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Review

Facemask use in community settings to prevent respiratory infection transmission: A rapid review and meta-analysis



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ABSTRACT

Introduction: Synthesis of the available evidence on the effectiveness of medical and cloth facemask use by the general public in community settings is required to learn lessons for future respiratory epidemics/pandemics.

Method: Search terms relating to facemasks, infection and community settings were used for PubMed, the Cochrane Library Database and Google Scholar. A meta-analysis was conducted using a random-effects model.

Results: The review included 12 primary studies on the effectiveness of medical facemask use to prevent influenza, influenza-like illness, SARS-CoV, and SARS-CoV-2 transmission. The meta-analysis demonstrated that facemask use significantly reduces the risk of transmitting these respiratory infections (pooled OR=0.66, 95% CI 0.54–0.81). Of the 12 studies, 10 clinical trials suggested that respiratory infection incidence is lower with high medical facemask compliance, early use and use in combination with intensive hand hygiene. One cohort study conducted during the SARS-CoV-2 pandemic demonstrated that facemasks are effective in reducing SARS-CoV-2 transmission when used before those who are infected develop symptoms. One case-control study reported that controls used medical facemasks more often than cases infected with SARS-CoV ($p < 0.05$). No primary study on cloth facemask effectiveness to prevent respiratory infection transmission was found.

Conclusion: Based on the available evidence, medical facemask use by healthy and sick individuals is recommended for preventing respiratory infection transmission in community settings. Medical facemask effectiveness is dependent on compliance and utilization in combination with preventive measures such as intensive hand hygiene. No direct evidence is currently available in humans supporting the recommendation of cloth facemask use to prevent respiratory infection transmission.

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Introduction

Respiratory infections can be caused by many viruses such as influenza and coronavirus. If a novel virus gains the capacity to spread globally with sustained human-to-human transmission, a pandemic can occur (Qatar National Cancer Registry). Influenza epidemics are happening every year. In the past, several influenza pandemics have occurred such as the 1918 pandemic (H1N1 virus), the 1957–1958 pandemic (H2N2 virus), 1968 pandemic (H3N2 virus), and the recent 2009 H1N1 pandemic (H1N1pdm09 virus) (Past Pandemics USA: Centers for Disease Control and Prevention, 2018). Additionally, the SARS-CoV virus pandemic also occurred in 2003. The current coronavirus disease 2019 (COVID-19) pandemic

caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has resulted in societal upheaval worldwide at many different levels. The transmission of SARS-CoV-2 can occur human-to-human through droplets while in close contact (within 1 m) with an infected person. Transmission can also occur via fomites or contaminated surfaces (Canini et al., 2010; Cowling et al., 2009). The transmission of SARS-CoV-2 is similar to the other respiratory viruses associated with previous epidemics/pandemics. Debate continues during the COVID-19 pandemic on the effectiveness of medical and cloth facemask use by the general public in community settings to prevent the transmission of respiratory infections. Respiratory viruses share similarities in their mechanisms of transmission (i.e. large droplet, aerosol or fomite). Since all are transmitted by the respiratory route (MacIntyre et al., 2009), their transmission is likely preventable with similar means.

In general, there are now consistent recommendations by international organizations such as the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC)

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on the mitigation measures (isolation of infected individuals, quarantining close contacts, regular disinfection, physical distancing, hand hygiene (Luan et al., 2020)) to contain respiratory virus spread. However, the recommendation of using facemasks by the general population in community settings – such as public areas, supermarkets, offices, schools, and households – has been inconsistent over time (World Health Organization, 2020). After several months of deliberation since the initiation of the COVID-19 pandemic, the WHO now recommends that “the general public should wear non-medical masks where there is widespread transmission and when physical distancing is difficult, such as on public transport, in shops or in other confined or crowded environments” (World Health Organization, 2020).

Worldwide, three main categories of facial coverings are used to prevent transmission of respiratory infection: respirators, medical facemasks and cloth facemasks (MacIntyre and Chughtai, 2015). Respirators are mainly used in healthcare settings (Gralton and McLaws, 2010). Medical facemasks, also called surgical facemasks, are commonly used in healthcare settings but also in community settings. Medical facemasks are usually worn by healthcare workers (HCWs) to protect themselves from infections transmitted by droplet route and from splashes or sprays of blood and body fluids (World Health Organization (WHO), 2014; MacIntyre et al., 2016). Cloth facemasks are meant to be used by the general population (Gralton and McLaws, 2010), which include cotton and gauze facemasks, can be homemade and are washable and reusable (MacIntyre and Chughtai, 2015).

The current review focused on medical and cloth facemasks. It aimed to inform policymakers and stakeholders by examining and synthesizing available evidence on the effectiveness of cloth and medical facemasks for preventing transmission of respiratory infections in community settings and pointing out the gaps in evidence. It explored the following questions: 1) Are facemasks effective in preventing the transmission of respiratory infections in community settings? 2) Who should wear facemasks: the sick individual (source control), household contacts, both sick individuals and household contacts, or everyone in community settings? 3) Are there differences in the effectiveness of cloth and medical facemask use for preventing transmission of respiratory infections in community settings?

