Public Health England

Protecting and improving the nation's health

# Face coverings in the community and COVID-19

## A rapid review

# Contents

# Main messages

1. Twenty eight studies were identified, but none of them provided high level evidence and more than half were non-peer-reviewed pre-prints. The evidence was mainly theoretical (based on modelling or laboratory studies) and epidemiological (highly subject to confounders).

2. There is limited and weak evidence from epidemiological and modelling studies that mask wearing in the community may contribute to reducing the spread of COVID-19 and that early intervention may result in a lower peak infection rate.

3. Evidence from modelling studies suggests that beneficial effects of wearing masks may be increased when combined with other non-pharmaceutical interventions, such as hand washing and social distancing.

4. Limited and weak evidence from laboratory studies suggests that materials such as cotton and polyester might block droplets reasonably well and might have similar filtering efficiency to medical masks when folded in 2 or 3 layers.

# Background

Face masks can play a role in controlling infection in clinical settings when used as part of a comprehensive package of infection control measures. However, the evidence is less clear regarding the use of face masks (or coverings) outside of clinical settings. Recent meta-analyses have reached opposite conclusions; however, this can partially be explained by differences in inclusion criteria (1 to 3). Two meta-analyses, including only randomised controlled trials (RCTs), reported that face masks are not effective in reducing transmission of influenza in the community, based on 10 RCTs (3) and 7 RCTs in the Cochrane review (2). Both reviews synthesised a similar body of evidence for non-healthcare settings, all in non-pandemic settings. In contrast, a meta-analysis published in the Lancet (1) included studies of any design focused on SARS, MERS or COVID-19 (that is, in pandemic settings) and suggested that the use of face masks in community settings may protect from infection. This review included only 3 observational studies for non-healthcare settings, all conducted in Asia during the SARS outbreak. In short; evidence from RCTs in non-pandemic settings suggests that the use of face masks within the community is not effective in reducing transmission of influenza-like illness, while evidence from observational studies during the SARS outbreak show an association between the use of masks in the community and reduced risk of infection. While observational studies typically provide lower-level evidence than RCTs, most of the RCTs identified were small underpowered studies that often combined use of face masks with other interventions such as hand washing, therefore providing limited evidence on use of face masks in the community.

Two non-peer-reviewed pre-print systematic reviews (4,5) have assessed the whole body of evidence (RCTs and observational, pandemic and non-pandemic settings), focusing on community settings, and have interpreted the inconsistencies highlighted above slightly differently. One review concluded that the use of face masks in the general population might offer benefits in preventing the spread of viruses, but that it was limited by population adherence and that early initiation of mask use was more effective (4). The other study concluded that evidence was not strong enough to support widespread use of face masks but that there was enough evidence to support their use for short periods of time by particularly vulnerable individuals when in transient higher risk situations (5). It was also suggested that the protective effect was increased when face masks were worn by both the susceptible person and the infected person (5) and that the use of face masks in the community might be more effective with viruses which transmit easily from asymptomatic individuals, as has been observed in SARS-CoV-2 (4).

In view of this conflicting evidence, national and international organisations have recently conducted analyses and evidence reviews supported by expert panel discussion to inform policy on whether widespread use of face masks in the community should be recommended to reduce the spread of COVID-19:

- the WHO reported, in its most recent guidance, that to prevent COVID-19 transmission effectively in areas of community transmission, governments should encourage the general public to wear masks only in specific situations and settings and as part of a comprehensive approach to suppress COVID-19 transmission (6)
- the Norwegian Institute of Public Health reported that there was evidence of protective effect of medical face masks against respiratory infections in community settings but that the results varied greatly; they concluded that in the current epidemiological situation in Norway the use of face masks in the community was not recommended but that, if the situation worsened, their use as a precautionary measure should be considered (7)
- the Alberta Health Services COVID-19 Scientific Advisory Group concluded that there was 'some modelling, ecological and anecdotal data suggesting benefit to medical mask use in the community'; they also reported that there was 'limited evidence of any harms related to community mask wearing, specifically, as it relates to any behavioural modifications that may ensue or non-adherence to other protective interventions such as social distancing or optimal hand hygiene practices' but noted concern of unintended negative consequences (8)
- in an analyses conducted by the New and Emerging Respiratory Virus Threats Advisory Group (NERVTAG) for the Scientific Advisory Group for Emergencies (SAGE), it was reported that there was 'indirect data and weak direct evidence that use of face masks by symptomatic individuals may reduce transmission from them' and that 'appropriate use of face masks is an important component of their effectiveness' (9)

The evidence is even more limited in relation to homemade masks and to the filtration properties of different fabrics (7,8). In its most recent guidance, the WHO acknowledge that few cloth masks have been systematically evaluated and that, due to their expected lower performances, they should only be considered as source control and for specific activities (for example, public transport) and that their use should always be accompanied by frequent hand hygiene and physical distancing (6). The NERVTAG report for SAGE concluded that 'cloth masks have a lower protective effect than surgical face masks or respirators and may have a lower source control effect' (9). In their recent systematic review (pre-print), Mondal and others concluded that 'although cloth masks generally perform poorer than the medical grade masks, they may be better than no masks at all' (10).

The current recommendations for England are that it is mandatory to wear face coverings, at all times, on public transport. It is also recommended, but not mandatory, to wear a face covering in other enclosed public spaces where social distancing isn't possible (11). Guidance is also provided on how to wear and make a cloth face covering (12).

# Objective

The purpose of this rapid review was to identify and assess the most recent and direct evidence from the COVID-19 outbreak on the use of face masks in the community, and the efficacy of different types of homemade masks for use in community settings (that is, not medical masks). It was agreed that the search dates would be from 25 March 2020, which was the cut-off date in the systematic review by Chu and others (1).

To note that in the following:

- 'face masks' refers to any type of face covering, unless specified otherwise
- 'community' refers to non-healthcare settings, including public spaces, households, shops, etc.

# Methodology

A literature search was undertaken to look for primary evidence related to the COVID-19 outbreak, published (or available as pre-print) between 25 March and 5 June 2020.

See Annexe A for details of the methodology. A protocol is available in Annexe D.

# Evidence

The search returned 1,063 records and one additional paper was identified by searching reference lists of relevant systematic reviews. After removal of duplicates, 626 records were screened by title and abstract. Of these, 57 full-text articles were assessed for eligibility and 28 were included in this review. A PRISMA diagram is provided in Annexe A. The list of excluded studies can be found in Annexe B.

Of these 28 papers, 7 were observational (mainly epidemiological), 13 were modelling studies and 8 were laboratory studies. More than half (15) of these articles were pre-print (not peer-reviewed). Full details of the studies can be found in Annexe C.

The evidence is summarised below for each review question. The observational and modelling studies mainly provide evidence for the first review question while the second question has been assessed mainly though laboratory studies.

# Q1. What is the effectiveness of face coverings to reduce the spread of COVID-19 in the community?

**Evidence from observational studies (Table C1)**

Seven observational studies provided evidence on the effectiveness of face coverings to reduce the spread of COVID-19 in the community (13 to 19). Of these, 3 were preprints (15 to 17).

One study was a retrospective cohort study (13) and the others were all epidemiological.

The retrospective cohort assessed the effect of face masks, social distancing and disinfection on secondary attack rates in 124 household in Beijing (13). In a multivariable logistic regression model, face mask use by the primary case and family contacts before the primary case developed symptoms remained significantly associated with a reduced risk of transmission (79% effective). While this study provides some evidence of effectiveness of mask use, it is unclear how this result would be transferable to the UK context which does not have previous experience of epidemics such as SARS and MERS and therefore no previous experience of public face mask wearing.

The epidemiological studies were conducted at community level in Asia (14,18) or at country level (up to 198 countries included) (15 to 17,19). These studies provide low-level evidence and are at risk of bias, especially for confounding. Not all them were adjusted for potential confounding factors and when they were, not enough information was provided to be able to rule out residual confounding such as other non-pharmaceutical interventions, stage of the epidemic or testing. They also present a risk of bias in measurement of the exposure as most of them assessed mask usage based on national policies rather than compliance data, and no information was provided on the type of masks used.

Among the country-level epidemiological studies, one specifically looked at European countries, analysing the different approaches and timing of the restrictions implemented to control the COVID-19 epidemic (17). The authors concluded that the use of face coverings in public was not associated with any independent additional impact of other measures, but noted that the data on face coverings were too preliminary to be reliable (17). The other 3 country-level studies suggest that the use of masks in the community might be effective in reducing the spread of COVID-19 (15,16,19), and that they might be more effective when used from the beginning of the epidemic (15,16). These results were obtained, broadly speaking, by comparing the effect of wearing a mask, using data from Asian countries, versus not wearing a mask, based on European data among others, and might therefore not be directly applicable to European countries. However, an epidemiological study conducted in Germany at the region-level also suggests that face masks might be associated with a 40% reduction in daily growth rate (20). The methodology was similar to other reported studies (comparing registered COVID-19 cases to when face masks became compulsory) and is subject to the same limitations. This study, not peer-reviewed, was not identified via the literature search as it was published after the cut-off date for this review.

Overall, these studies suggest that face masks use at community level might be effective in reducing the spread of COVID-19. However, these results are susceptible to residual confounding and might over-estimate the protective effect of face masks, and nearly half of these studies have not been peer-reviewed. It should also be noted that the evidence showing a protective effect of face masks comes from studies conducted in Asian countries and that the transferability and applicability of these results to European countries is unclear, among other reasons due to cultural differences.

### Evidence from modelling studies (Table S2)

Thirteen modelling studies assessed the effectiveness of wearing masks by the public, and in the community, in reducing the rate of transmission ($R_0$) of COVID-19 (21 to 33). Nine studies were in pre-print (21 to 23,25,27,30 to 33).

Ten studies reported the independent effectiveness of using masks in the community to reduce the rate of infection of COVID-19 (21 to 26,29,31 to 33). Seven reported effectiveness of wearing masks when other public health strategies or policies were also in place (21,25 to 28,30,33).

When wearing masks in the community was the only measure to prevent the spread of infection, the effect was positive in all studies, although the strength was variable. In all cases, the strength of the effect was related to the effectiveness of the mask and to the proportion of the population wearing a mask, where higher proportions of both resulted in a greater effect. For instance, one peer-reviewed study modelled the effect of lifting the lockdown in London on death rates and $R_0$ with and without additional measures: without any interventions, the model predicted a 14.5 fold increase in deaths and an $R_0$ of 2.56; however, when 30% of the infected population wore ‘face masks’ (30% effectiveness) and 30% of the general population wore ‘face coverings’ (10% effectiveness), the increase of deaths would reduce to 12.34-fold and $R_0$ to 2.23 (28). This continued to reduce as coverage within each population increased. A similar study predicted that an immediate 80% uptake of mask usage in the population, with masks that are 50% effective, could prevent 17% to 45% of deaths, and reduce peak daily deaths by 34% to 58%, over 2 months in New York State, accounting for variable values of $R_0$ (29).

Seven studies assessed the effectiveness of different types of masks by defining different levels of probable risk reduction (22 to 24,28,29,31,32). As expected, wearing masks that were more effective in reducing risk of transmission resulted in a lower rate of transmission in the population. The most frequently cited effectiveness of mask that may prove to be beneficial when worn in a population, was 50%, comparable to that of a surgical mask (22,23,26,29,31). However, all masks offered some form of risk reduction, and this was true at high and low levels of population adherence. One study further observed that having a smaller proportion of the population wearing high-quality masks may yield a similar reduction in the rate of transmission as having a larger proportion of the population wearing moderate-to-low quality masks (23). However, these studies also offered no consistency in quantifying the effectiveness of ‘face mask’ and ‘face covering’, nor do they offer definitions of what one would consider a ‘face mask’ to be, compared to a ‘face covering’.

When combined with other public health strategies, such as shielding vulnerable populations, hand washing, or social distancing recommendations, the effect of wearing a mask to reduce the spread of COVID-19 increased. Further, this increase was always multiplicative, not additive. One study that used existing epidemiological data on the spread of COVID-19 in France included 194 model parameters (disease characteristics and social behaviours) to simulate the outbreak and assessed the impact of different non-pharmaceutical interventions: compared to no intervention, mask-wearing and social distancing each resulted in 19% and 20% reductions in cumulative mortality respectively, this increased to 60% when both were in effect (25). Another study observed that a 70% or greater adherence to mask-wearing could theoretically eliminate the disease in New York State (26). The study went on to observe that when wearing a mask of 50% effectiveness, and with strict social distancing measures, an adherence of 30% in the population could see similar results.

