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A Clinical Review of the Efficacy of Masks in Preventing Spread of SARS-CoV-2

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Abstract

Introduction:

The COVID-19 pandemic, caused by SARS-CoV-2, has sparked debate over the effectiveness of masks in reducing viral transmission. This clinical review aims to evaluate the efficacy of cloth masks, medical masks, and N95 respirators in preventing COVID-19 transmission.

Methods:

A literature search was conducted on PubMed for articles published between January 2020 and August 2024. Out of 27 screened articles, 5 met the inclusion criteria, focusing on mask efficacy in preventing SARS-CoV-2 transmission.

Results:

Of the 5 studies included, three were systemic reviews, one was a metanalysis and one was a systemic review and meta-analysis. The largest meta-analysis included 78 RCTs and was inconclusive on mask efficacy. However, one systemic review of 35 studies suggested that masks could reduce viral transmission by up to 80% in healthcare settings.

Discussion:

The included studies showed mixed results regarding mask efficacy, with some suggesting no significant difference between mask types in preventing respiratory illness. The conflicting evidence highlights the need for more high-quality RCTs and research specifically targeting SARS-CoV-2. Future research should prioritize studies that assess mask effectiveness in diverse settings to guide public health strategies.

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INTRODUCTION

The global outbreak of COVID-19, caused by the novel coronavirus SARS-CoV-2, began in 2020, and quickly became a worldwide pandemic. With no effective treatment initially available, the primary focus shifted to public health measures aimed at reducing viral transmission. Among these measures, the use of face masks has been both widely implemented and widely debated. This clinical review aims to evaluate the efficacy of clot masks, medical masks, and N95 respirators in preventing the transmission of SARS-CoV-2.[1]

SARS-CoV-2 is a respiratory virus, with its particles ranging in size from 0.07 to 0.09 microns (μm).[2] To effectively block the virus, a mask must be capable of filtering particles of this size or smaller. Transmission of the virus occurs primarily through respiratory droplets and aerosols, which are much larger than the virus itself, with aerosol particles typically ranging from 0.35 to 9 μm.[3] Understanding the aerosol transmission route is essential to appreciating why masks are thought to reduce the spread of the virus.

R-naught (R_0) is important metric used to understand viral transmission is the basic reproduction number. R_0 represents the average number of secondary infections produced by one infected individual in a susceptible population.[4] For SARS-CoV-2, the R_0 is estimated to be around 2.5, meaning each infected person can, on average, spread the virus to 2.5 other persons.[4] In order to reduce the transmission to below one person per infected individual the effective reproduction number (Re) must reduce transmission by more than 60%. Lowering the Re below 1 is crucial for controlling the spread of the virus.[5]

By reducing the number of virus-containing particles a person inhales or exhales, masks can potentially reduce the viral load. This review will focus on three main types of masks: cloth masks, medical (surgical) masks, and N95 respirators.[6,7] Cloth masks are typically made from household materials, and their effectiveness varies depending on fabric type, weave, and layer count. Surgical masks are primarily designed to protect the wearer from large droplets, splashes, and sprays, but they offer limited protection against airborne viruses due to their relatively poor filtration efficiency for smaller particles.[6,8] N95 respirators, regulated by the National Institute for Occupational Safety and Health (NIOSH), must filter at least 95% of particles larger than 0.3 μm.[6,9]

This review will seek to summarize the current literature and provide conclusions about the role of masks in preventing the transmission of SARS-CoV-2.

METHODS

A search was conducted via PubMed using the keywords "mask" AND "spread" AND "covid-19" AND "sars-cov-2" to produce the search resulting in 710 articles. The search was then limited to articles published between January 1, 2020, and August 1st, 2024. Filters for free full text, and human participant were applied. The final search was "mask" AND "spread" AND "covid-19" AND "sars-cov-2" with the full free text and human participant filters applied. This resulted in 27 articles being searched. Out of the 27 articles five were selected, these articles were chosen after excluding two articles that were duplicates, 16 that did not include mask vs non mask to reduce transmission, and four did not include SARS-CoV-2 specifically.