Materials and methods

Eligibility criteria

This review identified primary studies from relevant systematic reviews and primary studies that evaluated the evidence on the effectiveness of facemasks in any community settings (human studies). Relevant primary studies that were included were: clinical trials and observational studies, excluding case series, case reports, and experimental laboratory studies. All types of interventions were included such as source control and mixed interventions, including a combination of hand hygiene and facemask use. Additionally, studies evaluating all types of facemasks (cloth and medical) were included. The type of facemask (medical or cloth) had to be clearly specified in the study methodology. Furthermore, the facemasks must have been used in the context of preventing transmission of any respiratory infection such as influenza, upper respiratory infection, influenza-like illness (ILI), or COVID-19, during an outbreak, an annual seasonal epidemic or a pandemic. It excluded systematic reviews and primary studies on the effectiveness of facemask use during mass gatherings and on passenger flights, as they are unique situations that need to be separately assessed. Mass gatherings are overcrowded settings with many people coming into contact with each other over a prolonged period of time in close proximity.

Passenger flights have unique characteristics, including controlled ventilation, possibility of non-airborne transmission and the possibility of transmission at the airport, which cannot be ruled out (Hoehl et al., 2020).

Search strategy

A comprehensive literature search strategy was conducted on 12 May 2020. Two databases were searched: PubMed and Cochrane Library. The search for systematic reviews was conducted with no time restriction. The search was supplemented on PubMed for primary studies published since 2014, which was the latest year of literature search completion in the included systematic reviews identified from the initial search. Searches were also carried out on 12 July 2020 for gray and non-gray literature on Google Scholar (Chaabna et al., 2020). Furthermore, a comprehensive scoping exercise was undertaken and the reference lists of included primary studies and systematic reviews were searched as well as other identified publications like perspectives, letters to the editor and commentaries recently published on the topic. No language restriction was applied (Chaabna et al., 2020). The search strategy was developed based on a previously published study on the same topic (MacIntyre and Chughtai, 2015). The list of search terms is reported in Supplementary Material 1. In brief, a combination of terms relating to facemasks, respiratory infection and community settings was used.

Screening and data extraction

Duplicate removal, title/abstract, full-text screening, and data extraction were conducted by KC. Inclusion and exclusion of identified systematic reviews and primary studies were discussed with SC and SD under the supervision of RM. Systematic reviews' characteristics and primary studies' characteristics, effectiveness and compliance data, limitations, and conclusions were extracted along with information related to conflict of interest and funding. Extracted data are presented in Supplementary Materials 2–5.

Quality assessment

The GRADE (grading of recommendations assessment, development, and evaluation) approach was used to examine the type of evidence. Randomized clinical trials were considered as high-level evidence (level 1), observational studies (such as cohort and case control studies) as low-level evidence (level 2), and any other evidence as very low evidence (level 3). Since a rapid review was conducted, the evidence from the included randomized clinical trials was not further graded as high, moderate, low, and very low. However, each trial's specific limitations were summarized (MacIntyre and Chughtai, 2015).

Statistical analysis

The effectiveness of facemask use for preventing transmission of respiratory infections in community settings was assessed with odds ratios (ORs) and their respective 95% confidence intervals (CI). A meta-analysis was conducted based on the random-effects model to compute pooled ORs and their 95% CI. Pooling was performed with the inverse method, which used inverse variance weighting. To calculate pooled ORs for all respiratory infections (influenza, ILI, COVID-19, and SARS), all eligible studies were used for the meta-analysis. Eligible studies were those reporting the number of respiratory infections among the facemask group and the control group. Z-test was conducted to evaluate the significance of the estimated pooled ORs. A p -value < 0.05 was considered as significant. The heterogeneity between studies

was assessed using the I^2 statistic, τ^2 , and Q test of heterogeneity. The heterogeneity was considered as insignificant when the Q test's p -value was >0.10 and $I^2 <50\%$.

A sub-group analysis was conducted to explore the heterogeneity between studies. Meta-analysis was conducted using only randomized clinical trials assessing the effectiveness of medical facemasks in preventing transmission of each type of respiratory infection, such as influenza and in preventing ILI, separately. Additionally, pooled ORs were calculated in the case of apparently healthy dormitory residents wearing facemasks before a first case was diagnosed in their community. Pooled ORs were also estimated in the case of preventing transmission of respiratory infection to apparently healthy household contacts from an index case with a respiratory infection. Sub-group analysis was also conducted to assess the effectiveness of facemask use alone and facemask use in combination with other intervention such as handwashing. Meta-analysis was conducted using R software (version 4.00).

Results

Literature search

The search results are presented according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines (Supplementary Material 6). Seven reviews were identified that reported data on the effectiveness of facemask use to prevent respiratory infection transmission in community settings (Supplementary Material 2). From the seven identified systematic reviews, nine randomized clinical trials published up to 2012 (Canini et al., 2010; Cowling et al., 2009; MacIntyre et al., 2009; Aiello et al., 2012; Aiello et al., 2010; Suess et al., 2012; Simmerman et al., 2011; Cowling et al., 2008; Larson et al., 2010) and one case-control study were retrieved (Wu et al., 2004). An additional search for primary studies identified the tenth randomized clinical trial (MacIntyre et al., 2016) published in 2016 and one retrospective cohort study published in 2020 (Wang et al., 2020) (Supplementary Material 3). All included trials studied medical facemask use to prevent transmission of respiratory infections other than SARS-CoV-2. The included cohort study looked at the effectiveness of medical facemask use to prevent transmission of SARS-CoV-2, whereas the included case-control study reviewed the effectiveness of medical facemask use to prevent transmission of SARS.