Where relevant, studies that use existing data to calibrate their models must make assumptions in cases where the evidence or data are lacking. For example, models used different parameters to define ‘effectiveness’ of masks, which ranged from an 8% (24) reduction in risk to more than 95% (29) reduction in risk. The nature of modelling studies also means that simulations are run in controlled environments that may not accurately reflect the behaviours that we observe in real life. Unless controlled for, parameters can be fixed that are usually variable. For example, unless explicitly included in the model, such as in the study by Eikenberry (29), the basic reproduction number may not change in a simulated outbreak. In cases where $R_0$ does change, other parameters may not. As these modelling studies were conducted using different models and are calibrated using different datasets, the estimations and assumptions that are made on the probability of model parameters are not equal across studies, making comparison between them difficult.

# Q2. What is the efficacy of different types of face coverings designed for use in community settings?

**Evidence from laboratories studies (Table S3)**

Eight laboratory studies were identified (34 to 41), of which 3 were pre-prints (36 to 38). Three studies assessed the filtration efficiency of different materials using particle respirator filter testers (pressure difference measurement) with NaCl aerosol generators (34 to 36). The other studies, mainly based on optical measurements, used less conventional approaches to simulate the droplets, including household spray bottles (39) and asthma inhalator (37).

Some studies considered droplets of 75 nm diameter to simulate the coronavirus (35,36), which might not take into account that the virus is more likely to be transmitted through larger droplets or aerosols. Other studies have considered this, simulating droplets of 4-5µm (41). Not all studies specified the size of the particles.

A wide range of materials were used, including different types of cotton, kitchen paper, synthetic fabric, silk, and clothes items such as T-shirt or bed sheet, and with different layer arrangement (one-layer, multi-layer and hybrid approaches), but the materials assessed were not consistently described in the studies. All studies included medical masks (either surgical or N95, or both) as a reference. Cotton was the material most studied, with some studies suggesting similar filtering properties than medical masks, and other showing lower efficiency. Difference in results might be explained by the weave intensity of the cotton, with denser fabric providing similar filtering properties than medical masks (34,35).

One of the most comprehensive laboratory studies identified here assessed the filtration efficacy of particles in the range of 10 nm to 10 µm, at 2 different flow rates representative of respiration rates at rest and during moderate exertion (34). Different types of fabrics (cotton, silk, synthetic fabric, etc) and combinations were tested, with hybrid approaches (cotton/silk, cotton/chiffon, cotton/flannel) showing superior filtering efficiency than N95 for particles smaller than 300 nm. This study is also the only one which assessed the effect of improper mask fitting on the filtering efficiency of cloth masks, showing that gaps can result in over a 60% decrease in the filtration efficiency, with similar trends observed in surgical masks and cotton/silk hybrid sample (34).

Using a different set-up and different materials, Ma and others showed that homemade masks made of 4-layer kitchen papers and 1-layer polyester cloth can block 95% of avian influenza virus in aerosol, compared to 97% for medical masks (41).

Due to the heterogeneity between studies, including differences in experimental set-up, aerosol generations, materials used, information provided on the material, etc, it is not possible to directly compare the results between studies, nor to reliably assess the efficacy of each material as function of the number of layers. Overall, laboratory studies provided mechanistic evidence that materials such as cotton and polyester can block droplets reasonably well and that 2 or 3 layers of cotton (high density), polyester (or a mix of both such as in a T-shirt), silk, chiffon, flannel, or combinations of these materials, might provide similar filtering efficiency than commercial medical masks (34,37,39).

Laboratories studies do not take into account real-life settings and only provide mechanistic evidence which should be considered with caution. In addition, half of the laboratory studies identified have not been peer-reviewed and there was some heterogeneity between studies. As a result, this body of evidence should be considered as low-certainty, weak evidence.

Finally, it has to be noted that even though these studies have been conducted, or at least published, during the COVID-19 outbreak, they do not constitute direct evidence from COVID-19 as none of them assessed the efficacy of different cloth masks with participants infected with SARS-CoV-2.

# Limitations

The literature search was limited to evidence drawn from COVID-19 published between 25 March and 5 June 2020. The studies identified provide weak evidence based on their design (no RCTs and no prospective cohorts identified) and quality (more than half were non-peer-reviewed pre-prints; risk of bias in observational studies; modelling and laboratories studies provide only theoretical evidence). In addition, the observational studies did not provide enough information on the types of masks use or on the compliance and do not allow to make the distinction between source control and prevention.

The limitations of modelling studies are to also be fully considered, and we feel it is necessary to highlight the precautions that should be taken when interpreting their results. Though the results offer what appears to be good evidence supporting the use of masks in the community, it is imperative that they are recognised as estimates, and viewed only in support of the observational evidence, for which there is little of good quality. We, therefore, cannot recommend the use of modelling studies alone as evidence to inform or change policy measures.

The evidence identified on the efficacy of different types of face coverings for use in the community was only from laboratories studies. While these studies have been conducted, or at least published, during the COVID-19 outbreak, they do not constitute direct evidence from COVID-19 as none of them assessed the efficacy of different cloth masks with participants infected with SARS-CoV-2. These studies should therefore be assessed within the broader body of evidence and, to do so, a full literature search should be completed.

# Conclusions

There is limited and weak evidence that that community-wide mask wearing may contribute to reducing the spread of COVID-19 and that early interventions might be associated with lower peak infection rate. The beneficial effects of wearing masks may increase when combined with other non-pharmaceutical interventions, such as social distancing or hand washing.

Based on laboratories studies, materials such as cotton or polyester might block droplets reasonably well and might have similar filtering efficiency to medical masks when folded in 2 or 3 layers. However, direct evidence from higher quality studies is needed to confirm this mechanistic evidence.

# Disclaimer

PHE's rapid reviews aim to provide the best available evidence to decision makers in a timely and accessible way, based on published peer-reviewed scientific papers, unpublished reports and papers on pre-print servers. Please note that the reviews: i) use accelerated methods and may not be representative of the whole body of evidence publicly available; ii) have undergone an internal, but not independent, peer review; and iii) are only valid as of the date stated on the review.

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# Annexe A. Methods

## Literature search

This report employed a rapid review approach to address the review questions:

1. What is the effectiveness of face covering to reduce the spread of COVID-19 in the community?
2. What is the efficacy of different types of masks?

Note that:

- a number of systematic reviews have recently been conducted to assess the effectiveness of face covering in healthcare and non-healthcare settings, and one of the most recent is the review published in the Lancet by Chu and others (1) which has been used by the WHO to update their guidance (6)
- the search strategy developed by Chu and others was comprehensive and included all study designs as long as they were conducted in pandemic settings (SARS, MERS or COVID-19), and they searched Medline, Embase and WHO COVID-19 Research Database up to 26 March 2020 and pre-print servers such as MedRxiv up to 3 May 2020
- it was therefore agreed that for this rapid review, searches would be conducted from 25 March 2020

## Protocol

A protocol was produced by the project team before the literature search began, specifying the research question and the inclusion and exclusion criteria. The protocol is available in Annexe D.

## Sources searched

Medline, Embase, medRxiv preprints, WHO COVID-19 Research Database.

## Search strategy

Searches were conducted for papers published between 25 March 2020 and 5 June 2020.

Search terms covered key aspects of the research question, including terms related to the intervention. The search strategy for Ovid Medline is presented below.

Reference lists of relevant systematic reviews were also searched.

**Search strategy Ovid Medline**

1. mask*.tw,kw.
2. (face-mask* or facemask*).tw,kw.
3. ((face or head) adj2 cover*).tw,kw.
4. (face-cover* or facecover*).tw,kw.
5. (cloth* adj2 (cover* or protect*)).tw,kw.
6. physical barrier*.tw,kw.
7. physical intervention*.tw,kw.
8. non-pharmaceutical.tw,kw.
9. (mouth adj2 (cover* or protect*)).tw,kw.
10. (nose adj2 (cover* or protect*)).tw,kw.
11. Masks/
12. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11
13. exp coronavirus/
14. exp Coronavirus Infections/
15. ((corona* or corono*) adj1 (virus* or viral* or virinae*)).ti,ab,kw.
16. (coronavirus* or coronovirus* or coronavirinae* or CoV or HCoV*).ti,ab,kw.
17. (2019-nCoV or 2019nCoV or nCoV2019 or nCoV-2019 or COVID-19 or COVID-19 or CORVID-19 or CORVID19 or WN-CoV or WNCoV or HCoV-19 or HCoV19 or 2019 novel* or Ncov or n-cov or SARS-CoV-2 or SARSCoV-2 or SARSCoV2 or SARS-CoV2 or SARSCov19 or SARS-Cov19 or SARSCov-19 or SARS-Cov-19 or Ncovor or Ncorona* or Ncorono* or NcovWuhan* or NcovHubei* or NcovChina* or NcovChinese* or SARS2 or SARS-2 or SARScoronavirus2 or SARS-coronavirus-2 or SARScoronavirus 2 or SARS coronavirus2 or SARScoronovirus2 or SARS-coronovirus-2 or SARScoronovirus 2 or SARS coronovirus2).ti,ab,kw.
18. (respiratory* adj2 (symptom* or disease* or illness* or condition*) adj10 (Wuhan* or Hubei* or China* or Chinese* or Huanan*)).ti,ab,kw.
19. ((seafood market* or food market* or pneumonia*) adj10 (Wuhan* or Hubei* or China* or Chinese* or Huanan*)).ti,ab,kw.
20. ((outbreak* or wildlife* or pandemic* or epidemic*) adj1 (Wuhan* or Hubei or China* or Chinese* or Huanan*)).ti,ab,kw.
21. or/13-20
22. 12 and 21
23. limit 22 to dt=20200325-20200605

# Inclusion and exclusion criteria

Article eligibility criteria are summarised in Table A.1.

Due to the absence of direct evidence from COVID-19 outbreak related to question 2, it was agreed that laboratory studies assessing filtration properties of different types of cloth masks would be included.

**Table A.1. Inclusion and exclusion criteria**

| | **Included** | **Excluded** |
|---|---|---|
| Population | Human | Non-humans studies |
| Settings | All community settings, including households | Healthcare settings |
| Context | COVID-19 disease | Other diseases |
| Intervention / exposure | All types of face covering, including (but not limited to) handmade and commercial cloth masks (cloth, cotton, gauze, etc), and medical masks | Studies comparing effectiveness of surgical masks to N95 respirators |
| Outcomes | • transmission of SARS-CoV-2<br>• SARS-CoV-2 infection<br>• basic reproduction number<br>• mask filtration capacity / droplet transmissions | |
| Language | English | |
| Date of publication | 25 March 2020 to 5 June 2020 | |
| Study design | • experimental or observational studies<br>• modelling studies<br>• laboratory studies | • Systematic reviews<br>• Guidelines<br>• Opinion pieces |
| Publication type | Published and pre-print | |

# Screening

Title and abstract screening was done by 2 reviewers: 10% of the eligible studies were screened in duplicate with a 96% agreement (disagreements were resolved by discussion) and the remainder were screened singly by 2 reviewers (half each). Full text screening was done by one reviewer and checked by a second. Figure A.1 illustrates this process. The list of excluded studies is provided in Annexe B.

## Data extraction and quality assessment

Data extraction was done by one reviewer.

Due to the rapid nature of the work, a validated risk of bias tool was not used to assess study quality. However, major sources of bias were noted when reviewing the papers.

