Summaries of Mask studies

Introduction: Here we provide an extensive summary of **peer-reviewed** literature as well as quotes from medical professionals on the effectiveness of face masks against viruses, as well as potential health concerns that could arise from improper face mask use. We also note where studies are flawed by making our own comments in [brackets].

Update: Studies published prior to 2020 did not include SARS-CoV2, since it was a presumably new virus, yet it is not significantly different in size or biologic properties so the earlier studies are very relevant. This report has since been updated with studies from 2020, which do focus on COVID19.

Scientific literature examining the effectiveness of face masks of various types against SARS-CoV-2 and other viruses

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4420971/

A cluster randomised trial of cloth masks compared with medical masks in healthcare workers

Moisture retention, reuse of cloth masks and poor filtration may result in increased risk of infection. Cloth masks should not be recommended for health care workers, particularly in high-risk settings such as emergency, infectious disease, respiratory disease and intensive care wards.

https://pubmed.ncbi.nlm.nih.gov/31479137/

N95 Respirators vs Medical Masks for Preventing Influenza Among Health Care Personnel: A Randomized Clinical Trial

In this pragmatic, cluster randomized trial that involved multiple outpatient sites at 7 health care delivery systems across a wide geographic area over 4 seasons of peak viral respiratory illness, there was no significant difference between the effectiveness of N95 respirators and medical masks in preventing laboratory-confirmed influenza among participants routinely exposed to respiratory illnesses in the workplace. In addition, there were no significant differences between N95 respirators and medical masks in the rates of acute respiratory illness, laboratory-detected respiratory infections, laboratory-confirmed respiratory illness, and influenza like illness among participants (including coronaviruses). A sensitivity analysis suggested that the primary analysis reported was fairly robust to the missing outcome data with quantitative outcomes varying by less than 5%. This supports the finding that neither N95 respirators nor medical masks were more effective in preventing laboratory-confirmed influenza or other viral respiratory infection or illness among participants when worn in a fashion consistent with current US clinical practice.

https://pubmed.ncbi.nlm.nih.gov/26952529/

Effectiveness of N95 Respirators Versus Surgical Masks in Protecting Health Care Workers From Acute Respiratory Infection: A Systematic Review and Meta-Analysis

A meta-analysis of several published studies to look at comparing N95 respirators and surgical masks for the prevention of transmissible acute respiratory infections in a hospital setting and also surrogate exposure studies to detect leakage and penetration from the masks were done. Although N95 respirators appeared to have a protective advantage over surgical masks in laboratory settings, the meta-analysis showed that there were insufficient data to determine definitively whether N95 respirators are superior to surgical masks in protecting health care workers against transmissible acute respiratory infections in clinical settings. The clinical significance was further put into question by the wide 95% CI of the data used in the meta-analysis. The potential harm or negative effects of using respirators and masks were also excluded from the study. The surrogate studies showed that the N95 masks were superior to surgical masks when it came to droplet penetration and leakage but the effects were not statistically significant to prevent infection.

https://pubmed.ncbi.nlm.nih.gov/20584862/

Simple Respiratory Protection--Evaluation of the Filtration Performance of Cloth Masks and Common Fabric Materials Against 20-1000 Nm Size Particles

Testing filtration performance against virus nano sized particles using various cloth materials were tested against N95 masks. After using two different face velocities, the results showed a range of 40-90% instantaneous penetration in all fabrics tested. Aerosol particles were much higher than the penetration for N95 respirator filter. Conclusions of results indicate fabric masks of any type provide marginal protection including virus particles.

https://www.nature.com/articles/s41591-020-0843-2?fbclid=IwAR0EA2SwcOc6o5fpnE8EOK4NToCjsMD7y5HQ_TaR5L0J8fUCIGKMNCB7h9M

Respiratory virus shedding in exhaled breath and efficacy of face masks

Surgical masks reduce detection of influenza RNA in respiratory droplets and coronavirus RNA in aerosols from individuals that were diagnosed with those infections. Viral RNA was detected in respiratory droplets from individuals both wearing and not wearing a mask: 30% of coronavirus patients wearing a mask vs 40% of those not wearing a mask, which was not statistically significant. The authors concluded that aerosol transmission is a potential mode of transmission for coronavirus, and that masks could be used by ill people to reduce onward transmission.

https://pubmed.ncbi.nlm.nih.gov/31289698/

Optical Microscopic Study of Surface Morphology and Filtering Efficiency of Face Masks

Authors observe that the pore sizes of cloth masks are substantially larger than the particular matter they are intended to filter. Filtering efficiency was noted to range between 63% and 84% with a 20% decrease in filtering efficiency after the 4th washing and drying cycle.