A higher number of trials studying the effectiveness of medical facemask use to prevent transmission of respiratory infections among apparently healthy individuals was identified than the number of trials studying their use by sick individuals only. No primary study evaluated the effectiveness of using cloth facemasks to prevent transmission of respiratory infections in community settings. One case-control study (Zhang et al., 2013) on facemask use conducted during the 2009 pandemic (H1N1) was excluded because it did not specify the type of facemask that was studied (medical or cloth).

Quality assessment

Ten of the included primary studies in this review were randomized clinical trials (Canini et al., 2010; Cowling et al., 2009; MacIntyre et al., 2009; MacIntyre et al., 2016; Aiello et al., 2012; Aiello et al., 2010; Suess et al., 2012; Simmerman et al., 2011; Cowling et al., 2008; Larson et al., 2010). All of them were considered as high-level evidence and were reported as such in this review (Supplementary Material 4). The two additional identified observational studies were a retrospective cohort study

and a case-control study, which were considered as having a low level of evidence (Wang et al., 2020).

Conflict of interest

Four of the included studies (MacIntyre et al., 2009; MacIntyre et al., 2016; Simmerman et al., 2011; Larson et al., 2010) reported being funded or receiving a contribution of supplies from pharmaceutical and/or non-pharmaceutical industries (Supplementary Material 5).

Overview of primary studies evaluating medical facemask use by apparently healthy individuals having no identified infected close contacts to prevent transmission of respiratory infections

Two randomized clinical trials (high level of evidence) (Aiello et al., 2012; Aiello et al., 2010) used a mixed intervention consisting of a combination of intensive hand hygiene (handwashing and alcohol-based hand sanitizer use) and medical facemask use by healthy adult university residents to prevent transmission of ILI and influenza (Supplementary Material 3). Both trials were conducted in shared living settings (university dormitory). The findings of these trials demonstrated a significantly lower incidence of ILI and confirmed influenza infection in the 'handwashing and facemask' group when compared with the control group. No statistically significant findings were observed for the 'facemask' only group when compared with the control group (Aiello et al., 2012; Aiello et al., 2010). These two clinical trials recommend combining facemask use with intensive hand hygiene (including washing and using alcohol-based sanitizer) as effective measures to mitigate respiratory infection spread during outbreaks and potentially during pandemics (Aiello et al., 2012; Aiello et al., 2010). Additionally, one case-control study (low level of evidence) explored risk and protective factors by comparing SARS infected cases and healthy controls (Wu et al., 2004). This study demonstrated that facemask use was higher in controls than in infected cases (individuals wearing medical facemasks always: OR=0.3, 95% CI 0.2–0.6, $p < 0.001$, infected cases vs. controls). This case-control study recommended facemask use in community settings to prevent the transmission of SARS (Wu et al., 2004).

Overview of primary studies evaluating medical facemask use to prevent transmission of respiratory infections to close contacts of infected individuals

The effectiveness of medical facemask use to prevent transmission of a respiratory infection has only been studied in household settings (Supplementary Material 3). Studies in other community settings, such as workplaces and schools, were not identified.

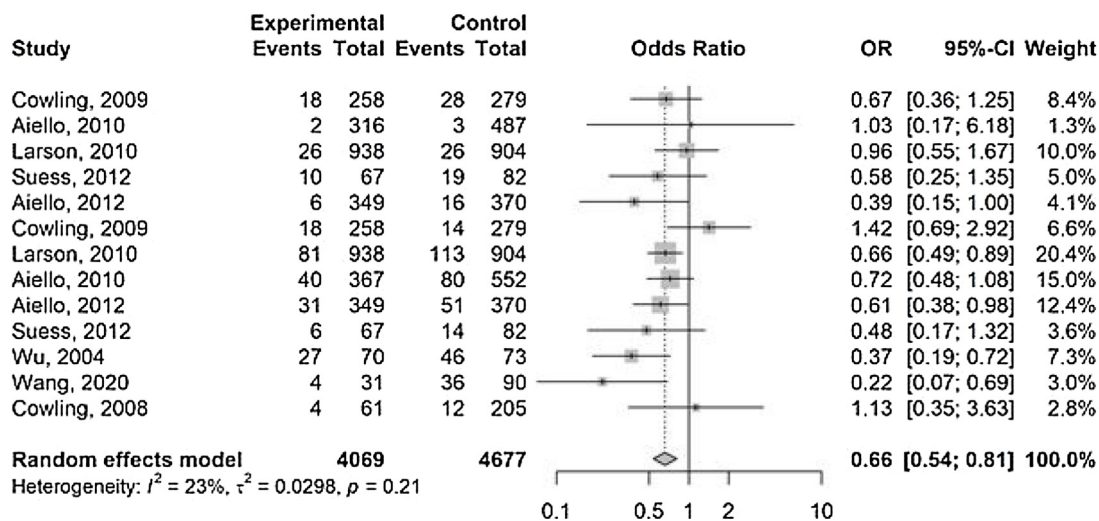
Use of medical facemasks by index cases only (source control)

Two trials (high-level evidence) studied the effectiveness of medical facemask use by sick individuals (index cases) to prevent transmission of respiratory infections, other than SARS-CoV-2, to household members (Canini et al., 2010; MacIntyre et al., 2016). Potential benefits of medical facemasks for source control were suggested; however, no significant difference was demonstrated between the intervention and control groups. Both trials had poor statistical power.