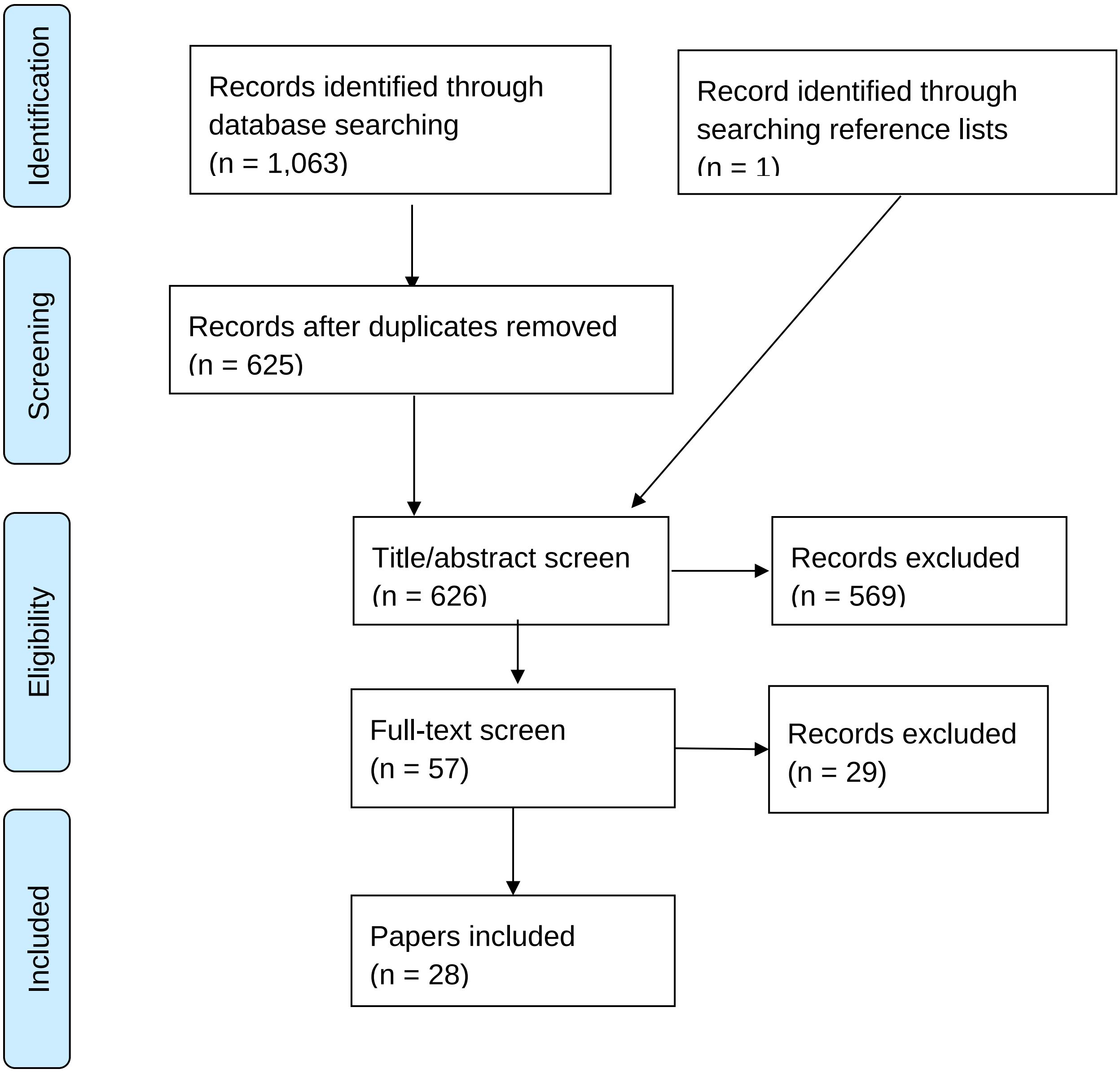


**Figure A.1. PRISMA diagram**

Figure A.1. PRISMA diagram alt text

A PRISMA diagram showing the flow of studies through this review.

There were n = 1,063 records identified through database searching, reduced to n = 625 records after duplicates removed, and n = 1 record identified through searching reference lists, meaning n = 626 were screened on titles and abstracts.

Of these, n = 569 records were excluded, leaving n = 57 records which underwent full-text screening.

Of these, n = 29 records were excluded, leaving n = 28 included papers.

# Annexe B. Excluded studies

| Reference | Reason for exclusion |
|---|---|
| Aggarwal and others, Facemasks for prevention of viral respiratory infections in community settings: A systematic review and meta-analysis | Not primary evidence (systematic review) |
| Amendola and others, A rapid screening method for testing the efficiency of masks in breaking down aerosols | Methodology proposal for testing efficacy of aerosol dissemination in masks. |
| Bae and others, Notice of Retraction: Effectiveness of Surgical and Cotton Masks in Blocking SARS-CoV-2 | Retracted |
| Bae and others, Effectiveness of Surgical and Cotton Masks in Blocking SARS-CoV-2: A Controlled Comparison in 4 Patients | |
| Barraclough & Parmar, A new modification of a visor mask for use with a head-light and loupes | Not primary evidence (opinion) |
| Brainard and others, Facemasks and similar barriers to prevent respiratory illness such as COVID-19: A rapid systematic review | Not primary evidence (systematic review) |
| Chen and others, Hand Hygiene, Mask-Wearing Behaviors and Its Associated Factors during the COVID-19 Epidemic: A Cross-Sectional Study among Primary School Students in Wuhan, China | Outcome: prevalence & behaviour changes; no results on effectiveness |
| Chowell and others, Sustainable social distancing through facemask use and testing during the Covid-19 pandemic | Not primary evidence (opinion) |
| Chu and others, Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis | Not primary evidence (systematic review) |
| Clase and others, Cloth Masks May Prevent Transmission of COVID-19: An Evidence-Based, Risk-Based Approach | Not primary evidence (opinion) |
| Cowling and others, Impact assessment of non-pharmaceutical interventions against coronavirus disease 2019 and influenza in Hong Kong: an observational study | Outcome: behaviour & behaviour changes; no results on effectiveness |
| Di Lorenzo & Di Trolio, Coronavirus Disease (COVID-19) in Italy: Analysis of Risk Factors and Proposed Remedial Measures | Not primary evidence (opinion) |

| Reference | Reason for exclusion |
| --- | --- |
| Elachola and others, COVID-19: Facemask use prevalence in international airports in Asia, Europe and the Americas, March 2020 | Not primary evidence (letter to editor) |
| Esposito and others, Universal use of face masks for success against COVID-19: evidence and implications for prevention policies | Not primary evidence (letter to editor) |
| Grover, Efficacy of face masks depends on spatial relation between host and recipient and who is being protected | Not primary evidence (opinion) |
| Gunasekaran and others, Prevalence of facemask use among general public when visiting wet market during Covid-19 pandemic: An observational study | Outcome: prevalence; no results on effectiveness |
| Gupta and others, The use of facemasks by the general population to prevent transmission of Covid 19 infection: A systematic review | Not primary evidence (systematic review) |
| Ho and others, Medical mask versus cotton mask for preventing respiratory droplet transmission in micro environments | Mentioned COVID-19 but no direct evidence from COVID-19 |
| Jefferson and others, Physical interventions to interrupt or reduce the spread of respiratory viruses. Part 1 - Face masks, eye protection and person distancing: systematic review and meta-analysis | Not primary evidence (systematic review) |
| Kamata and others, Universal public use of surgical mask and respiratory viral infection Universal public use of surgical mask and respiratory viral infection | No direct evidence from COVID-19 (Cross-sectional survey, Japan, 2017) |
| Kim, What Type of Face Mask Is Appropriate for Everyone-Mask-Wearing Policy amidst COVID-19 Pandemic? | Not primary evidence (opinion) |
| Leung and others, Respiratory virus shedding in exhaled breath and efficacy of face masks | No direct evidence from COVID-19 and surgical masks only |
| Liang and others, Efficacy of face mask in preventing respiratory virus transmission: A systematic review and meta-analysis | Not primary evidence (systematic review) |
| MacIntyre & Chughtai, A rapid systematic review of the efficacy of face masks and respirators against coronaviruses and other respiratory transmissible viruses for the community, healthcare workers and sick patients | Not primary evidence (systematic review) |

| Reference | Reason for exclusion |
|---|---|
| Matusiak and others, Inconveniences due to the use of face masks during the COVID-19 pandemic: a survey study of 876 young people | Outcome: inconvenience; no results on effectiveness |
| Mondal and others, Utility of Cloth Masks in Preventing Respiratory Infections: A Systematic Review | Not primary evidence (systematic review) |
| Pleil and others, The scientific rationale for the use of simple masks or improvised facial coverings to trap exhaled aerosols and possibly reduce the breathborne spread of COVID-19 | Not primary evidence (editorial) |
| Stern and others, [Rapid review of the use of community-wide surgical masks and acute respiratory infections] | Not primary evidence (systematic review) |
| Szarpak and others, Cloth masks versus medical masks for COVID-19 protection | Not primary evidence (letter to editor) |

# Annexe C. Data extraction

**Table C1. Observational studies**

Acronyms used: CI = confidence interval, HKSAR = Hong Kong Special Administrative Region, OR = odds ratio

| Reference | Study design | Methods | Findings in relation to masks use in the community | Comments |
|---|---|---|---|---|
| Cheng and others, 2020 (14)<br>In press<br><br>'The role of community-wide wearing of face mask for control of coronavirus disease 2019 (COVID-19) epidemic due to SARS-CoV-2' | Study type:<br>epidemiological study.<br>Participants: Hong Kong Special Administrative Region (HKSAR).<br>Objective: to assess the effect of community-wide mask usage to control COVID-19 in HKSAR.<br>Settings: community. | Patients with respiratory symptoms at outpatient clinics or hospital wards were screened for COVID-19 per protocol.<br>Epidemiological analysis was performed for confirmed cases.<br>Compliance of face mask usage was monitored by 69 University staff members during their morning commute among the first 50 persons they saw and over 3 consecutive days (6 to 8 April 2020).<br>Incidence of COVID-19 (per million population) in HKSAR was compared to that of non-mask-wearing countries which are comparable with HKSAR in terms of population density, healthcare system, BCG vaccination and social distancing measures but not community-wide masking. | Within first 100 days (31 December 2019 to 8 April 2020), 961 COVID-19 patients were diagnosed in HKSAR.<br>Compliance of face mask usage in April: 10,050 persons were observed, of which 337 (3.4%) did not wear face mask.<br>11 COVID-19 clusters were observed in recreational 'mask-off' settings compared to only 3 in workplace 'mask-on' settings (p=0.036).<br>The incidence of COVID-19 in HKSAR was significantly less than that of the selected countries in Asia, Europe (including UK), and North America, where face mask usage was not universally adopted in the community.<br>The authors concluded that community-wide mask wearing may contribute to the control of COVID-19. | Authors-identified limitations<br>Mask-off settings in the family were not analysed.<br>Type of mask used in the community cannot be controlled, and compliance (no touching, hand-washing before and after, etc) cannot be assessed.<br>Mask compliance cannot be directly counted for every community settings.<br>Notes from the review team<br>No information provided on whether the results were adjusted for potential confounding factors.<br>There is a potential risk of bias in the methods used to ascertain the exposure (mask usage); however, this risk is lower in this study than in some of the other studies identified. |
| Fan and others, 2020 (18)<br>In press<br><br>'The epidemiology of reverse transmission of COVID-19 in Gansu Province, China' | Study type: epidemiological study or case report.<br>Participants: 311 citizens evacuated from Iran to the quarantine centre of Gansu Province; 82% were students, median age 23 years old.<br>Settings: community.<br>Objective: to report the epidemiological characteristics | Screening (temperature, symptom questionnaire and epidemiological history) and SARS-CoV-2 test (PCR, oral/nasopharynx swab) performed at the airport upon arrival.<br>Those testing positives were admitted to hospital, and the others were isolated for 14-day.<br>Demographic data, including sex, age, occupation, nationality and exposure history were provided by Gansu Provincial Centre for Disease Control and Prevention, and clinical data were provided by Lanzhou | 37 out of 311 returnees (12%) tested positive. All were international Chinese students from 2 universities (one in Qom province and one in Golestan province).<br>Higher rate of infection observed amongst the returnees from Qom (15%) and Golestan provinces (30%), compared to Tehran (3%). Note: at the time of evacuation, Qom and Tehran reported larger number of infections in local population (more than 400) compared to Golestan province (100 to 199).<br>Significant positive correlation between the incidence of infection and male sex ($\chi2$=11.615, p=0.001), younger age (16 to 30 years) (p=0.014), Hui and other races (p=0.026), or residing in a dormitory ($\chi2$=4.088, p=0.043). | Authors-identified limitations<br>Scarce literature about demographics and clinical aspects of COVID-19 in Iran.<br>Spatial risk factors in Iran and potential risk in China difficult to assess due to the low number of cases and short study period.<br>Comments by the review team<br>No information provided on whether the results were adjusted for potential confounding factors, for example not clear whether the association between mask and increased risk would still be significant if controlled for 'residing in a dormitory'. |