Surgical mask filter and fit performance.

Masks have been used since the early 1900's to help reduce bacteria spread. The goal of this study was to evaluate the filter performance since the shift has been to use masks as respiratory protection devices.   Filter penetration was measured for at least 3 replicates of 9 surgical masks using monodisperse latex sphere aerosols and facial fit was measured on 20 subjects for the 5 masks. The study concluded that none of these surgical masks exhibited adequate filter performance and facial fit characteristics to be considered respiratory protection devices.

https://pubmed.ncbi.nlm.nih.gov/22188875/

The Use of Masks and Respirators to Prevent Transmission of Influenza: A Systematic Review of the Scientific Evidence

Of 17 eligible studies, mask use appeared to reduce transmission of some viruses in some cases, however study authors note that findings were not conclusive and may not be applicable to all viruses, such as influenza, and that many of the studies were of suboptimal quality. Personal hygiene (washing hands) and correct and consistent usage (uncommon outside medical professionals in medical settings) are most likely the main factors in reducing viral transmission.

https://pubmed.ncbi.nlm.nih.gov/27531371/

Evaluating the Efficacy of Cloth Facemasks in Reducing Particulate Matter Exposure

"Standard N95 mask performance was used as a control to compare the results with cloth masks, and our results suggest that cloth masks are only marginally beneficial in protecting individuals from particles<2.5 μm. Compared with cloth masks, disposable surgical masks are more effective in reducing particulate exposure."

Viruses are 0.004 to 0.1 μm in size or about 100 times smaller than bacteria.

https://www.pnas.org/content/117/26/14857?fbclid=IwAR2lM9ezV4vb26mx8KQydxcirkODYMzaT02VcAbz21Keg8AcXkHcu3yIPo

Identifying airborne transmission as the dominant route for the spread of COVID-19

This study examined the impact of different mitigation strategies (social distancing, mask wearing, etc) implemented in different world governments on changes in epidemic curves. The analysis was based on linear interpolation on the observed epidemic curves. This article makes strong claims about airborne transmission and significant impact of the aforementioned mitigation strategies; in other words, the claim that "masks work". However, this analysis is

biased by an ecological fallacy, that observations made at the population level are appropriate at the individual-level, and disregards any impact of changing treatment modalities, differences in susceptibility by age, and differences over time in other important public health parameters including recovery rate, hospitalization rate, and death rate, all of which declined in many principalities independent of mitigation strategy.

https://arxiv.org/pdf/2004.13553.pdf

Universal Masking is Urgent in the COVID-19 Pandemic: SEIR and Agent Based Models, Empirical Validation, Policy Recommendations

This paper develops an SEIR (susceptible-exposed-infectious-recovered) theoretical transmission model to better understand the impact of wearing masks. As with many theoretical models, the parameter estimates were based on hypothesized values not rooted in actual data. A few papers were cited that said masks were effective, but the authors did not describe how these few reports led to their parameter estimates. A "validation study" compared the "degree of success in managing COVID-19" by countries and provinces with different "masking cultures"; [such an analysis is prone to ecological fallacy and confounding]. While this paper makes strong recommendations for universal masking, it is based on strong underlying assumptions.

https://www.researchgate.net/publication/342198360_Association_of_country-wide_coronavirus_mortality_with_demographics_testing_lockdowns_and_public_wearing_of_masks_Update_June_15_2020

Association of country-wide coronavirus mortality with demographics, testing, lockdowns, and public wearing of masks (Update June 15, 2020)

This presents an ecological analysis, examining the association between country-level coronavirus mortality and several population-level factors. In multivariable analyses, lockdowns and per-capita mask wearing were associated with lower mortality, though importantly, neither were statistically significant.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6482848/

Assessment of influenza virus exposure and recovery from contaminated surgical masks and N95 respirators

These results also support previous studies that suggest that virus trapped on the outside of facemasks and respirators may pose an indirect contact transmission risk as the healthcare worker doffs these PPE after seeing a patient or continues to wear their PPE for an extended period of time.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6547584/