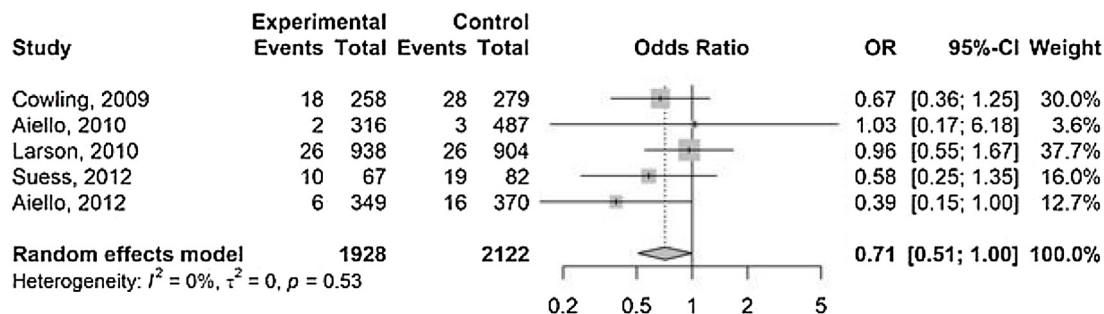
Use of medical facemasks by both index cases and household contacts

Four trials (high-level evidence) studied the effectiveness of medical facemask use by both index cases and their healthy household contacts to prevent transmission of respiratory infections, other than SARS-CoV-2, to the household members (Cowling et al., 2009; Suess et al., 2012; Simmerman et al., 2011;

a- Influenza, ILI, COVID-19, SARS



b- Influenza



c- ILI

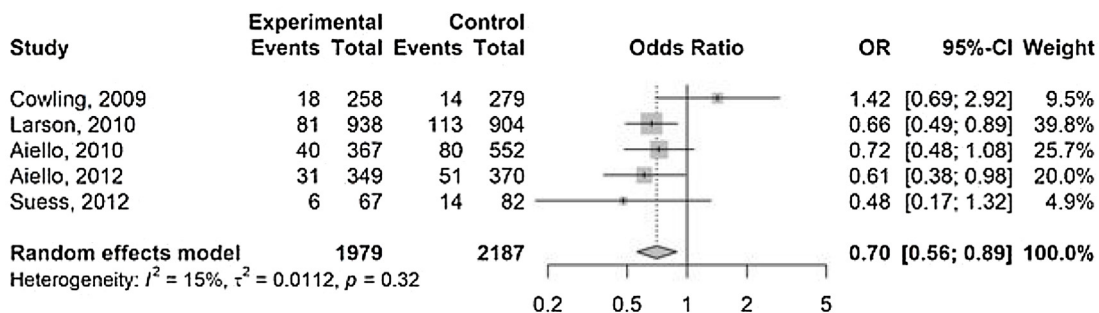


Figure 1. Meta-analysis on the effectiveness of medical facemasks in preventing respiratory infections in community settings, by type of infection. Meta-analysis conducted based on the random-effects model to compute pooled ORs and their 95% CI. To calculate pooled ORs for all respiratory infections (influenza, influenza-like-illness (ILI), COVID-19, and SARS), all studies eligible for meta-analysis were used. Eligible studies in the meta-analysis are those reporting the number of respiratory infections among the facemask and control groups. To explore the heterogeneity between studies, a sub-group analysis was conducted. Meta-analysis was conducted using only randomized clinical trials assessing the effectiveness of medical facemasks in preventing influenza and in preventing ILI, separately.

Larson et al., 2010). It appears from these trials that there was a significant difference between the facemask and control groups if medical facemask use was combined with hand hygiene (Cowling et al., 2009; Suess et al., 2012; Larson et al., 2010) when these interventions were applied together within 36 h of the onset of the symptoms in the case of influenza and ILI (Cowling et al., 2009; Suess et al., 2012), and when compliance with facemask use was relatively high (Cowling et al., 2009; Suess et al., 2012). The use of medical facemask alone (Suess et al., 2012) appeared to be ineffective in reducing the risk of transmission of respiratory infection in a household setting.

One cohort study (Wang et al., 2020) looked at the effectiveness of medical facemask use by both index cases and their healthy household contacts to prevent transmission of SARS-CoV-2 to the household members. After statistical adjustment (multivariate analysis), the study demonstrated significant effectiveness of medical facemask use only when facemasks were worn before the index case developed symptoms. Also, home cleaning with chlorine or ethanol-based disinfectant was significantly associated with a lower risk of transmission.