| Reference | Study design | Methods | Findings in relation to masks use in the community | Comments |
|---|---|---|---|---|
| | and the clinical features of these 31 citizens to provide critical and objective information to help control the spread of COVID-19 to other provinces and countries. | Pulmonary Hospital and Gansu Provincial Hospital.<br><br>Geographical analysis (spatial distribution) and statistical analysis performed. | Wearing a facemask while in Iran also increased the risk for COVID-19 infection: 24% amongst those wearing mask vs 10% in those not wearing masks ($\chi 2=7.902$, $p=0.005$).<br><br>Authors' comments on these results:<br>• source of infections may be from University (dormitories in shared facilities) and Mosques<br>• it is possible that those wearing masks i) were involved in higher risks activities, for example dormitories, classes, mosques or ii) neglected other measures, for example social distancing and hygiene, or that iii) masks may not have been P2 or N95 and may not have been used adequately. | The population studied here is not representative of the general population (international students).<br><br>Overall, this study was judged as being at high risk of bias. |
| Hunter and others, 2020 (17)<br><br>PRE-PRINT<br><br>'Impact of non-pharmaceutical interventions against COVID-19 in Europe: a quasi-experimental study' | Study type: epidemiological study.<br><br>Participants: 30 European countries (including UK).<br><br>Settings: country-level or community.<br><br>Objective: to analyse the different approaches to and timing of restrictions in the different countries and identify what effects such restriction may have had on the control of the epidemic. | Data analysis: 2 sets of analyses conducted:<br>1) multi-level mixed effects regression analysis, using a mixed effects negative binomial regression model with cases or deaths on a specific day as the outcome variable, country population as the exposure variable, country as a mixed affect, and days from start of the epidemic as a fixed effect.<br>2) R modelling using Bayesian generalised additive mixed models (GAMM) to adjust for spatial dependency in disease between nation states.<br><br>Data source: the European Centre for Disease Control for data on case numbers (up to 24 April 2020), the Institute of Health Metrics and Evaluation website and published sources for dates of initiation of various control strategies. | The exposure-response relationships estimated by the models show that the use of face coverings initially seemed to have had a protective effect but that, after day 15 of the face covering advisories or requirements, the number of cases started to rise. Similar patterns were observed for the relationship between face coverings and deaths.<br><br>The authors noted that there was even a suggestion that they may actually increase risk, but they estimated that the data on face coverings were too preliminary to be reliable (due to recent introduction) and should not be used to inform public policy.<br><br>The authors concluded that the wearing of facemasks or coverings in public was not associated with any independent additional impact. | Authors-identified limitations<br><br>Hard to separate out individual intervention effects due to collinearity and to many interventions having been implemented in different ways and at different points in the local epidemic.<br><br>Many subtle variations in how control measures were implemented could not be captured in this model. Lack of direct observation of these variations may have biased the results.<br><br>Notes from review team<br><br>The authors described their study as being a quasi-experimental study, although it used a similar design to the country-level epidemiological studies reported here.<br><br>A number of factors were adjusted for in the model, but residual confounding cannot be ruled out.<br><br>The potential risk of bias in the methods used to ascertain the exposure is high as mask usage was assessed based on national policies. |

| Reference | Study design | Methods | Findings in relation to masks use in the community | Comments |
|---|---|---|---|---|
| Kenyon, 2020 (15)<br>PRE-PRINT<br><br>'Widespread use of face masks in public may slow the spread of SARS CoV-2:<br>an ecological study' | Study type: epidemiological study.<br>Participants: 49 countries (including UK).<br>Settings: country-level or community.<br>Objective: to assess if there is ecological level evidence that countries that promoted face mask usage in public had a lower number of COVID-19 diagnoses per capita. | Hypothesis: population level usage of face masks may be negatively associated SARS CoV-2 spread.<br>Statistical analysis: linear regression was used to assess at country level the association between COVID-19 diagnoses per inhabitant and the national promotion of face masks in public (coded as a binary variable), controlling for the age of the COVID-19 epidemic and testing intensity.<br>Data source: European Centre for Disease Control (up to 29 March 2020) and national documents and guidance. | Out of the 49 countries, 8 advocated wearing face masks in public: China, Czechia, Hong Kong, Japan, Singapore, South Korea, Thailand and<br>Malaysia.<br>In multivariate analysis, face mask use was negatively associated with number of COVID-19 cases per inhabitant (coefficient = -326, 95% confidence interval [CI]: -601 to -51, p=0.021).<br>The analyses were repeated excluding Czechia (only country to introduce universal face masks late in the epidemy), which slightly strengthened the association between COVID-19 cases and face mask usage.<br>The authors concluded that whilst these results are susceptible to residual confounding, they do provide ecological level support to the individual level studies that found face mask usage to reduce the transmission and acquisition of respiratory viral infections. | Authors-identified limitations<br>Lack of accurate data to control for confounders such as contact tracing or isolation; if these were responsible for slower spread, this model would have falsely attributed this effect to face masks.<br>It was not possible to quantitate the intensity of face mask use per country, resulting in a crude binary classification of face mask usage.<br>Notes from the review team<br>Results were adjusted for only 2 factors and are likely to be subject to confounding.<br>The potential risk of bias in the methods used to ascertain the exposure is high as mask usage was assessed based on national policies (coded as 0 or 1). |
| Leffler and others, 2020 (16)<br>PRE-PRINT<br><br>'Association of country-wide coronavirus mortality with demographics, testing, lockdowns, and public wearing of masks (Update June 2, 2020)' | Study type: epidemiological study.<br>Participants: 198 countries.<br>Settings: country-level or community.<br>Objective: to assess the impact of masks on per-capita COVID-19-related mortality. | Hypothesis: in countries where mask use was either an accepted cultural norm or favoured by government policies on a national level, the per-capita mortality might be reduced, as compared with remaining countries.<br>Statistical analysis: significant predictors of per-capita coronavirus mortality in the univariate analysis were analysed by stepwise backwards multivariable linear regression analysis.<br>Potential predictors analysed included age, sex ratio, obesity prevalence, temperature, urbanization, smoking, duration of infection, lockdowns, viral testing, contact tracing policies, and public mask-wearing norms and policies.<br>Data source: Worldometers Database (9 May 2020). Countries were included if either:<br>1) coronavirus testing data were available by 9 May 2020 | In some Asian countries, masks were used extensively by the public from the beginning of the outbreak. Despite the fact that the outbreak tended to appear quite early in these countries, they had experienced a low per-capita coronavirus mortality by 9 May 2020.<br>Multivariable analyses with obesity data (194 countries):<br>• 'duration since masks were recommended' significant predictor of the logarithm of each country's per-capita coronavirus mortality (p<0.001)<br>• in countries not recommending masks, the per-capita mortality tended to increase each week by 47.4%; in countries recommending masks: 9.0%; under lockdown (without masks): 38.7%.<br>Multivariable analyses with obesity and testing data (179 countries):<br>• 'duration since masks were recommended' continued to be a significant predictor (p≤0.001)<br>• 49.1% increase in per-capita mortality each week in countries without masks; in countries where masks were recommended: 13.1% | Authors-identified limitations<br>Evidence concerning the actual levels of mask-wearing by the public are not available for most countries, especially in Western countries were mask-wearing is recommended rather than mandatory.<br>Source of mortality data is often from governments which may not have the resources to provide a full accounting of their public health crises, or an interest in doing so.<br>Country-wide analyses are subject to the ecologic fallacy.<br>Notes from the review team<br>A number of factors were adjusted for in the model, but residual confounding cannot be ruled out.<br>The potential risk of bias in the methods used to ascertain the exposure is high as mask usage was assessed based on national policies. |

| Reference | Study design | Methods | Findings in relation to masks use in the community | Comments |
|---|---|---|---|---|
| | | 2) testing and lockdown policies had been graded by the University of Oxford Coronavirus Government Response Tracker<br><br>Additional data were obtained from European Centre for Disease Control and other public databases.<br><br>Assumption made: the date of each country's initial infection was estimated as the earlier of: i) 5 days before the first reported infection, or ii) 23 days before the first death. | Multivariable analyses with containment, testing and health policies data (161 countries):<br>• 'duration that masks were recommended' was independently predictive of per-capita mortality<br>• weekly increase in per-capita mortality was 26.68%; when masks were worn: 0.4%<br><br>The authors concluded that these results support the universal wearing of masks by the public to suppress the spread of the coronavirus. | The list of the 198 countries included was not provided, although it can be assumed that UK was one of them.<br><br>The authors noted that given the low levels of coronavirus mortality in the Asian countries which adopted widespread public mask usage, it seems highly unlikely that masks are harmful. However, it is not clear whether these observations are transferable to European countries, among other dur to cultural differences. |
| Wang and others, 2020 (13)<br><br>Accepted manuscript<br><br>'Reduction of secondary transmission of SARS-CoV-2 in households by face mask use, disinfection and social distancing: a cohort study in Beijing, China' | Study type: retrospective cohort study.<br><br>Participants: 335 people in 124 families with at least one laboratory-confirmed case of COVID-19 in Beijing, China.<br><br>Setting: households.<br><br>Objective: to study the use of NPIs such as face masks, social distancing and disinfection in the household setting to inform community epidemic control and prevent transmission of COVID-19 in households. | Families with and without secondary transmission were compared for various measured risk factors, preventive interventions and exposures in order to analyse the predictors of household transmission.<br><br>Duration: 28 February to 27 March 2020<br><br>Outcome: secondary transmission of SARS-CoV-2 within the family.<br><br>Data collection: 3-part structured questionnaire (by telephone?).<br><br>Data on primary case extracted from epidemiological reports from the Beijing Center for Disease Prevention and supplemented by telephone interview.<br><br>Statistical analyses: multivariable logistic regression model to identify risk factors associated with SARS-CoV-2 household transmission. | Secondary attack rate in family: 23.07% (77/335)<br><br>4 factors were significantly associated with secondary transmission:<br>• increased risk: primary case having diarrhoea; and daily close contact with primary case<br>• reduced risk: frequent use of chlorine or ethanol-based disinfectant in households and family members (including the primary case); wearing a mask at home before the primary case developed illness<br><br>Face mask use by the primary case and family contacts before the primary case developed symptoms was 79% effective in reducing transmission (odds ratio [OR]=0.21, 95% CI: 0.06 to 0.79).<br><br>Wearing a mask after illness onset of primary case was significantly protective in univariate analysis but not in multivariate analysis. | Authors-identified limitations<br><br>Telephone interview has limitations for example, recall bias.<br><br>The evaluation results of mask wearing were reliable, but data on the concentration of disinfectant used by families were not collected.<br><br>Notes from the review team<br><br>Based on its design, this study might be less subject to bias than the other observational studies identified, among other due to:<br>• exposure assessed in a more reliable way (at individual level rather than based on national policies)<br>• the results are still subject to residual confounding, but probably less than the epidemiological studies<br><br>The results from this study, conducted in Chinese households, might not be applicable to the UK context. |
| Zeng and others, 2020 (19)<br><br>In press | Study type: epidemiological study.<br><br>Participants: China, South Korea, Italy and Spain. | Data analysis: the generalized additive model was used to generate the epidemiological curves (daily infection and daily reported) and simulate infection curves with reported incubation period. | In China, mandatory mask wearing by the public likely played an important role in stopping the spread of the disease. The combination of the measures taken (mask wearing, city lockdown and medical resources) collectively contained the epidemic and dramatically reduced the number of infected cases. | Authors-identified limitations<br><br>None reported.<br><br>Notes from the review team<br><br>This study seems to be mainly based on visual assessment of the epidemiological curves with |

| Reference | Study design | Methods | Findings in relation to masks use in the community | Comments |
|---|---|---|---|---|
| 'Epidemiology reveals mask wearing by the public is crucial for<br>COVID-19 control' | Settings: country-level or community.<br>Objective: to analyse the epidemiological features of China, South Korea, Italy and Spain to find out the relationship of major public health events and epidemiological curves. | Data source: from publicly available sources.<br>Assumptions made: the interval from symptom onset to report was around 8 days and the median of the incubation period was 5.2 days (95% CI: 4.1 to 7.0). | In South Korea, the epidemic was predominantly confined to spread within religious groups and not to the wider community. This may be because of the general practice of mask wearing by the public, based on 1) sales numbers and 2) 10 days after government instructed face-wearing by the public, the number of daily reported cases declined.<br>The authors noted that the epidemic could not be satisfactorily contained in in Italy and in Spain, due to the shortage of medical resources, non-mandatory advice on wearing of masks and the people are not adapted to wearing masks.<br>The authors concluded that their analysis supports the importance of mask wearing by the public. | the date of introduction of the different measures; confounding factors were not considered.<br>The potential risk of bias in the methods used to ascertain the exposure is high as mask usage was assessed based on national policies or news articles.<br>The conclusions for Spain and Italy seem to be more an opinion than based on data.<br>Overall, this study was judged as being at high risk of bias. |