Contamination by respiratory viruses on outer surface of medical masks used by hospital healthcare workers

Virus positivity was significantly higher in masks samples worn for > 6 h. Respiratory pathogens on the outer surface of the used medical masks may result in self-contamination. The risk is higher with longer duration of mask use (> 6 h). Most of the participants (83.8%, 124/148) reported at least one problem associated with mask use. Commonly reported problems were pressure on face (16.9%, 25/148), breathing difficulty (12.2%, 18/148), discomfort (9.5% 14/148), trouble communicating with the patient (7.4%, 11/148) and headache (6.1%, 9/148).

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6037910/

Surgical masks as source of bacterial contamination during operative procedures

This study provides strong evidence for the identification that surgical masks as source of bacterial contamination during operative procedures, which should be a cause for alarm and attention in the prevention of surgical site infection in clinical practice. The bacterial count on the surface of SMs increased with extended operating times; significant difference was found between the 4- to 6-hour and 0-hour groups. These results demonstrated that the contamination of the SM surface worsens with wearing time extension. We recommend that surgeons should change the mask after each operation, especially those beyond 2 hours.

https://pubmed.ncbi.nlm.nih.gov/32467353/

Reduction of secondary transmission of SARS-CoV-2 in households by face mask use, disinfection and social distancing: a cohort study in Beijing, China

The new study was a retrospective cohort study of 124 households with an index SARSCoV-2 case and 355 uninfected household contacts.   Households in which masks were used by at least one family member (including the index case) prior to the development of symptoms by the index case were associated with decreased risk of incident infections, after adjusting for other hygiene and infection control practices, physical distance to index case, environmental factors, and presence of diarrhea in the index case (adjusted odds ratio 0.21, 95% confidence interval 0.06 to 0.79). There was no association between mask use after illness onset in the index case and risk of SARS-CoV-2 infections in family members. Masks included N95 respirators, surgical masks, or cloth face coverings, and the study did not conduct analyses by specific mask type. The study was susceptible to recall bias; in addition, the analysis used households (rather than exposed individuals) as the unit of analysis and did not analyze mask use by the index case ("source control") separately from mask use by household contacts. The applicability of findings to wearing of masks in public is also uncertain. Therefore, the strength of evidence on masks in community settings for prevention of SARS-CoV-2 infection is insufficient.

*** Summary provided by https://effectivehealthcare.ahrq.gov/sites/default/files/pdf/masks-prevention-covid-surveillance-report.pdf?fbclid=IwAR2Dnd1Lqb2tpB-NJR0A-Ae_SXYeZ2tacqrugyunNAke1ce4hn8FbQgVvUM

https://academic.oup.com/cid/article/65/11/1934/4068747?fbclid=IwAR3JpR7ToJAmsTVqpmoE45TDb95-FUGhOH8hQotemONQfT3Hwfdvdy8lJX0

Effectiveness of Masks and Respirators Against Respiratory Infections in Healthcare Workers: A Systematic Review and Meta-Analysis

Meta-analysis of randomized controlled trials indicated a protective effect of masks and respirators against self-reported clinical respiratory illness (CRI) and influenza-like illness (ILI) in healthcare workers, and the protective effect against laboratory-confirmed viral infections was not statistically significant. N95 respirators conferred superior protection compared to standard face masks against CRI and laboratory-confirmed bacterial, but not viral infections or ILI. Meta-analysis of observational studies provided evidence of a protective effect of masks and N95 respirators against severe acute respiratory syndrome (SARS). The existing evidence is sparse and findings are inconsistent within and across studies, and the studies included in this analysis may have been prone to recall bias.

https://www.cdc.gov/mmwr/volumes/69/wr/mm6936a5.htm

Community and Close Contact Exposures Associated with COVID-19 Among Symptomatic Adults ≥18 Years in 11 Outpatient Health Care Facilities —United States, July 2020

The purpose of this study was to identify risk factors associated with COVID19 in a national survey conducted by the CDC and collaborating hospitals. This study did not find a significant difference in mask wearing behaviors between people who tested positive for COVID19 (N=154) versus those that did not (N=160) (p=0.86). Of the people who tested positive, 70.6% reported "always" wearing a mask, versus]74.2% of those that tested negative. Among those who reported "never" wearing a mask, 3.9% texted positive for COVID19 versus 3.1% who tested negative.