Use of medical facemasks by household contacts only

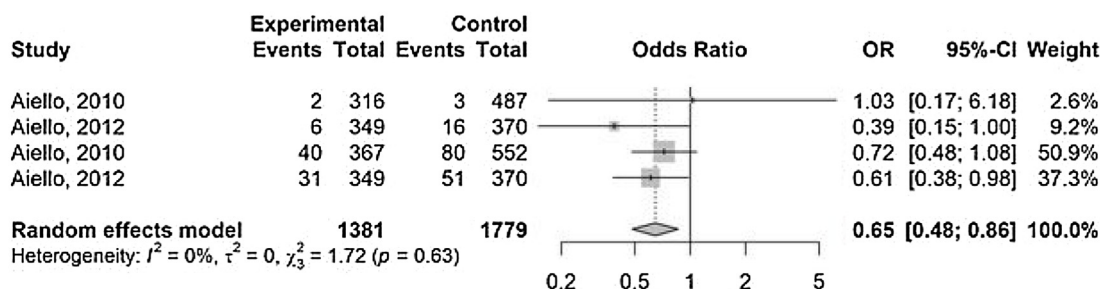
One trial (high-level evidence) (MacIntyre et al., 2009) studied the effectiveness of medical facemask use by only healthy household contacts of an index case to prevent transmission of a respiratory infection other than SARS-CoV-2 to the household members. The trial demonstrated a significant reduction in the risk

of acquiring a respiratory infection associated with compliance with medical facemask use.

Meta-analysis and sub-group analysis

The current meta-analysis demonstrated a significant protective effect of medical facemask use (combined or not with other interventions) in preventing the transmission of all respiratory infections, including SARS-CoV-2 and SARS-CoV (OR = 0.66, 95% CI 0.54–0.81, Figure 1). Sub-group analysis including only randomized clinical trials (high level evidence) also showed significant protective effect of medical facemask use in preventing influenza and ILI transmission (OR = 0.71, 95% CI 0.51–0.999 and OR = 0.70, 95% CI 0.56–0.89, respectively). Due to lack of data, sub-group analysis was not feasible for SARS-CoV-2 and SARS-CoV. Additionally, a significant protective effect was also demonstrated in preventing transmission of all respiratory infections to apparently healthy individuals having no identified infected close contact (OR = 0.65, 95% CI 0.48–0.86, Figure 2), and in preventing transmission of all respiratory infections (including SARS-CoV-2) to close contacts of index cases (OR = 0.67, 95% CI 0.49–0.90). In addition, sub-group analysis including only randomized clinical trials (high level evidence) showed a significant protective effect of medical facemask use when combined with handwashing (OR = 0.70, 95% CI 0.59–0.83, Figure 3). Sub-group analysis assessing the use of facemask alone was not feasible because of lack of data. Heterogeneity between studies was not significant, except for the

a



b

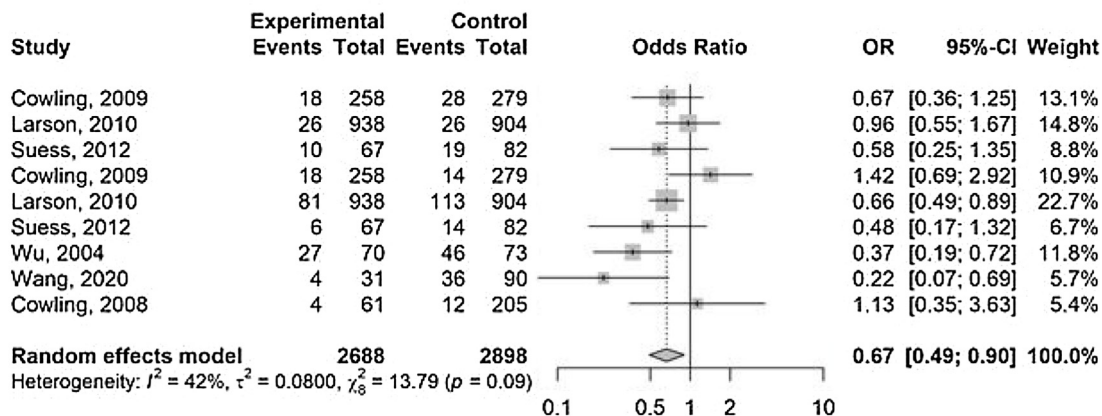


Figure 2. Meta-analysis on the effectiveness of medical facemask use in preventing transmission of respiratory infections (a) to apparently healthy individuals having no identified infected close contacts and (b) to close contacts of infected individuals in community settings.

The random-effects model was used in this meta-analysis to compute pooled odds ratios (OR) to assess the effectiveness of medical facemask use in preventing primary and secondary transmission of respiratory infections, separately. Meta-analysis on the effectiveness of medical facemask use combined with handwashing in preventing transmission of respiratory infections in community settings.