**Table C2. Modelling studies**

Acronyms used: ABR = Aerosol Block Rate, ICU = intensive care unit, NPI = non-pharmaceutical intervention, SEIR = susceptible, exposed, infected, recovered, SIR = susceptible, infected, recovered, VPR = Virus Penetration Rate

| Reference | Model characteristics | Scenarios/models and outcome measures | Findings relating to use/efficacy of masks |
|---|---|---|---|
| Barr, G., May 2020 (32) PRE-PRINT<br>'A model showing the relative risk of viral aerosol infection from breathing and the benefit of wearing masks in different settings with implications for COVID-19' | Model: Basic Model<br>Model calibration data: Not reported<br>Model Parameters:<br>1. Infectious dose<br>2. Viral density in aerosol particles<br>3. Particle exhalation per Litre for an infectious person<br>4. Volume of air expired per minute by infectious person<br>5. Volume of air inspire per minute for non-infected person<br>6. Mask<br>7. No Mask<br>8. Distance between persons<br>Mask parameters:<br>1. Cloth mask<br>2. Surgical mask<br>3. FFP3 mask<br>4. Inspiratory filtration factor for infected person breathing out<br>5. Filtration factor for non-infected person breathing in<br>Author-identified limitations: | Scenarios:<br>A. Close by, breathing the exhaled air of an infectious person with no dilution. Both breathing normally<br>1. Non-infected wearing surgical mask<br>2. Both wearing surgical mask<br>3. Non-infected wearing surgical mask and infected wearing FFP3 mask<br>4. Non-infected wearing FFP3 mask and infected wearing surgical mask<br>5. Both wearing cloth mask<br>B. 2 people in car, one infected, 2m apart, no ventilation, fresh uncontaminated air at the start.<br>1. No masks<br>2. Non-infected wearing surgical mask<br>3. Non-infected wearing FFP3<br>4. Both wearing surgical mask<br>5. Both wearing cloth mask | Wearing a mask is beneficial at every aspect of infection modality, when compared to no masks.<br>For 2 people wearing masks, the protection is multiplicative, not additive. Increase in protection is 17-fold if infectious and non-infected both wear a mask, compared to no mask at all. This protection is increased by only 2.8-fold if only the non-infected wears a surgical mask<br>Wearing a mask will reduce the number of infectious particles which could mean reducing chance of infection or having a milder infection.<br>All masks reduce infectious dose if worn by a non-infected person.<br>The effects of social distancing in confined areas, such as work place, can be time limited if one person is infected. This time can be extended over a longer period with use of masks and air replacement. An infectious and non-infected both |

| Reference | Model characteristics | Scenarios/models and outcome measures | Findings relating to use/efficacy of masks |
|---|---|---|---|
| | This is a comparative analysis and not an actual situation. Assumptions made on parameters could be less or more than what is actually the case, for example, minimum or maximum infectious dose. Account for decay of aerosol is estimated as it can be greatly affected by particle size and humidity. | C. 2 people in confined space such as car 2m$^3$, one infected person already present for 3 hours and no ventilation.<br>1. No masks<br>2. Non-infected wearing FFP3<br>3. Non-infected wearing surgical mask<br>4. Non-infected wearing cloth mask<br>5. Both wearing surgical mask from the start<br>Ventilation introduced at start of 3 hours as described above.<br>1. Non-infected with no mask<br>2. Non-infected with cloth mask<br>D. Infected person in a room or working in small shop 30m$^3$ for 3 hours, no ventilation.<br>1. Non-infected with no mask<br>2. - Non-infected with cloth mask | wearing surgical masks in this environment has a beneficial effect greater than equivalent of 200 litres per minute air replacement. These effects combined made an extremely large difference. |
| Brauner, J. and others June 2020 (33)<br>PRE-PRINT<br>'The effectiveness and perceived burden of nonpharmaceutical interventions against COVID-19 transmission: A modelling study with 41 countries.' | Model: Semi-mechanistic Bayesian hierarchical model<br>Model Calibration data:<br>Epidemic Forecasting Global NPI Database<br>Data Characteristics:<br>1. Data from 67 countries on general population<br>2. 1700 events<br>3. Distilled in to 24 classes of NPI<br>Setting:<br>Country-specific<br>Community and publicly accessed facilities and/or environments<br>Model parameters:<br>1. Nine defined Non-pharmaceutical interventions (NPI) including Mask-wearing<br>2. Growth rate of new infections<br>3. Infection rate of infections that are confirmed positive or lead to a reported death.<br>4. Observation for confirmed cases<br>5. Observation model for deaths<br>6. Preference elicitation (survey data) | Outcome:<br>Growth reductions of NPIs when compared to growth rate without NPIs of Basic reproduction number ($R_0$)<br>Effectiveness-burden-ratio | Each NPI in the model reduces $R_0$ by a multiplicative factor and assumes no interaction between different NPIs.<br>All NPIs except mask-wearing had a more than 95% posterior probability of being effective.<br>Mask-wearing was observed as a more preferable NPI against all others over a 50 week period, except for 'gatherings limited to 1,000 people or less'.<br>While these observations were made, the author concluded that there is insufficient data to make claims about the effectiveness for mask-wearing from this model. |

| Reference | Model characteristics | Scenarios/models and outcome measures | Findings relating to use/efficacy of masks |
|---|---|---|---|
| | Mask parameters:<br>Satisfying one, or both of:<br>• a country has implemented a policy of requiring mask usage among the general public, sometimes limited to certain domains like a duty to wear masks in public transport and supermarkets.<br>• survey reports indicate that over 60% of people were wearing masks in public.<br>Author-identified limitations:<br>Mask-wearing NPIs had the least available data which may explain the lack of observed effect. | | |
| Chen, Y., & Dong, M. June 2020 (31)<br>PRE-PRINT<br>'How Efficient Can Non-Professional Masks Supress COVID-19 Pandemic?' | Model: Monte Carlo simulation<br>Model calibration data:<br>N/A<br>Model Parameters:<br>1. No mask use<br>2. Cotton face mask (non-professional)<br>3. Mask Aerosol Block Rate (ABR)<br>4. Virus Penetration Rate (VPR)<br>5. Aerosol diameter<br>6. Transmission rate ($R_0$)<br>7. Contact rate (C)<br>Mask Parameters:<br>Pore size and density (µm)<br>Setting: Social network<br>Author-identified limitations: None disclosed | Simulation:<br>1. ABR and VPR performance of masks of variable pore density<br>2. COVID-19 pandemic simulation in a Social Network with no NPI measures.<br>3. COVID-19 Pandemic simulation in a Social Network introducing 5 types of face mask<br>A+: VPR = 20%, Pore Size= 20µm)<br>A: VPR = 50%, Pore Size= 37.3µm)<br>B: VPR = 60%, Pore Size= 49.4µm)<br>C: VPR = 70%, Pore Size= 70.7µm)<br>D: VPR = 80%, Pore Size= 110.3µm)<br>Outcome<br>Change in Basic reproduction number ($R_0$) | VPR was lowest, and ABR highest, when using masks with smaller Pore Diameters.<br>Non-professional (Pore size between 20 µm and 120 µm) masks satisfy VPR and ABR; VPR between 50.71% and 90.33%, and ABR between 6.15% and 32.92%. Detailing that masks with Pore diameter 120 µm can block 6.15% aerosols and 9.67% viruses, whereas face masks with pore diameter 20 µm can block 32.92% aerosols and 49.29% viruses.<br>Exploitation of face masks, even those with large pores, appear to be effective at reducing $R_0$.<br>With Class A+ Face masks, the outbreak curve can be flattened both at the beginning of COVID-19 Pandemic, or one-week after the outbreak. This assumes full population coverage.<br>Exploitation of Class A+ masks since day 7, day 14, and day 17 of outbreak revealed a much stronger suppressive effect on $R_0$ over time, even compared to exploitation on day 21, 4 days later. |
| Chernozhukov, V. and others May 2020 (30)<br>PRE-PRINT<br>'Causal impact of masks, policies, behaviour on early | Model: Causal model with SIR-based case growth model.<br>Model Calibration data:<br>1. New York Times daily COVID-19 Cases and Deaths<br>2. John Hopkins University CSSE Reported Cases and Deaths<br>3. COVID Tracking project reported cases and deaths.<br>4. COVID Tracking project number of tests.<br>Setting:<br>General population, Employees of public-facing businesses, U.S | The effect of the model parameter variables were inputted to the model to evaluate their dynamic impact of the spread of COVID-19 infection.<br>Outcome:<br>1. Basic reproduction rate ($R_0$)<br>2. Reported cases | Mandating the use of masks by employees that work for public-facing businesses could potentially affect the COVID-19 transmission directly.<br>Weekly policies and behaviour variables were highly correlated, except for the 'Masks for employees' policy. Their effects however, are difficult to separate. |

| Reference | Model characteristics | Scenarios/models and outcome measures | Findings relating to use/efficacy of masks |
|---|---|---|---|
| COVID-19 Pandemic in the U.S' | Model parameters:<br>Dynamic impact of policy on spread of COVID-19 Policies:<br>1. State of emergency<br>2. Mandatory face masks for employees of public-facing businesses<br>3. Stay at home order,<br>4. Closure of school<br>5. Closure of restaurant, except take out,<br>6. Closure of movie theaters<br>7. Closure of non essential businesses.<br>8. Effect of behaviour on spread of COVID-19<br>Behaviour:<br>1. Intensity of visit to transit, grocery, retail, and work place.<br>2. Growth and log rate of tests.<br>Mask parameters:<br>Introduction (time) of mandated use of masks by employees of public-facing businesses<br>Author-identified limitations:<br>None declared | | The effect of policies and behaviour on case growth showed a reduction in cases only for the 'Wearing face masks' policy and was the only policy to meaningfully affect case growth when behaviours remained constant. |
| Eikenberry, S., and others April 2020 (29)<br><br>'To mask or not to mask: Modelling the potential for face mask use by the general public to curtail the COVID-19 Pandemic' | Model: Compartmental<br>Model Calibration data: US Census (2019)<br>Model Parameters:<br>1. No mask use<br>2. Epidemiological factors ($R_0$)<br>3. Mask efficiency<br>4. Mask use<br>Mask Parameters:<br>1. Cloth (20% to 80% efficiency)<br>2. Surgical (70% to 90% efficiency)<br>3. N95 (over 95% efficiency)<br>Data Characteristics:<br>General population (Asymptomatic)<br>Setting:<br>New York & Washington State – General public<br>Author-identified limitations: | Baseline Scenario:<br>No mask used and Basic reproduction number ($R_0$)<br>Comparator Scenarios:<br>1. General population mask uptake (%) & mask effectiveness (%) with fixed & variable transmission rates.<br>2. All symptomatic persons wear mask and variable general population mask uptake (20%, 40%, 60%, 80%) + variable mask effectiveness (20%, 40%, 60%, 80%).<br>3. General population mask coverage and Mask efficiency of outgoing or incoming transmission blocking.<br>Outcome:<br>1. Change in number of deaths, peak hospitalisation, & SARS-COV-2 Infection rate<br>2. Basic reproduction number ($R_0$) | In a hypothetical scenario, In Washington and New York states, immediate near universal (80%) uptake of moderately (50%) effective masks could prevent 17 to 45% of projected deaths over 2 months. Further, peak daily death rate may reduce by 34 to 58%<br>Broad adoption of even relatively ineffective face masks may meaningfully reduce community transmission of COVID-19.<br>Relative benefit may increase as masks can synergise with other public health measures.<br>The $R_0$ decreased when masking symptomatic individuals. This improve when sequentially increasing the total population mask coverage and the effectiveness of the mask used. Masking the general population also yielded increased benefits when 25%, 50%, and 75% of general population were assume asymptomatic. |