RESULTS

Jefferson T et al.[10] conducted a meta-analysis of 78 RCTs with 610,872 participants. The search was conducted on CENTRAL, PubMed, Embase, and CINAHL. The selection criteria included RCTs and cluster-RCTs. The data analysis was done via standard Cochrane methodological procedures.[10] Several of the included studies were conducted during the 2009 H1N1 pandemic and other influenza epidmics.[10] These studies were included as a comparison to the studies focused on SARS-CoV-2. 12 trials compared medical masks to no mask to prevent viral spread with 276,9217 total participants. The outcome, prevention of spread, showed no difference between the medical mask or no mask groups when looking at laboratory confirmed influenza or SARS-cov-2 as the endpoint (RR 1.01, 95% CI 0.72 to 1.42).[10] Three trials included 7779 participants and compared N95 masks to medical masks and found no difference in efficacies in preventing clinical respiratory illness (RR 0.70, 95% CI 0.45 to 1.10).[10] The N95/P2 respirator was compared to medical masks on reducing clinical respiratory illness and showed no difference (RR 0.70, 95% CI 0.45 to 1.10).[10] When comparing N95/P2 respirators vs medical masks on the outcome of laboratory-confirmed influenza infection there was no statistically significant difference in the efficacy of the masks (RR 1.10, 95% CI 0.90 to 1.34).[10]

Coclite D et al.[11] conducted a systematic review which included 35 studies, including three RCTs, 10 comparative studies, 13 predictive model studies, and nine laboratory experimental studies.[11] The search used MEDLINE, EMBASE, SCISEARCH and The Cochrane Library. The search terms included masks, diverse types of mask material, mortality, infection rate and filtration capacity of masks.[11] The data was reviewed by two reviewers and was assessed using the Newcastle-Ottawa scale and Cochrane Risk of Bias tools for RCTs. The three cluster RCTs found non-significant reduction in infection of H1N1 virus in groups wearing a mask vs no

mask (RR 0.97, 95% CI 0.72–1.31, I^2 = 62%).[11] In 10 observational studies the level of certainty of evidence was very low with no statistically significant effect and high heterogeneity in groups wearing a mask vs no mask (OR 0.90, 95% CI 0.74–1.10, I^2 = 74%).[11] Sensitivity analysis was performed to further determine if there was any difference due to special settings of certain studies. Case controlled studies then showed statistically significant effect with low heterogeneity (OR 0.46, 95% CI 0.34–0.62, I^2 = 47%).[11]

The systematic review by Ataei M et al.[12] involved two reviewers to conduct a search of PubMed, Scopus, and Web of Science.[12] The search terms included mask, fabric masks, textile to name a few.[12] There were no restrictions on year or language of the articles searched.[12] The primary outcome was the effectiveness of cloth masks in reducing the spread of respiratory particles.[12] Secondary outcomes included comparison of cloth masks with other mask types and the impact of various cloth mask designs and materials on particle filtration.[12] The three RCTs used sodium chloride particles to examine the filtration efficacy (FE) in various materials.[12] Hybrid cotton mask material had a 97% FE for particles sized 60-100nm. The cotton quilt material with 120 threads per inch achieved 96% FE for particles sized 60-100nm. hybrid of cotton/silk (No Gap): 94% FE, hybrid of Cotton/Flannel: 95% FE. The 2-Ply 100% cotton mask showed a 77% FE for 10–1000 nm particles.[12] Cloth mask with exhalation valve achieved a 90% FE for 100 nm particles. The N95 respirator achieved a 95% FE for particles of 0.3 microns and higher.[12] The quality of evidence varied, with experimental studies providing higher-quality data compared to observational studies. The review noted significant heterogeneity in study designs, making it difficult to draw definitive conclusions about the overall effectiveness of cloth masks. Cloth masks showed lower filtration efficiency (FE) compared to surgical masks and N95 respirators.[12]

Camargo MC et al.[13] Conducted a rapid systematic review. The reviewers searched Medline/PubMed, Embase, Cinahl, The Cochrane Library and Trip Database for articles, their search included systematic reviews, meta-analysis, clinical trials, and randomized trails. The inclusion criteria required systematic reviews, meta-analysis clinical trials, and specifically non-woven facemasks vs no mask.[13] Exclusion criteria included studies evaluating healthcare workers, N95, surgical masks or any editorials or opinion studies.[13] A total of three studies, one of which is a cluster RCT and two were systematic reviews. The RCT only evaluated influenza in close contact to an infected person with a total of 245 participants. The intention to treat analysis and relative risk ratio for clinical diagnosis of respiratory infection when comparing mask use with non-mask use was (RR 0.61, 95% CI 0.18 - 2.13). In prevention of influenza like illness in masks use vs non-mask use there was no statistically significant difference (RR 0.32, 95% CI 0.03 - 3.13).[13] When laboratory-confirmed infection was the end point in masks use vs non-mask use it was not statistically significant (RR 0.97, 95% CI0.06 - 15.54).[13] The systematic review included 8,686 subjects from 21 studies. There was a statistically significant reduction of viral respiratory infection in the mask group vs non-mask (OR = 0.35.95% CI = 0.24-0.51, I^2 = 60) and in healthcare workers specifically it was 20% lower in mask group vs non-mask (OR = 0.20. 95% CI = 0.11-0.37, I^2 = 59%).[13] Looking at COVID-19 specifically the risk reduction was 4% in mask group vs non-mask (OR = 0.04. 95% CI = 0.00-0.60).[13]