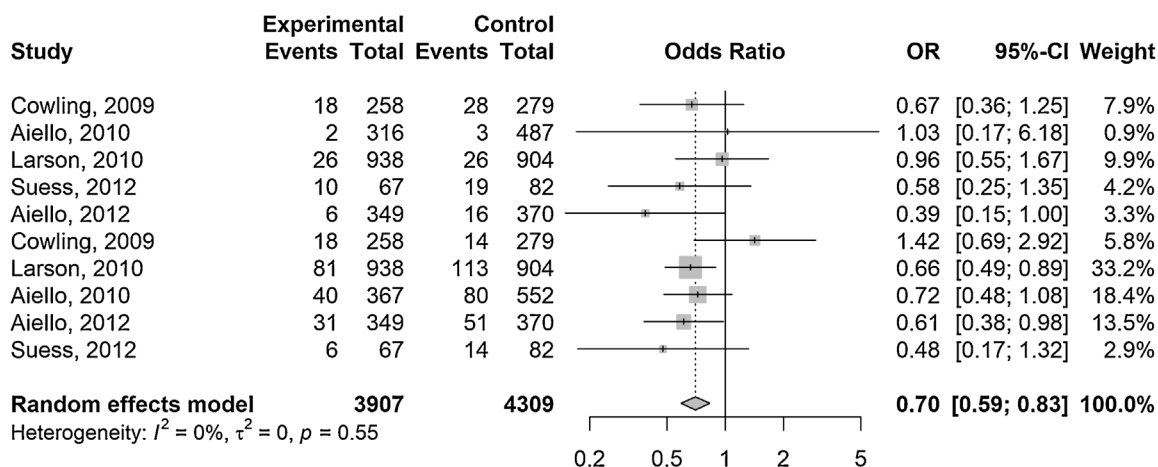


Figure 3. xxx.

meta-analysis related to close contacts of index cases ($p < 0.1$, Figure 2b). However, the heterogeneity between studies included in this meta-analysis was low ($I^2 = 42\%$, $< 50\%$, Figure 2b).

Discussion

This comprehensive review of facemask use effectiveness in preventing transmission of respiratory infections focused only on community settings without mixing data from healthcare settings.

Are medical facemasks effective in preventing transmission of respiratory infection in community settings?

The randomized clinical trials (high-level evidence) assessing the effectiveness of medical facemask use to prevent transmission of respiratory infections in community settings were conducted in closed settings with high transmission risk of respiratory infections (e.g. households and university dormitories). No trial studied medical facemask use effectiveness to prevent transmission of respiratory infections in open areas. According to the available scientific evidence, medical facemask use in closed community settings appears to be effective in preventing transmission of respiratory infections if a) medical facemask use is combined with intensive hand hygiene and b) compliance with wearing the medical facemask is high. Additionally, for prevention of transmission from an individual diagnosed with a respiratory infection, medical facemask use should also be initiated as soon as possible (within 36 h of the onset of the symptoms, as in the case of influenza and ILI, and before the onset of symptoms, as in the case of COVID-19). As medical facemask use for preventing transmission of respiratory infections, in general, seems effective in closed and shared living settings, which have a higher risk of respiratory infection transmission, this may also benefit the general population in public areas where the risk of transmission is at lower levels, such as on the streets and in parks (MacIntyre and Hasanain, 2020).

Who should wear medical facemasks in community settings?

The use of medical facemasks for source control (MacIntyre et al., 2016) (i.e. only worn by sick individuals) was studied by two underpowered trials. Hence, significant effectiveness could not be demonstrated. This review shows that the effectiveness of medical facemask usage for preventing respiratory infections in community settings has been demonstrated in the following: 1) apparently healthy individuals having no contact with identified sick individuals, 2) only healthy household contacts of a sick individual, and 3) both sick individuals and healthy household contacts.

Are cloth facemasks effective in preventing transmission of respiratory infection in community settings?

None of the primary studies (consisting of high and low levels of evidence) evaluated the use of cloth facemasks for preventing transmission of respiratory infection in community settings. A rapid expert consultation assessed the effectiveness of homemade cloth facemask use by the general population to prevent transmission during the COVID-19 pandemic (National Academies of Sciences Engineering and Medicine, 2020). Experts evaluated available laboratory studies (constituting very low level of evidence) assessing cloth facemask use to prevent transmission of all types of respiratory infections. The rapid expert consultation concluded that the available evidence is inconclusive about the effectiveness of cloth facemask use. Arguably, the effectiveness of cloth facemasks varied according to the fabric used for the mask and the number of layers that the mask was made of. These two parameters impact facemask breathing resistance. The higher the breathing resistance, the higher the filtration of the facemask; however, higher breathing resistance can negatively affect compliance with facemask use. On the contrary, the experts highlight that wearing a cloth facemask can be a reminder of the importance of physical distancing for some, but it can also give a false sense of protection and may undermine the implementation of other protective measures (National Academies of Sciences Engineering and Medicine, 2020). During the current COVID-19 pandemic, cloth facemasks have been recommended as a substitute for medical facemasks because of their ready availability and to minimize the shortage risk of medical facemasks for HCWs. However, there is no direct evidence or high-quality evidence that this review identified that demonstrates efficacy of cloth facemask use to prevent transmission of respiratory infections.

Are there differences in the effectiveness of cloth and medical facemasks in community settings?

The WHO recommends that cloth facemasks “should only be considered for source control (used by infected persons) in community settings and not for prevention” (World Health Organization (WHO), 2020). The CDC states “cloth face coverings may help prevent people who have COVID-19 from spreading the virus to others” (CDC, 2020). The available laboratory studies demonstrate a lower efficacy of cloth facemasks than medical facemasks in preventing transmission of respiratory infections (National Academies of Sciences Engineering and Medicine, 2020; Howard et al., 2020; van der Sande et al., 2008; Davies et al., 2013).

