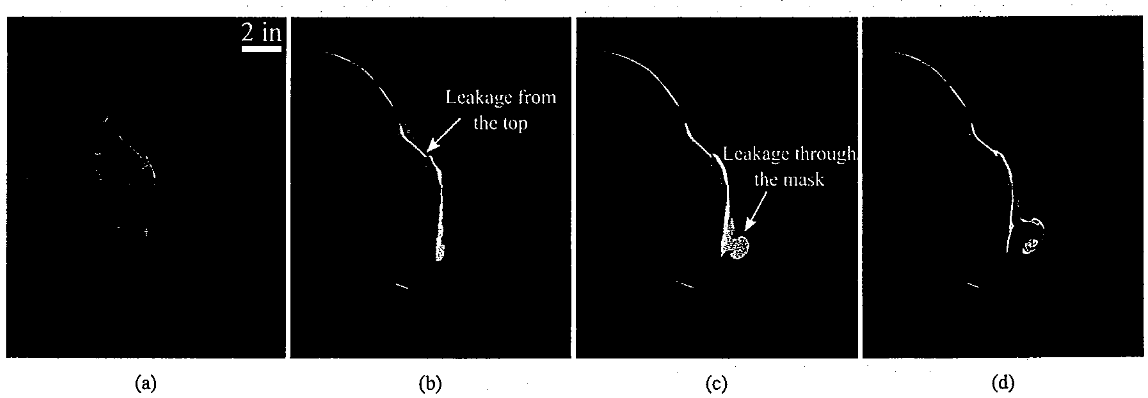


FIG. 4: (a) A homemade face mask stitched using two-layers of cotton quilting fabric. (b) 0.2 seconds after initiation of the emulated cough (c) 0.47 seconds (d) 1.68 seconds.

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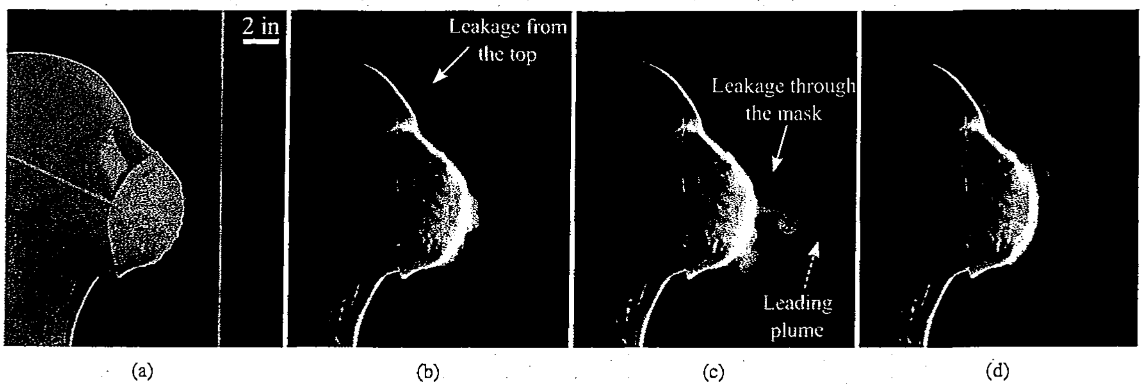


FIG. 5: (a) An off-the-shelf cone style mask. (b) 0.2 seconds after initiation of the emulated cough (c) 0.97 seconds. The leading plume, which has dissipated considerably, is faintly visible. (d) 3.7 seconds.

TABLE I: A summary of the different types of masks tested, the materials they are made of, and their effectiveness in impeding droplet-dispersal. The last column indicates the distance travelled by the jet beyond which its forward progression stops. The average distances have been computed over multiple runs, and the symbol '∼' is used to indicate the presence of high variability in the first two scenarios listed.

| Mask type | Material | Threads per inch | Average jet distance |
|---|---|---|---|
| Uncovered | — | — | ∼ 8 feet |
| Bandana | Elastic T-shirt material | 85 | ∼3 feet 7 inches |
| Folded handkerchief | Cotton | 55 | 1 foot 3 inches |
| Stitched mask | Quilting cotton | 70 | 2.5 inches |
| Commercial mask[a] | Unknown | Randomly assorted fibers | 8 inches |

[a] CVS Cone Face Mask

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## 16-405. City council; ordinances; style; publication; emergency ordinances.

The style of ordinances of a city of the first class shall be: "Be it ordained by the mayor and city council of the city of ................," and all ordinances of a general nature shall, within fifteen days after they are passed, be published in a legal newspaper in or of general circulation within the city, or in pamphlet form, to be distributed or sold, as may be provided by ordinance. Every ordinance fixing a penalty or forfeiture for its violation shall, before the ordinance takes effect, be published for at least one week in the manner prescribed in this section. In cases of riots, infectious diseases, or other impending danger, or any other emergency requiring its immediate operation, such ordinance shall take effect upon the proclamation of the mayor immediately upon its first publication as provided in this section.

**Source:** Laws 1901, c. 18, § 47, p. 245; R.S.1913, § 4898; C.S.1922, § 4066; C.S.1929, § 16-405; R.S.1943, § 16-405; Laws 1971, LB 282, § 1; Laws 2016, LB704, § 74; Laws 2019, LB194, § 26.

**Annotations**

Publication in one regular issue of a legal newspaper in any week was sufficient notwithstanding this section and home rule charter. Skag-Way Department Stores, Inc. v. City of Grand Island, 176 Neb. 169, 125 N.W.2d 529 (1964).

One insertion in a daily paper does not meet the requirement of statute, since a publication must be continued in each issue thereof for a week. Union Pacific Railway Co. v. McNally, 54 Neb. 112, 74 N.W. 390 (1898); Union Pacific Railway Co. v. Montgomery, 49 Neb. 429, 68 N.W. 619 (1896).

One publication is sufficient if in weekly paper. State ex rel. Hahn v. Hardy, 7 Neb. 377 (1878).