https://pubmed.ncbi.nlm.nih.gov/33205991/

Effectiveness of Adding a Mask Recommendation to Other Public Health Measures to Prevent SARS-CoV-2 Infection in Danish Mask Wearers: A Randomized Controlled Trial

As stated in the title, this was a randomized controlled trial in Denmark to assess whether recommending surgical mask use outside the homereduces wearers' risk for SARS-CoV-2 infection. The primary outcome of SARS-CoV-2 infection was defined as a positive result on an oropharyngeal/nasal swab test for SARS-CoV-2, development of a positive SARS-CoV-2 antibody test result (IgM or IgG) during the study period, or a hospital-based diagnosis of SARS-CoV-2 infection or COVID-19. The study found no significant difference in that composite endpoint between the mask-wearing group and the non-mask wearing group (p=0.38).

https://aip.scitation.org/doi/10.1063/5.0034580

Effects of mask-wearing on the inhalability and deposition of airborne SARS-CoV-2 aerosols in human upper airway

The study looked at the effects of wearing a standard surgical mask on airflow and aerosol dynamics using a computer model and compared it to not wearing a mask. They tried to determine the amount of ambient aerosols through the mask landing on the face and in the respiratory tract. Some of the findings were that wearing a mask significantly slows down

particle flows through the mask and disperses the area of particle spread increasing the amount of aerosols going into the nasal and oral cavity. They also found high concentrations of particles in the mask pleats. Then they go on to say that for a standard 3-layer surgical mask with 65% filtering efficiency all particle sizes are reduced except those between 1-3 microns (which is the size (which means SARS-COV2 is not stopped). Lastly, this article concludes that the same surgical masks should not be worn over a long period of time; as they get older, the flow rates drop and the risk of infection is higher from COVID like particles entering the respiratory area in larger numbers due to higher particle density. In summary, this article provides some evidence that particles may be prevented from entering the airway due to wearing a mask, but also provides evidence that viral particles may not be stopped and that extended mask wearing reduces the effectiveness of the mask.

https://www.medrxiv.org/content/10.1101/2021.05.19.21257467v1

[note, this is a preprint server]

COVID-19 Mitigation Practices and COVID-19 Rates in Schools: Report on Data from Florida, New York and Massachusetts

While staff COVID19 rates were higher in areas without mask mandates, this difference was no longer statistically significant after adjusting for community-level COVID-19 rates. There was no difference in student COVID19 rates in areas with and without mask mandates. The authors are careful to point out that these analyses do not reflect individual behavior, only the presence of mandates.

https://www.cdc.gov/mmwr/volumes/70/wr/mm7021e1.htm

Mask Use and Ventilation Improvements to Reduce COVID-19 Incidence in Elementary Schools — Georgia, November 16–December 11, 2020

While COVID-19 incidence rates were significantly lower when there were mask requirements for teachers and staff, the rate was not significantly different when masks were required for students. These analyses were adjusted for county-level COVID-19 incidence.

https://www.medrxiv.org/content/10.1101/2021.05.18.21257385v1

[note this is a preprint server]

Mask mandate and use efficacy in state-level COVID-19 containment: A Systematic Review and Meta-Analysis

While 80% of US states implemented mask mandates, COVID-19 case growth varies with time, not as a direct result of mask mandates. Mask mandates are not associated with, nor can be used as a prediction of, state COVID-19 case spread.

Commentaries not using data

https://www.thenewamerican.com/print-magazine/item/35788-should-i-wear-a-face-mask

Should I Wear a Face Mask?

While this is not in a scientific journal, it is written by an environmental, health and safety manager, responsible for respiratory protection. The writer has degrees in engineering/materials science, and pharmacology and toxicology.