The only randomized clinical trial (considered as a high level of evidence) comparing medical and cloth facemask use was conducted in a healthcare setting (MacIntyre et al., 2015). HCWs who used cloth facemasks (two layers, cotton fabric) were 13 times more likely to be infected by ILI than HCWs who used medical facemasks (MacIntyre et al., 2015). This may suggest that a medical facemask should not be substituted by a cloth facemask to prevent transmission of respiratory infections when both are ideally available for use by the community. For the ongoing COVID-19 pandemic, the CDC does not provide guidance on the type of cloth/fabric and the number of layers with which to make the cloth face coverings, recommending that they can even be homemade (CDC, 2020). The WHO recommends that a minimum of three layers is required for fabric masks, depending on the fabric used, to help curb coronavirus spread (World Health Organization (WHO), 2020).

Recommendations for medical facemask use to prevent transmission of respiratory infection in community settings

An evidence-based recommendation also considering the precautionary principle (Greenhalgh et al., 2020) would be to support medical facemask use in community settings, along with intensive hand hygiene (hand washing and alcohol-based hand sanitizer use) by a) all individuals in any public area (MacIntyre and Hasanain, 2020) and b) sick individuals and their household contacts with as limited time-lapse as possible from the onset of the symptoms or even before the onset of the symptoms in household settings. However, the criticality of ensuring compliance for the effectiveness of such measures is essential. Nonetheless, any recommendation involving behavioral change can be a challenge for compliance. However, it should be recognized that behavioral compliance with such preventive measures highly depends on risk perception by the general population and this can likely be expected to be high in a pandemic situation (Cava et al., 2005).

Recommendations for medical facemask use to prevent transmission of SARS-CoV-2 in community settings

A laboratory study (which constitutes a very low level of evidence) recently conducted on hamsters in cages (i.e. closed setting) demonstrated that when medical facemasks were used to prevent transmission of coronavirus, a significant reduction of transmission rate through respiratory droplets or airborne particles was observed of up to 75% when compared with the control group, which had no facemask covering the cage (Turak, 2020). The main results of the study suggest that transmission of coronavirus might be prevented in humans when asymptomatic or symptomatic individuals wear medical facemasks. While the study results are promising, a small experimental study in humans recently evaluated the effectiveness of medical and cloth facemasks in filtering SARS-CoV-2 when four symptomatic patients were asked to cough five times (Bae et al., 2020). The results showed that neither medical nor cloth facemasks effectively filtered SARS-CoV-2. Conflicting results were reported by the aforementioned laboratory study on hamsters and the very small experimental study conducted on humans on the effectiveness of facemasks in preventing SARS-CoV-2 transmission. However, the current review included a cohort study with a higher level of evidence than these experimental studies demonstrating the effectiveness of facemask use when both the index case and household contacts wore the facemask before symptom onset.

The current review also considered data from randomized clinical trials (considered as a high level of evidence) on several types of respiratory viruses, which increased the generalizability of

the findings to SARS-CoV-2 (also a respiratory infection). Although various respiratory viruses differ in their characteristics – such as virulence, pathogenicity, reproductiveness and infectivity – there are general similarities in transmission mechanisms via direct and indirect contact (i.e. large respiratory droplets, fomites and aerosols). Due to such similarities, a broad-based prevention approach of minimizing and mitigating transmission risk could be very effective in containing respiratory infections (MacIntyre et al., 2009). In view of the available evidence, use of medical facemasks should be seriously considered in the prevention of transmission of SARS-CoV-2. In the circumstances, promoting medical facemask use in respiratory infection outbreak situations, such as the COVID-19 pandemic, is recommended as part of a holistic strategy, which includes physical distancing, intensive hand hygiene (i.e. hand washing and alcohol-based sanitizer use), and home and public area cleaning with chlorine and alcohol-based disinfectant.

Other considerations in the current COVID-19 pandemic

At the start of the COVID-19 pandemic the WHO did not recommend facemask use in community settings, on the basis that “no evidence is available on its usefulness to protect non-sick persons” (World Health Organization, 2020). However, on 05 June 2020 the WHO issued updated guidance about medical and cloth facemask use in areas with ongoing widespread community transmission and where physical distancing is difficult to implement (e.g. public transportation, shops, etc.). They recommended that countries should encourage the general population to wear facemasks in the aforementioned settings (World Health Organization (WHO), 2020). Since medical facemasks are a critical resource for healthcare workers, the WHO clarified that when medical facemasks are in shortage, these must be reserved for frontline workers and at-risk individuals. A few months into the pandemic, the CDC recommended the use of ‘cloth face coverings’ by the general population in public spaces where 6-foot social distancing measures are difficult to maintain (e.g. in grocery stores and pharmacies). From the beginning of this recommendation, the CDC did make the distinction that the public must use ‘cloth face coverings’ as opposed to medical facemasks, which constitute critical personal protective equipment for frontline HCWs (CDC, 2020). However, the CDC calls for wearing cloth facemasks by the public a “voluntary public health measure”. The inconsistent recommendations by the two leading health organizations has led to confusion among the general population regarding the effectiveness of facemask use to prevent SARS-CoV-2 in community settings.