| Reference | Model characteristics | Scenarios/models and outcome measures | Findings relating to use/efficacy of masks |
|---|---|---|---|
| | Results should be interpreted with caution, owing to potentially high non-compliance of mask wearing, uncertainty on effectiveness of home masks, and some uncertainties around infection transmission mechanisms. | 3. Simulated future deaths. | Masks found to be useful in preventing illness in healthy persons and preventing asymptomatic transmission. |
| Gosce, L., and others, May 2020 (28)<br>In Press<br><br>'Modelling SARS-COV2 Spread in London: Approaches to Lift the Lockdown' | Model: SEIR deterministic compartmental with a daily-time step<br>Model Calibration data:<br>1. Public Health England (PHE)<br>2. National Health Service (NHS)<br>3. Transport for London (TFL)<br>Model Parameters:<br>Symptom status (asymptomatic vs symptomatic) in<br>1. General population<br>2. By age group<br>3. By borough<br>Mask Parameters: Face masks, estimated at 30% efficacy transmission prevention. Face coverings, estimated at 10% efficacy transmission prevention.<br>Data Characteristics: General population<br>Setting: Urban, City (London) – General population<br>Author-identified Limitations: Improving available data in Hospital admission & testing and community testing would allow a more precise calibration of mortality and notification rates and estimates on size of the epidemic within the model. | Baseline Scenario:<br>Comparator scenarios compared with Lockdown being lifted on 8 May 2020 with no further intervention.<br>Comparator scenarios:<br>1. A City-wide lockdown continuation, comparing impact with an early removal of lockdown limitations.<br>2. Universal testing (once, twice, or three times per week) when less stringent social distancing than full lockdown is in place (for example, business reopen but people encouraged to work from home)<br>3. Shielding vulnerable groups (ages more than 60 years) in context of lifting of lockdown more generally.<br>4. Impact of combining universal testing & face coverings use without lockdown<br>5. Universal testing, isolation of infectious cases and their contacts & use of face coverings during lockdown.<br>Outcome:<br>1. Change in number of deaths & SARS-COV-2 Infections<br>2. Basic reproduction number ($R_0$) | Lifting lockdown with no additional intervention yielded the greatest change in deaths (14.5-fold) and highest rate of infection ($R_0$=2.56)<br>Weekly universal testing was more effective under lockdown compared to without lockdown & with face coverings (0.42-fold, $R_0$=0.5; 11.4-fold, $R_0$=1.92 respectively)<br>Weekly universal testing under lockdown improved further when face coverings were used (0.45-fold, $R_0$=0.44) and when face covering and contact tracing was used (0.48-fold, $R_0$=0.27)<br>Efficacy of mask use greatly improved change in deaths and infection rate where lockdown was lifted and no additional intervention put in place (30% mask, 30% face covering: 12.34-fold, $R_0$=2.23; 50% mask, 50% face covering: 8.86-fold, $R_0$=1.59; 80% mask, 50% face covering: 8.26-fold, $R_0$=1.53; 80% mask, 80% face covering: 0.26-fold, $R_0$=0.64) |
| Hoertel, N. and others May 2020 (25)<br>PRE-PRINT<br><br>'Lockdown exit strategies and risk of a second epidemic peak: a | Model: Stochastic agent-based microsimulation model<br>Model calibration data:<br>Calibrated based on two-sample Kolmogrov-smirnov test and visual comparison of predicted & observed curves of cumulative incidence, intensive care unit (ICU) admissions, ICU bed occupancy and cumulative mortality.<br>Setting:<br>General population, France | Scenario considerations:<br>In all scenarios, the following were considered, based on statements from the French government:<br>1. Quarantine and restrictions for school, work, and public transport will be lifted on 11 May.<br>2. Restaurants and bars will remain closed from 11 May until 11 June | Social distancing along slowed the epidemic after an 8-week quarantine by flattening the cumulative incidence curve and a 20% decrease in cumulative mortality. Combined with mask-wearing, the curve was further flattened and the decrease in cumulative mortality increased to 60% compared to absence of post-quarantine measures.<br>While effective, it is unlikely that this combination of measures alone would be effective in preventing a second epidemic peak. |

| Reference | Model characteristics | Scenarios/models and outcome measures | Findings relating to use/efficacy of masks |
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| stochastic agent-based model of SARS-COV-2 epidemic in France' | Model parameters:<br>194 parameters were included in the Stochastic agent based model including:<br>1. Individual and disease characteristics based on prior studies and model calibrations (n=161)<br>2. Social contacts based on prior studies (n=11)<br>3. Social contacts where no data were available (n=22)<br>4. Diagnosed cases assumed to be quarantined<br>Mask Parameters<br>A 50% reduction in risk of transmission of infection between individuals was assumed if all individuals either adhered to social distancing or wore masks. If both measures applied, this risk reduction increased to 75%.<br>Author-identified limitations:<br>Potential for bias in diagnosis and mortality rates. Approximations made in some of the parameters used in the model. | 3. Attendance to cinemas, museums and public events will be authorised on 11 July.<br>Baseline Scenario:<br>8-week quarantine and no specific post-quarantine measures<br>Comparator Scenario Components:<br>1. Natural course of epidemic if no quarantine ordered.<br>2. Effect of 8-week quarantine and a 16-week quarantine<br>3. Post-quarantine protection measures, including social distancing and mask-wearing.<br>4. Post-quarantine shielding of individuals vulnerable to severed SARS-COV-2 infection.<br>5. Components compiled in to seven separate scenarios.<br>6. Microsimulation performed on 500,000 individuals, extrapolated to French population (n=67m)<br>Outcome:<br>1. Cumulative incidence of COVID-19<br>2. Cumulative mortality of COVID-19<br>3. ICU-bed occupancy | Mask-wearing only resulted an additional 19% in cumulative mortality compared to partial adherence to shielding vulnerable populations (defined at 50%).<br>As such, combining measures of social distancing, mask wearing, and full or partial shielding of vulnerable populations would result in a greater reduction of cumulative deaths if a lockdown were lifted. |
| Javid, B., & Balaban, N. June 2020 (24)<br><br>'Impact of population mask wearing on COVID-19 post lockdown.' | <u>Model:</u> Simplified SIR model<br>Model calibration data: None mentioned<br>Setting:<br>General population of Israel post lockdown<br>Model Parameters:<br>1. Infection rate<br>2. Recovery rate<br>3. Critical Deterioration rate<br>4. Death rate<br>5. Recovery of critically ill<br>6. Total population size<br>7. Max number of ICU beds | Baseline model:<br>A model where no parameters of masks were used was run to give an estimate of the progression of disease after lockdown, given the estimated parameters, and its effect on the outcomes. This was done for multiple value of $R_0$.<br>Comparator models:<br>The same model was run again separately, including parameters on effectivity of masks (8% and 16%), assuming a fixed adherence to mask-wearing within the population.<br>Outcome: | The model intended to show the impact of reducing infectivity (by use of masks) at high or low values of $R_0$.<br>When the $R_0$ was high (2.2), there was a minor effect of mask use (for both 8% and 16% effective masks) in reducing the number of deaths, or critically ill patients.<br>When $R_0$ approached 1 (1.3 in the model), the effect of mask use was greater for both 8% and 16%-effective masks. |

| Reference | Model characteristics | Scenarios/models and outcome measures | Findings relating to use/efficacy of masks |
|---|---|---|---|
| | Mask Parameters:<br>An assumed 8% or 16% mask efficiency was calculated, based on existing literature.<br>Author-defined limitations:<br>The model is relatively straight forward, basic, and assumes a high compliance of mask-wearing. | 1. Number of critically ill patients<br>2. Cumulative mortality<br>3. Change in Basic reproduction number ($R_0$) | |
| Kot, A., May 2020 (22)<br>PRE-PRINT<br><br>'Critical levels of mask efficiency and of mask adoption that theoretically extinguish respiratory virus epidemics.' | Model: Respiratory Virus epidemiological using Compartmental SIR<br>Model Calibration data: None mentioned<br>Setting:<br>General population and public use<br>Model parameters:<br>- Basic Reproduction Number ($R_0$)<br>- Mask efficiency<br>- Mask adoption levels<br>- Linear or non-linear probability of infection<br>- Ocular route infection transmission contributions<br>Mask Parameters:<br>Estimates of measures of most-penetrating particle-size, and evidence from current literature are used to determine efficiency of masks (0 to 1). In this study, the minimal effective mask efficiency to eradicate the epidemic, given a value for $R_0$ is considered (critical efficiency) so no definitive type of mask is named, though some numerical examples are comparable to that of Surgical masks.<br>Author-defined limitations:<br>SIR models assume homogeneous populations with fixed contacts per day and fixed probability of infection. | Baseline model:<br>The model is run for linear, exponential and approximate Beta-Poisson dose response functions that determine the critical efficiency of a mask to push the $R_0$ of an epidemic below 1, theoretically eradicating the disease.<br>Outcome:<br>1. Peak infection<br>2. Cumulative infection<br>3. Basic reproduction number ($R_0$) | The findings of this model present estimates for critical effectiveness of masks in a population where no other non-pharmaceutical interventions are implemented.<br>Considering when $R_0$=2.5, and with a linear-dose response, the critical mask efficiency is calculated to be 0.5, with a mask adoption level of 80% of the population in order to reduce the $R_0$ to below 1.<br>The estimate is below that of an N95 mask, but well above that of some fabric masks.<br>Considering Surgical masks of efficiency 0.58 and given $R_0$=2.5, 73% mask adoption in the population would be required. For $R_0$=3 and $R_0$=4, 80% and 90% population mask adoption levels would be required to theoretically extinguish the disease.<br>For practical means of population-wide adoption of masks that meet critical effectiveness, A nylon overlay can raise the efficiency of several fabric masks above that of a baseline surgical mask. Subsequently, a Nylon-lined surgical mask is equivocally improved in its effectiveness. |
| Ngonghala, C. and others July 2020 (26)<br><br>'Mathematical assessment of the impact of non-pharmaceutical interventions on | Model: Novel Kermack-McKendrick-type<br>Model Calibration data:<br>New York State real-time assessment and estimate data of the burden on COVID-19.<br>Data is stratified by mutually exclusive compartments of combined elements of susceptibility, quarantine status, symptomatic status, Hospitalisation, and recovery.<br>Setting: Community or General Public | Baseline Model:<br>Baseline epidemiological parameters were estimated or fitted to the model using available COVID-19 data and sources from the available literature.<br>Simulation:<br>The simulation then ran to assess the population-level impact of the 18-various control and mitigation measures in New York state. The simulation also ran the same simulations with | The combined effect of face-mask strategies (even with masks of relatively low efficacy) and social distancing strategies have a greater effect on reducing burden of disease than each intervention individually.<br>When run with various values of mask efficiency and coverage, the model showed a marked decrease in the number of hospitalisations both in New York state, and in the US. Using a mask of efficacy 50% or greater may greatly flatten the pandemic curve. |