First, cloth face masks show only marginal filtration performance against virus-size particles when sealed around the edge. Face seal leakage will further decrease the respiratory protection offered by fabric materials. Thus, cloth masks are not recommended. Second, surgical masks also do not form a seal, which allows for air leakage and thus respiratory droplets. Third, N95 do not provide complete protection against small virions. In addition, training is required for effective PPE use. Frequently touching ones face to adjust an ill-fitting or uncomfortable mask increases the risk of viral exposure. In summary, the general public should not be wearing face mask to lessen viral transmission because of the potential drawbacks.

https://www.cidrap.umn.edu/news-perspective/2020/04/commentary-masks-all-covid-19-not-based-sound-data

COMMENTARY: Masks-for-all for COVID-19 not based on sound data

Masks may give people a false sense of security. The general public who do not have symptoms of COVID-19-like illness should not routinely wear cloth or surgical face masks. There is no scientific evidence that face masks are effective in reducing the risk of SARS-CoV-2 transmission. Cloth masks exhibit very low filter efficiency. Even masks that fit well against the face will not prevent inhalation of small particles by the wearer or emission of small particles from the wearer. Cloth masks offer no protection for healthcare workers inhaling infectious particles near an infected or confirmed patient.

https://www.nejm.org/doi/10.1056/NEJMp2006372?fbclid=IwAR0KybFx09FFIuFX6xfLeX38eWizRW8Y8kcwKtu9UVdtxGe2M4AeQ9owT5Y

Universal Masking in Hospitals in the Covid-19 Era

Universal masking of the public offers little, if any protection and is mostly a knee jerk reaction to fear and anxiety over the virus. Universal masking of hospital personnel offers very little protection and must be used in conjunction with other meticulous measures as outlined below. It could actually lead to more infections if the other measures are not followed since people wearing masks have a tendency to touch their face more often.

Quoting directly from the New England Journal of Medicine:

"We know that wearing a mask outside health care facilities offers little, if any, protection from infection. Public health authorities define a significant exposure to Covid-19 as face-to-face contact within 6 feet with a patient with symptomatic Covid-19 that is sustained for at least a few minutes (and some say more than 10 minutes or even 30 minutes). The chance of catching Covid-19 from a passing interaction in a public space is therefore minimal. In many cases, the desire for widespread masking is a reflexive reaction to anxiety over the pandemic."

In hospital settings where Covid-19 infections are present, the article states, "A mask alone in this setting will reduce risk only slightly, however, since it does not provide protection from droplets that may enter the eyes or from fomites on the patient or in the environment that providers may pick up on their hands and carry to their mucous membranes (particularly given the concern that mask wearers may have an increased tendency to touch their faces)….What is clear, however, is that universal masking alone is not a panacea. A mask will not protect providers caring for a patient with active Covid-19 if it's not accompanied by meticulous hand hygiene, eye protection, gloves, and a gown. A mask alone will not prevent health care workers with early Covid-19 from contaminating their hands and spreading the virus to patients and colleagues. Focusing on universal masking alone may, paradoxically, lead to more transmission of Covid-19 if it diverts attention from implementing more fundamental infection-control measures."

https://www.nejm.org/doi/full/10.1056/NEJMc2020836

Universal Masking in the Covid-19 Era

This letter was a response to the letter cited above. It is interesting that in the original article, the authors state that is "unclear to what extent transmission from asymptomatic individuals contributed to the spread of infection", but in this article, they say that asymptomatic or presymptomatic individuals may be "highly contagious".   Here, the authors emphasize the importance of masks for passing encounters in public spaces, then say that the risk of SARS-CoV-2 transmission is strongly correlated with intensity and duration of contact [though "passing encounters" are not intense or of long duration]. The authors close by saying they "support the calls of public health agencies for all people to wear masks when circumstances compel them to be within 6 ft of others for sustained periods."

https://pubmed.ncbi.nlm.nih.gov/32532940/

Comprehensive Review of Mask Utility and Challenges During the COVID-19 Pandemic

The paper discusses the universal masking strategy and challenges faced during COVID-19. Symptomatic patients who wore cloth or surgical masks were seen to not filter out SARS-COV2 during coughing. In one study more contamination was found outside the mask than on the inside owing to the masks' aerodynamic properties. Universal masking may also give a false impression of protection and may result in increased face touching leading to more contamination.

Furthermore, even the most effective mask is useless if not worn correctly or fitted properly. Though healthcare workers may feel falsely safe or protected while wearing a mask (particularly loose-fitting industrial masks), minimal air leakage, regular fit-testing and seal checks with N95 respirators are of paramount importance. The authors conclude that masking alone is not sufficient to stop the spread of COVID-19 and other non-pharmacological interventions such as social distancing, quarantining/isolation, and diligent hand hygiene must be coupled with mask wearing for better outcomes.