The meta-analysis and systematic review by Liang M et al.[14] involved two reviewers which searched multiple data bases including PubMed, Web of Science, Cochrane Library, and Chinese National Knowledge Infrastructure (CNKI), VIP (Chinese) database.[14] The inclusion criteria focused on the relationship between face masks and preventing respiratory infections.[14] The studies needed to be large scale and not abstracts, case reports or editorials. A total of 21

studies were found with 13 case control studies, six cluster randomized trials and two cohort studies.[14] Only one of the studies was on SARS-Cov-2 specifically, others were older and looked at MERS or H1N1. The results found that in the 8,686 participants of the 21 studies there was a statistically significant reduction in risk of contracting respiratory infection with the pooled OR (OR 0.35 and 95% CI = 0.24–0.51).[14] When looking at healthcare workers vs non-healthcare workers there was a larger effect with the OR of 0.20 (95% CI = 0.11–0.37, I^2 = 59%) for all virus types and when looking at SARS-CoV-2 the OR was 0.04 (95%CI = 0.00–0.60).[14] There was not a difference between Asian or Western countries.[12]

DISCUSSION

The articles reviewed suggest that while there is evidence supporting the use of face masks in reducing the spread of respiratory viruses, including SARS-CoV-2, the literature remains inconsistent and lacks robust data specific to the virus. While some studies suggest a modest benefit, others indicate little to no effect. For instance, Jefferson et al.[10] included the most robust dataset, analyzing 78 RCTs with 610,872 participants. However, even with this large dataset, few trials specifically addressed SARS-CoV-2. Moreover, the combination of masking and hand hygiene interventions showed no statistical significance, although one trial on hand hygiene alone did. This variability in outcomes makes it increasingly difficult to draw solid conclusions about the efficacy of masks.

Ataei M et al.[12] found that cloth masks, medical masks, and N95 respirators are able to filter particles that are in the same rage of the SARS-CoV-2 but to various efficacies. The review was limited by the fact that sodium chloride was used as the test particle and there is not an established link in filtration ability of sodium chloride and viral particles.[12]

Liang et al.[14] found lower infection rates associated with mask use, although most included studies evaluated other viruses, and only one study focused specifically on SARS-CoV-2. Of the studies reviewed by Liang et al.,[14] only six were randomized controlled trials (RCTs), involving 8,686 participants, which limits the ability to generalize these findings to a larger population.

The review by Camargo et al.[13] included 3 RCTs found no difference in masks vs non-mask when looking at prevention of laboratory confirmed influenza or influenza like illness. When looking specifically at reduction of SARS-CoV-2 infection reduction they found a 4% reduction of in the mask group vs non-mask group.[13]

The inconsistent results across these studies raise important questions about the role of masks in public health strategies, particularly in community settings. One significant limitation in the existing literature is the potential bias present in studies. Many rely on self-reported data, predictive models, or observational designs, which inherently introduce uncertainty. Coclite et al.[11] after reviewing over 600 articles, found three RCTs. Their final review included predictive models, laboratory studies, cross-sectional studies, and case-control studies, which further highlights the lack of RCTs during the global health crisis. Coclite et al.[11] were unable to draw a conclusion on COVID-19 infection reduction with mask use in the community setting due to lack of RCT data.[11] The use of facemasks results in a reduction of at least 2.0% and up to 99% depending on the scenario and mask type according to the data.[11] Reliance on older studies, such as those conducted during the H1N1 epidemic, may add another limitation to the applicability of findings in the context of SARS-CoV-2, as Coclite et al.[11] note.

Future research should aim for ethical high-quality studies that balance the need for rigor with ethical considerations. While RCTs are the gold standard, they must be designed to ensure

participant safety. More research should be conducted with cloth masks, medical masks, and N95 respirators specifically for SARS-CoV-2 infection prevention. Future trials should account for factors like fabric type, number of layers, fit, and real-world usage, and they should be conducted in both low-risk community settings and high-risk healthcare environments to gather comprehensive data.

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