| Reference | Model characteristics | Scenarios/models and outcome measures | Findings relating to use/efficacy of masks |
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| curtailing the 2019 novel Coronavirus' | Model parameters:<br>18 Epidemiological, parameters were added to the model, including proportion of the population who wear masks in a public place (mask compliance), and efficacy of face-masks to prevent acquisition of infection by susceptible individuals<br>Mask parameters:<br>For mask efficacy probability estimates (0 to 1) were derived from available literature on previously conducted clinical trials that assess inward efficiency of cloth masks, optimal material masks, surgical masks, and N95 masks. The resulting parameter was a combined probability estimate of all masks.<br>Author-defined limitations:<br>None identified | calibrated and estimated $R_0$ for the US country as a whole.<br>Outcome:<br>The model estimated the effect of non-pharmaceutical interventions on number of hospitalisations and cumulative deaths arising from COVID-19 infection.<br>The model also examined Change in $R_0$ as a result of the effect of non-pharmaceutical interventions. | Although less efficacious masks may not lead to eradication of COVID-19, a population adherence of 75%, wearing masks that are 25% effective, for example, could greatly reduce the burden of COVID-19 by reducing state and country-wide hospitalisations by 63% and 64% respectively.<br>Disease elimination would be feasible, but relies on a 70% or greater population adherence to mask-wearing.<br>Mask-wearing in public (Mask efficacy at least 50%) with strict social distancing measures, reduce the required proportion of population adherence to mask-wearing down to 30%, leading to disease elimination in New York state. |
| Silva, T. and others May 2020 (27)<br>PRE-PRINT<br>'Quantitative analysis of the Effectiveness of Public Health Measures of COVID-19 Transmission' | Model: Spectral network analysis<br>Model Calibration Data:<br>Brazilian State health department COVID-19 Epidemiological bulletins<br>Brazilian Institute of Geography and Statistics<br>Data Characteristics:<br>1. 60,021 city time bulletins<br>2. 2,754 cities<br>Setting:<br>Urban, city – Brazil, General Public<br>Model parameters:<br>1. COVID-19 Network transmission based off available real-life data<br>2. Three-day smoothing filter applied to alleviate concerns with late contamination.<br>Mask parameters:<br>Recommended use of masks by State government and Health Departments as a predictor for changes in<br>Author-defined limitations:<br>None disclosed | Baseline Model:<br>Using the COVID-19 network transmission model, evolution and spread of COVID-19 is simulated in every city of the network, simulating the course that was taken in real life.<br>Comparator Model:<br>Network structure is then changed to simulate the omission of public health policies in the above model as to observe transmission without government interventions.<br>Outcome:<br>1. Changes in Basic reproduction number ($R_0$)<br>2. Change in COVID-19 Epidemic peaks within cities. | Social isolation and the use of masks can effectively reduce the transmission rate of COVID-19 in Brazil.<br>There was a drastic change in the graph spectrum of intercity transmission network of Brazil following an incubation period and introduction of use of mask recommendations.<br>The spectrum then reduced, indicating that the $R_0$ was reducing due to imposed government public health policies.<br>The model does not give an isolated causal impact of the use of masks recommendation, nor of the quarantine measures. Data presented helps to understand a combined effect of Public Health policy change.<br>It was observed however, that introduction of masks reduced growth rates in cities with relatively low social distancing indices, though a causal effect cannot be inferred.<br>There is a suggestion that use of masks may be a more effective measure than social isolation, however the term 'social isolation' and 'social distancing' have been used interchangeably throughout this study and it is unclear to what results support this notion. |

| Reference | Model characteristics | Scenarios/models and outcome measures | Findings relating to use/efficacy of masks |
|---|---|---|---|
| Tian, L. and others April 2020 (21)<br>PRE-PRINT<br><br>'Calibrated intervention and containment of the COVID-19 Pandemic' | Model: Simple novel quantitative model with compartmentalised pre-symptomatic groups (non-infectious latent followed by infectious pre-symptomatic)<br>Model Calibration data:<br>Combined data sets from two existing literature sources.<br>159 infection cases and validated against a serial interval study on 468 infection pairs.<br>Setting: Not declared<br>Model parameters:<br>1. Probability of individual infected being in each of the disease phases (latent, pre-symptomatic infectious without symptom, symptomatic)<br>2. Reproduction rate and $R_0$<br>3. Exponential growth or decay<br>4. Allows for transformation of symptom onset time distribution.<br>Mask parameters:<br>1. Efficacy of a masks ability to trap particles<br>2. The percentage of the population wearing masks.<br>Author-identified limitations:<br>The model does not account for the role played by asymptomatic carriers. Assumptions have been made on some parameters where data is lacking. | Baseline Model:<br>Transmission of COVID-19 during disease progression is predicted using the model parameters of probabilities of infection, reproduction, probability of symptom grouping at a given time, percentage of the population who are infected at each phase of the epidemic and other model parameters to give an estimated baseline $R_0$ of 3.86<br>Model Variables:<br>1. The estimated change of the outcome due to the following (individually or in combination):<br>2. Contact tracing,<br>3. Wearing masks,<br>4. Other measures<br>Outcome:<br>Reduction of $R_0$ | Mask wearing at 96% alone could flatten an epidemic growing at a rate of 0.3 per day by bring down $R_0$ from a base value of 3.68 to 1.<br>When combined with contact tracing, the two effects multiply, and as such, a lower proportion of the general public wearing masks is needed. For example, contact tracing at 60% efficiency, within 4 days of infection confirmation and 70% of general public wearing masks yields the same result as 96% of the population wearing masks.<br>This can be further lowered if contact tracing can be done within 2 days of infection.<br>Where contact tracing measures can not be implemented effectively, strict social distancing and stay at home regulations, and mask-wearing could reduce transmission by both symptomatic and asymptomatic viral carriers. |
| Worby, C., & Chang, H. April 2020 (23)<br>PRE-PRINT<br>'Face mask use in the general population and optimal resource allocation during the COVID-19 pandemic.' | Model:<br>Both a Resource Allocation Model and a Supply & demand model were used to explore the population-level effects of distributing facemasks to different subpopulations, as well as the supply and demand dynamics during an epidemic.<br>Both models share a SIERD model structure. Compartments partitioned in to both wearing mask and not wearing mask.<br>Model calibration data: None mentioned<br>Setting:<br>General population setting (no specific country)<br>Model parameters:<br>1. Epidemiological baseline parameters including:<br>2. Basic reproduction number ($R_0$)<br>3. 14-day recovery period | Resource allocation Model scenarios:<br>The models simulate different distribution proportions of masks among a population and its effect on relative deaths throughout an epidemic. Modelled each are:<br>1. A naïve distribution of masks to the susceptible population at the start of the epidemic.<br>2. A naïve distribution of masks to the susceptible population at the start of the epidemic with priority coverage of the elderly.<br>3. All masks made available to confirmed detected infected individuals | Reduction in total deaths increased with mask effectiveness and availability.<br>Even a 10% adoption could result in 5% fewer deaths, with reduction in deaths increasing when adoption rate increases.<br>Naïve distribution of masks was the most suboptimal approach, unless resources are plentiful.<br>Providing masks only to confirmed infected cases was an effective strategy when resources were limited, and containment was high. However, as many infections aren't detected, this strategy struggles to meet practical needs.<br>Providing masks of 50% effectiveness to all detected infectious cases, death could be reduced |

| Reference | Model characteristics | Scenarios/models and outcome measures | Findings relating to use/efficacy of masks |
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| | 4. Varied proportion of Asymptomatic cases<br>5. Mild/asymptomatic cases<br>6. Resources allocation model parameters: Proportion of people aged 70 and over<br>7. Death rate among symptomatic in 70 and over and in under 70<br>8. Detection of non-severe infections<br>9. Supply and demand model parameters<br>10. Average time wearing disposable mask<br>11. Daily mask production<br>12. Ratio of rate of symptomatic-infected wearing mask to rest of population.<br><br>Mask parameters:<br>1. Varied relative transmissibility with mask (0.5 if not specified)<br>2. Varied relative susceptibility with mask (0.5 if not specified).<br><br>Author-defined limitations:<br><br>Model assumes some parameters are perfect, such as complete detection of symptomatic cases, or compliance with mask wearing. Model does not account for other NPIs. | 4. 25% of susceptible population wear masks at the start of the epidemic, prioritising the elderly.<br>5. Remaining masks distributed to detected infectious individuals until supplies are diminished.<br>6. As above with 50% distribution to susceptible population.<br>7. As above with 75% distribution to susceptible population.<br><br>Outcome:<br>1. Relative deaths<br>2. Proportion of population infected.<br>3. Basic reproduction number ($R_0$) | by 30%. This is achievable with resources to reach 25% of the population.<br><br>A balance of provision of masks to the elderly and confirmed infectious persons yielded the greatest reduction in deaths. This balance shifts according to the effectiveness of masks distributed and assumes 40% resource coverage.<br><br>For population coverage of masks, a smaller supply of highly effective masks achieved similar reduction in deaths as a greater supply of less effective masks. (65% death reduction with 15% coverage of 75%-effective masks; 30% reduction with 25% coverage of intermediate mask [% not given]; 10% reduction with 30% coverage of 25% effective mask. |

**Table C3. Laboratory studies**

Acronyms used: SARS = severe acute respiratory syndrome, TPI = threads per inch

| Reference | Method and materials | Experiment characteristics | Findings |
|---|---|---|---|
| Aydin and others, 2020 (37)<br>PRE-PRINT<br><br>'Performance of fabrics for home-made masks against spread of respiratory infection through droplets: a quantitative mechanistic study' | Mask types: cloth/homemade.<br>Mask materials: 10 different fabrics (100% cotton, 100% polyester, several combinations of cotton and polyester, used dishcloth, and silk) assessed, 3-layered commercial medical mask used as a benchmark material.<br>Objective: to evaluate medical masks along with 10 regular household fabrics for their droplet blocking efficiency against high and low velocity droplets in a laboratory setting.<br>Author-defined limitations: none reported. | Experimental set-up: the droplets that penetrate the fabric were collected in a petri dish placed at 25 mm of the fabric. A high-speed camera was also used to record the motion of the droplets.<br>Aerosol simulation details: To generate droplets with high initial velocity, a metered-dose inhaler was used and the nozzle of the inhaler loaded with 10 µl of a suspension of 100 nm diameter fluorescent beads in distilled water.<br>The fluorescent beads serve two purposes: (1) mimic SARS-CoV-2 virus (70 to 100 nm diameter) in terms of size, and (2) allow to quantify the blocking efficiency of the fabric samples.<br>Breathability was also measured (set-up not described here). | Blocking efficiency at 25mm of selected materials:<br>• medical mask: 96.3%<br>• used shirt (100% cotton): 91.1%<br>• new quilt cloth (100% cotton): 60.1%<br>• used shirt (75% cotton, 25% polyester): 42.6%<br>• used shirt (70% cotton, 30% polyester): 90.1%<br>• new t-shirt (60% cotton, 40% polyester):<br>• 1 layer: 43.3%<br>• 2 layers: 98.6%<br>• 3 layers: 99.98%<br>• new quilt cloth (35% cotton, 65% polyester): 71.8%<br>• new bed sheet (100% polyester): 83.1%<br>• used dishcloth (85% polyester, 15% nylon): 97.9%<br>• used silk shirt: 91.3%<br>• used silk shirt: 92.3%<br>The authors concluded that most home fabrics with one layer can block both high and low impact droplets reasonably well and that, with 2 or 3 layers, their blocking efficiency may exceed that of medical masks while still having comparable or higher breathability.<br>The authors also discussed the underlying mechanism of droplet blocking by hydrophobic home fabrics, when medical masks are made of hydrophobic fabric. |
| Carnino and others, 2020 (40)<br>Pre-proof<br><br>'Pretreated household materials | Mask types: cloth/homemade.<br>Mask materials: kitchen paper towel, laboratory paper towel and the middle filter layer of a standard surgical mask.<br>Objective: to assess the filtration ability of readily available materials pre-treated with a salt-based solution.<br>Author-defined limitations: none reported. | Experimental set-up: fluorescently labelled particles of 70 to 90 nm (similar size to the SARS-CoV-2) were placed into contact on the material to test, and particle penetration through the material was then assessed using a fluorescence microscope.<br>Salt-based soaking treatment was based on protocol described by Quan and others (42) and consist of | Fluorescence images show that the 3 materials don't properly filter the particles when untreated.<br>Materials treated with NaCl and TWEEN20 show a dramatical decreased penetration of nanoparticles. |