A possible solution to alleviate mask shortages that might arise due to universal mask wearing is to modify the mask policy to stagger the requirement based on the severity of community transmission in each particular area of residence.

https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(20)30134-X/fulltext?fbclid=IwAR2qZ-vJyCjKoQnrFahQmg86bKF3zizujsAQUEkZOdgcI-dlq9M999n5jZw

Rational use of face masks in the COVID-19 pandemic

(The following are direct quotes from the paper.)

"Evidence that face masks can provide effective protection against respiratory infections in the community is scarce, as acknowledged in recommendations from the UK and Germany.... It would be reasonable to suggest vulnerable individuals avoid crowded areas and use surgical face masks rationally when exposed to high-risk areas. As evidence suggests COVID-19 could be transmitted before symptom onset, community transmission might be reduced if everyone, including people who have been infected but are asymptomatic and contagious, wear face masks.... One advantage of universal use of face masks is that it prevents discrimination of individuals who wear masks when unwell because everybody is wearing a mask.... WHO currently recommends that people should wear face masks if they have respiratory symptoms or if they are caring for somebody with symptoms. Perhaps it would also be rational to recommend that people in quarantine wear face masks if they need to leave home for any reason, to prevent potential asymptomatic or presymptomatic transmission. In addition, vulnerable populations, such as older adults and those with underlying medical conditions, should wear face masks if available. Universal use of face masks could be considered if supplies permit."

Health concerns associated with wearing face masks

https://pubmed.ncbi.nlm.nih.gov/18500410/

Preliminary Report on Surgical Mask Induced Deoxygenation During Major Surgery

"Our study revealed a decrease in the oxygen saturation of arterial pulsations (SpO2) and a slight increase in pulse rates compared to preoperative values in all surgeon groups. The decrease was more prominent in the surgeons aged over 35."

"Oxygen saturation of hemoglobin decreased significantly after the operations in both age groups ($p<0.0001$). The post operational decrease was more prominent in surgeons over 35 when compared to the surgeons under 35 ($p=0.0073$)"

https://pubmed.ncbi.nlm.nih.gov/15340662/

The Physiological Impact of Wearing an N95 Mask During Hemodialysis as a Precaution Against SARS in Patients With End-Stage Renal Disease

Seventy percent of the patients showed a reduction in partial pressure of oxygen (PaO2), and 19% developed various degrees of hypoxemia. Wearing an N95 mask significantly reduced the

PaO2 level (101.7 +/- 12.6 to 92.7 +/- 15.8 mm Hg, p = 0.006), increased the respiratory rate (16.8 +/- 2.8 to 18.8 +/- 2.7/min, p < 0.001), and increased the occurrence of chest discomfort (3 to 11 patients, p = 0.014) and respiratory distress (1 to 17 patients, p < 0.001)."

https://pubmed.ncbi.nlm.nih.gov/32232837/

Headaches Associated With Personal Protective Equipment - A Cross-Sectional Study Among Frontline Healthcare Workers During COVID-19

Healthcare workers assigned to high risk Covid hospital areas in Singapore were mandated to wear personal protective equipment, so a questionnaire was given to them to determine if increased in headaches were occurring in 158 participants. The study indicates this population wore a mask and goggles greater than 4 hours per day. Out of 158 respondents, 128 (81.0%) respondents developed de novo PPE-associated headaches.

https://pubmed.ncbi.nlm.nih.gov/23514282/

Carbon Dioxide Rebreathing in Respiratory Protective Devices: Influence of Speech and Work Rate in Full-Face Masks

Overall, the results of the study indicate speech and low work rates significantly increase CO2 rebreathing in RPDs. Based on Australian respirator design standards it is evident speech could contribute to inspired CO2 exceeding the maximal allowable concentrations in inspired air…The implication of these findings is that high CO2 concentrations in full face RPDs may be linked to wearer discomfort and contribute to reduced tolerability and wear time of the device. Since many occupations require workers to communicate while wearing RPDs these findings must be taken into consideration.

https://clinicaltrials.gov/ct2/show/NCT00173017

The Physiological Impact of N95 Masks on Medical Staff

Authors of this clinical trial observe that, "Wearing N95 masks results in hypooxygenemia [lowered blood oxygen levels] and hypercapnia [increased blood carbon dioxide levels] which reduce working efficiency and the ability to make correct decision[s]... dizziness, headache, and short[ness] of breath are commonly experienced by the medical staff wearing N95 masks."