The application of the above evidence-based recommendations in the COVID-19 pandemic context may be slow, due to concerns about critical shortages of medical facemasks for HCWs (MacIntyre and Hasanain, 2020). Healthcare professionals are a population at a higher risk of being infected by SARS-CoV-2, as they can more often be in close contact with infected individuals. In addition to protecting the healthcare workforce itself, prioritizing the allocation of medical facemasks to HCWs might also be a strategy to reduce nosocomial transmission of the virus. Furthermore, the allocation of medical facemasks can also be prioritized to the household contacts of HCWs and quarantined individuals (Wang et al., 2020). The only primary study evaluating the effectiveness of medical facemasks in the COVID-19 pandemic context demonstrated the effectiveness of the facemasks in preventing household transmission in the pre-symptomatic or early symptomatic period of COVID-19 when both index cases and healthy household contacts wore medical facemasks (Wang et al., 2020). Additionally, countries substantially counting on migrants to build their workforce, such as the countries of the Gulf Cooperation Council (Mamtani et al., 2014; Chaabna et al., 2018a; Chaabna et al., 2018b),

should also consider prioritizing the allocation of facemasks to this population, as they are likely to be at higher risk of being infected by the coronavirus (Nadeem, 2020) because these migrant workers live in high-density shared accommodation (Babar, 2020).

What do we not know?

No primary study (observational studies – low level of evidence, and randomized clinical trials – high level of evidence) conducted in community settings that evaluated the use of cloth facemasks was identified. As recommendations supporting cloth facemask use have been formulated by international organizations based on laboratory studies (very low level of evidence), primary studies conducted in community settings are urgently needed.

While randomized clinical trials were conducted in closed community settings (university dormitory and household) to assess the use of medical facemasks, none were in open public areas. They often had low power and/or compliance and were sometimes unable to demonstrate significance in effectiveness. The trials studying medical facemask effectiveness to prevent primary transmission of respiratory infections compared the hand hygiene and facemask group with a control group but did not have a hand hygiene alone group. This is a limitation, as the marginal benefits of facemasks are difficult to determine. Future high-quality trials are needed to assess cloth and medical facemask effectiveness in the community, especially for the COVID-19 pandemic context.

This review highlights that facemask use is negatively impacted by low compliance. As such, there are questions as to where and when it is more essential to wear facemasks (e.g. workplace, supermarkets, schools, and before the onset of symptoms in a population at higher risk of being infected by SARS-CoV-2, such as HCWs) and how many hours a household contact should wear a facemask. Future research is required to establish the effectiveness of such specific measures.

Strengths and limitations

The strengths and limitations of this review must be pointed out. A strength of this rapid review was the systematic and comprehensive nature of the literature search, which was not limited to only peer-reviewed publications. Potentially relevant gray literature was also explored. It identified the highest number of primary studies that evaluated facemask use effectiveness in community settings compared with systematic reviews on the same topic (Chu et al., 2020; Liang et al., 2020; The Royal Society, 2020). Therefore, this meta-analysis is comprehensive and up-to-date on this topic. Additionally, this review evaluated facemask use effectiveness by solely using primary data from community settings without mixing these data with any data from healthcare settings, as performed in other recently published reviews (Chu et al., 2020; Liang et al., 2020). HCWs are well-trained in the use of medical facemasks; therefore, facemask usage and its compliance uptake are likely different among HCWs than among the general population. Hence, data from healthcare settings may not be helpful in answering the question of facemask effectiveness when used by the general population (Chu et al., 2020; Liang et al., 2020; The Royal Society, 2020). This review provides additional evidence about facemask use providing protective value for mitigating the spread of SARS-CoV-2 among the general population. Due to the urgency of the situation, given the ongoing COVID-19 pandemic and the need for rapid evidence synthesis, no dual title/abstract and full-text screening and data extraction were conducted. Additionally, the included literature did not undergo formal quality assessment. However, of the 12 primary studies, 10 were

randomized clinical trials, which are considered as the highest level of evidence.

Conclusion

Overall, this review suggests that there is enough evidence to show that medical facemasks are effective in community settings to prevent transmission of respiratory viral infections. Medical facemask use in community settings is strongly recommended, especially when widespread community transmission may be ongoing and where physical distancing may not be possible, (e.g. public transportation, grocery shops, etc.). However, facemask use must not be considered as a replacement for physical distancing, hand hygiene and other essential preventive public health measures. Facemask use should be an integral part of any prevention package to stop respiratory infection transmission. Such a package should also include physical distancing, frequent handwashing and other preventive measures. There is no available direct evidence in humans (National Academies of Sciences Engineering and Medicine, 2020; World Health Organization (WHO), 2020) for recommending cloth facemask use. Based on the very low-level evidence from laboratory studies and the precautionary principle, cloth facemask use in community settings is recommended only if medical facemasks are unavailable. Additionally, high compliance and adherence to the recommendations by the general population are necessary for the maximal effectiveness of interventions to prevent transmission of respiratory infections in community settings.

Author contribution

KC, RM, SC, and SD conceptualized the study. KC designed the search strategy with input from SC, SD and RM. KC carried out the literature search and screening. Inclusion of relevant articles was discussed with SD, SC and RM. KC performed data extraction, which was discussed with SD, SC and RM. KC conducted the statistical analysis with input from SD, SC, and RM. KC wrote the first draft of the review with input from SD, SC and RM. All authors reviewed and edited the manuscript and provided substantial input to the manuscript.

Conflicts of interest

The authors report no potential conflicts of interest.

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Ethical approval

Not applicable.

Uncited references

Anon, Wong et al. (2014), Cowling et al. (2010), Jefferson et al. (2009) and Aledort et al. (2007).

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.ijid.2020.09.1434>.

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