https://www.researchsquare.com/article/rs-124394/v1?fbclid=IwAR0vIhyBeph3ZBo084rymYkHpuWqeVnPDvTw6gWtkBADrIxmuz6S4ZD8BA0

Corona children studies "Co-Ki": First results of a Germany-wide registry on mouth and nose covering (mask) in children

This study, in Germany, utilized a registry to allow parents, teachers, and older children to report the effects of wearing masks in children. 17,854 parents answered the survey. Impairments

caused by wearing the mask were reported by 68% of the parents. These included irritability (60%), headache (53%), difficulty concentrating (50%), less happiness (49%), reluctance to go to school/kindergarten (44%), malaise (42%) impaired learning (38%) and drowsiness or fatigue (37%). Other complaints included worsened skin, rashes and allergic reactions, and fungal diseases around the mouth. The authors stated, "it can be said that the effects of compulsory masks on the quality of life and presumably also on the health of individual children should not be ignored by politics and society."

Is a Mask That Covers the Mouth and Nose Free from Undesirable Side Effects in Everyday Use and Free of Potential Hazards?

https://pubmed.ncbi.nlm.nih.gov/33923935/

This study reviewed data from 65 publications regarding the adverse effects of wearing face masks, including some published prior to the COVID-19 pandemic and some during the pandemic. Using regression analysis, they demonstrated a statistically significant correlation between blood-oxygen depletion and fatigue in mask wearers. They also observed common appearance of statistically significant confirmed effects of masks including rise in carbon dioxide, decrease in oxygen saturation, respiratory impairment, headaches, fatigue, increase in pulse rate, drop in blood oxygen partial pressure, and increase in heart rate and respiratory rate. The authors point out that while these issues may seem minor at first, exposure over longer periods of time may lead to long-term disease-relevant consequences.

Media reports including interviews with physicians and scientists

https://www.forbes.com/sites/tarahaelle/2020/04/01/should-everyone-wear-a-mask-in-public-maybe-but-its-complicated/#21f0fcaea02f

Gregory Poland, MD, an infectious disease & vaccine expert at the Mayo Clinic, stated that the mask is an indicator of a constellation of behaviors that collectively reduce transmission. Wearing a mask leads someone to touch their face less often & serves as a constant psychological reminder to do other known infection prevention behaviors, such as frequent, rigorous hand-washing and keeping a good distance from other people.

https://web.archive.org/web/20200302132318/https:/www.cnn.com/2020/03/02/health/surgeon-general-coronavirus-masks-risk-trnd/index.html

America's surgeon general, Jerome Adams, M.D., M.P.H., said in an interview in March that masks can be dangerous is because people tend to touch their masks many times per hour and can spread the disease that way. [The media has reported that Dr. Adams has backtracked on this statement.]

https://www.independent.co.uk/news/health/coronavirus-news-face-masks-increase-risk-infection-doctor-jenny-harries-

Dr. Jennie Harries says that masks could actually "trap the virus" and cause the person wearing it to breathe it in. "For the average member of the public walking down a street, it is not a good idea" to wear a face mask in the hope of preventing infection. "Because of these behavioural issues, people can adversely put themselves at more risk than less."

Dr. Jake Dunning said "Face masks must be worn correctly, changed frequently, removed properly, disposed of safely and used in combination with good universal hygiene behaviour in order for them to be effective."

This media article presents the analysis of researchers at RationalGround.com, a clearinghouse of COVID-19 data trends run by a grassroots group of data analysts. Though this is data-driven, because it is not in a scientific journal, we list it here under media reports. They compared states with mandates vs. those without, or periods of times within a state with a mandate vs. without (ecological analysis). In total, in the states that had a mandate in effect, there were 9,605,256 confirmed COVID cases over 5,907 total days, an average of 27 cases per 100,000 per day. When states did not have a statewide order (which includes the states that never had them and the period of time masking states did not have the mandate in place) there were 5,781,716 cases over 5,772 total days, averaging 17 cases per 100,000 people per day. In short, this shows an inverse relationship between mask mandates and case numbers, where the states without mask mandates had a lower daily rate of COVID19 case identification. The data were analyzed in a number of ways to account for various confounding factors, and the conclusion remained the same.