| Reference | Method and materials | Experiment characteristics | Findings |
|---|---|---|---|
| carry similar filtration protection<br>against pathogens when compared with surgical masks' | | mixing 30g of NaCl with 100ml of distilled water, stirring at 90ºC and 400 reps per minute until full dissolution. 1 mL of TWEEN20 (a polyoxyethylene sorbitol ester and nonionic surfactant) was then added.<br>The material to test was soaked for 5 minutes in this solution and then soaked overnight.<br>2 samples were tested for each material | Materials treated with NaCl only were less effective in filtering the particles than when treated with NaCl and TWEEN20, but were still showing a notable decrease in particles penetration compared to not treatment.<br>Additional tests using *E. Coli* bacteria suggested that pre-soaking the filter materials in either solution effectively prevents penetration of larger bacteria as well.<br>For handmade masks, the authors recommended, based on their results, to use a salt-soaked paper towel sandwiched between 2 fabric materials (inner and outside layers). |
| Foschini and others, 2020 (38)<br>PRE-PRINT<br><br>'Aerosol blocking assessment by different types of fabrics for homemade respiratory<br>masks: spectroscopy and imaging study' | Mask types: medical and cloth/homemade.<br>Mask materials: N95 mask, surgical mask, confectioner mask, 97 % cotton fabric, 100 % cotton fabric, unwoven fabric, multi-use wipes, legging fabric, elastane fabric, paper coffee, paper towel, among others.<br>Objective: to assess the relative efficiencies of commercial respiratory masks (medical masks) and homemade fabric masks.<br>Author-defined limitations: none reported. | Experimental set-up: 2 optical methodologies were used to quantify the percentage of aerosol retention by the fabric through optical scattering measurements: one using white light scattering measurement before and after the mask, one using spatial frequency domain imaging technique.<br>Aerosol simulation details: a piezoelectric nebulizer was used to create the aerosol from distilled water. The aerosol was then transported through a line attached to a vacuum cleaner, to which a valve for pressure and flow control were added.<br>Size of aerosols generated was not specified. | Aerosol blocking efficiency (average of both results):<br>• N95 mask: 99.95%<br>• Surgery mask: 99.7%<br>• Coffee filter: 99.6%<br>• 2-layer cotton: 66%<br>• 2-layer knitted cotton: 64.2%<br>• confectioner mask: 51%<br>• 1-layer cotton: 46.5%<br>• 2-layer TNT: 46.3%<br>• 2-layer multi-use wipes: 46.3%<br>• 1-layer multi-use wipes: 34.9%<br>• 1-layer knitted cotton: 34.9%<br>• 1-layer TNT: 26.05%<br>Paper towels were disqualified due to integrity problems with increased humidity.<br>Overall, both techniques showed that fabrics and meshes having some elasticity showed less performance than cotton, because the elastic deformations increases air passage.<br>Legging fabric performed well but was not included in the results due to breathing difficulty. |
| Konda and others, 2020 (34) | Mask types: cloth or homemade. | Experimental set-up: the aerosol is sampled before and after it passes through the material being tested. | Single layer: filtration efficiencies ranged from 5 to 80% and 5 to 95% for particle sizes of |

| Reference | Method and materials | Experiment characteristics | Findings |
|---|---|---|---|
| 'Aerosol Filtration Efficiency of Common<br><br>Fabrics Used in Respiratory Cloth Masks' | Mask materials: 15 different types of fabrics tested, including cotton, silk, chiffon, flannel, various synthetics, and their combination. N95 respirators and surgical masks tested for comparison.<br><br>Objective: to assess the performance of various commonly available fabrics used in cloth masks and to evaluate filtration efficiencies as a function of aerosol particulate sizes in the 10nm to 10μm range (respiratory infection: droplets less than 5μm considered primary source of transmission and droplets less than 1μm tend to stay as aerosol in environment for up to 8 hours).<br><br>Author-defined limitations: none reported. | The pressure difference is measured by a manometer and the aerosol flow velocity is measure by a velocity meter. Particle sizes and concentration are measured using particle analysers (OPS and Nanoscan), and the resultant particle concentrations are used to determine filter efficiencies.<br><br>Test specimen (mask) is held in place using a clamp for better seal. Two circular holes with a diameter of 0.635 cm are used to simulate the effect of gaps (improper fit of the mask) on the filtration efficiency.<br><br>Aerosol simulation details: particles in the range of 10nm to 10μm produced by an NaCl aerosol generator and passed through the material to test.<br><br>Flow rates: 1.2 and 3.2 CFM, representative of respiration rates at rest (around 35 L/min) and during moderate exertion (around 90 L/min), respectively.<br><br>Each sample was tested 7 times. | less than 300 nm and more than 300 nm, respectively. Materials such as satin and synthetic silk did not provide strong filtration protection (less than 30%).<br><br>Cotton, the most widely used material for cloth masks, performs better at higher weave densities (threads per inch, [TPI]): a 600 TPI cotton showed more than 65% efficiency at less than 300 nm and more than 90% efficiency at more than 300 nm, while a 80 TPI cotton had efficiencies varying from around 5 to around 55% across the entire range of particle sizes. Cotton quilt also provided excellent filtration (more than 80% for less than 300 nm and more than 90% for more than 300 nm).<br><br>Fabrics with moderate electrostatic discharge values (silk with one, 2 and 4 layers, chiffon and flannel) were also assessed. In all cases, the performance in filtering nanosized particles less than 300 nm is superior to performance in the 300 nm to 6 μm range and particularly effective below around 30nm, consistent with the expectations from the electrostatic effects of these materials. 4-layer silk composite offers more than 80% filtration efficiency across the entire range, from 10 nm to 6 μm.<br><br>Hybrid approaches (600 TPI cotton and 2-layer silk; 600 TPI cotton and 2-layer chiffon; 600 TPI cotton and one-layer flannel) combined effects of electrostatic and physical filtering, all resulting in increased efficiency: more than 80% (for particles less than 300 nm) and more than 90% (for particles more than 300 nm). These cloth hybrids are slightly inferior to the N95 mask above 300 nm, but superior for particles smaller than 300 nm.<br><br>Gaps (as caused by an improper fit of the mask) can result in over a 60% decrease in the filtration efficiency, with similar trends |

| Reference | Method and materials | Experiment characteristics | Findings |
|---|---|---|---|
| | | | observed in surgical masks and cotton/silk hybrid sample, and at both high and low flow rates. |
| Ma and others, 2020 (41)<br><br>‘Potential utilities of mask-wearing and instant hand hygiene for fighting SARS-CoV-2’ | Mask types: medical and homemade masks.<br>Mask materials: one-layer polyester cloth, one one-layer polyester cloth and 4-layer kitchen paper, medical masks, N95 masks.<br>Objective: to evaluate the efficacy of 3 types of masks and instant hand wiping using the avian influenza virus to mock the coronavirus.<br>Author-defined limitations: none reported. | Experimental set-up: open syringes were wrapped with the tested masks. The air containing the aerosols was inhaled into and out of the syringes through the piston movement 100 times, to mock human breath. The syringes were filled with alcohol to collect the virus passing through the masks, then quantified by reverse transcriptase polymerase chain reaction.<br>Aerosol simulation details: a nebulizer was used to produce aerosols with a median diameter of 3.9µm (65% of the aerosol had diameters less than 5.0µm). The aerosols contained the avian influenza virus (diameter: 80 to 120 nm).<br>Each treatment was conducted independently for 4 times. | N95 masks, medical masks, and homemade masks made of 4-layer kitchen paper and one-layer cloth could block 99.98%, 97.14%, and 95.15% of the virus in aerosols compared with the polyester cloth.<br>Instant hand wiping using a wet towel soaked in water containing 1.00% soap powder, 0.05% active chlorine, or 0.25% active chlorine from sodium hypochlorite removed 98.36%, 96.62%, and 99.98% of the virus from hands, respectively.<br>Based on their results and on the experience from 7 countries, the authors propose the approach of mask-wearing plus instant hand hygiene to slow the exponential spread of the virus. |
| Rodrigues-Palacios and others, 2020 (39)<br><br>‘Textile Masks and Surface Covers – A ‘Universal Droplet Reduction Model’ Against Respiratory Pandemics’ | Mask types: cloth or homemade.<br>Mask materials: 6 household textiles, including 100% combed cotton (T-shirt material), 100% polyester microfiber 300-thread count fabric (pillow case), two loosely woven ‘homespun’ 100% cotton fabrics (140 grams per square metre, 60x60-thread count; and 115 grams per square metre, 52x48-thread count), and ‘dry technology’ 100% polyester common (sport jerseys). Medical masks and surgical cloth material tested for comparison.<br>Objective: to assess household textiles to quantify their potential as effective environmental droplet barriers.<br>Author-defined limitations: none reported. | Experimental set-up: droplets passing through the tested material were quantified using Petri-dished placed on a table every 30 cm (from 0 to 180cm). Plates remained open for 10 minutes to allow droplet landing.<br>Sneeze simulation details: household spray bottles were filled with aqueous suspension of probiotics; nozzles were adjusted to produce cloud and jet-propelled droplets that match the visual architecture of droplet formation.<br>Droplet size: 20 to 900µm (peak at 70 to 100 µm)<br>Each experiment was conducted in duplicate. | All textiles reduced the number of droplets reaching surfaces, restricting their dispersion to less than 30cm, when used as single layers. When used as double-layers, textiles were as effective as medical mask/surgical-cloth materials, reducing droplet dispersion to less than 10cm, and the area of circumferential contamination to around 0.3%.<br>The least-effective textile as single-layer (most-‘breathable’, 100%-cotton homespun-115 material) achieved a 90% to 99.998% droplet retention improvement when used as two-layers.<br>To note that droplets were bigger than what was used in most experiments. |
| Wang and others, 2020 (36)<br>PRE-PRINT | Mask types: cloth or homemade.<br>Mask materials: 17 materials and 15 combinations of paired materials. | Material selection: Pubmed and Embase were systematically searched to identify civilian homemade mask materials under the epidemic of H5N1 and SARS, including T-shirts, scarves, tea towels, pillowcases, antibacterial pillowcases, vacuum | 17 materials were selected: T-shirt, fleece sweater, outdoor jacket, down jacket, sun-protective clothing, jeans, hairy tea towel, granular tea towel, non-woven fabrics shopping bag, vacuum cleaner dust bag, |

| Reference | Method and materials | Experiment characteristics | Findings |
|---|---|---|---|
| 'Selection of homemade mask materials for preventing transmission of COVID-19: a laboratory study' | Objective: to combine the comprehensive literature and expert advice to screen the materials of homemade masks with good accessibility, and, through laboratory performance testing, to select materials suitable for homemade masks to protect against respiratory infectious diseases.<br>Author-defined limitations:<br>The study did not test the flame retardant properties, skin irritation, and delayed-type hypersensitivity of the materials.<br>Samples tested in the study were only the original materials rather than the masks made of these materials.<br>Most the materials were purchased from local supermarkets, thus testing results of these materials could be greatly affected by their types, batches, and manufacturers.<br>Mask performance on wearing time, wearing frequency, and environment were not tested because no moulded masks were made.<br>All the data were based on laboratory testing, its actual effectiveness in real-world setting still need to be assessed. | cleaner dust bags, linen, silk, etc. 6 papers were identified, and a panel of 8 experts (from different fields) determined the candidate materials.<br>Experimental set-up: standard procedures were implemented, using a TSI 8130 Automated Filter Tester to test particle filtration efficiency.<br>Material pre0treatment: 24 hours in an environment with a relative humidity of 85% and at 38C; test conducted within 2h after pre0treatment.<br>Aerosol simulation details: 0.075 plus and minus 0.02 µm (count median diameter) NaCl aerosols.<br>Flow rate: 30L per min<br>5 samples were tested for each material.<br>Materials were tested in 4 key areas:<br>1. pressure difference<br>2. particle filtration efficiency<br>3. bacterial filtration efficiency<br>4. resistance to surface wetting<br>Findings reported are mainly related to the particle filtration testing. | diaper, sanitary pad, non-woven shopping bag, vacuum cleaner bag, pillowcase (3 different types), medical non-woven fabric, and medical gauze.<br>Only 1 material (medical non-woven fabric) met the standards of particle filtration efficiency (at least 30%), pressure difference (less than or equal to 49 Pa) and resistance to surface wetting. None met the standard of bacterial filtration efficiency (at least 95%).<br>3 double-layer materials (double-layer medical non-woven fabric; medical non-woven fabric plus non-woven shopping bag; medical non-woven fabric plus granular tea towel) met all the standards of pressure difference, particle filtration efficiency, and resistance to surface wetting, and were close to the standard of the bacterial filtration efficiency.<br>Particle filtration efficiency results of interest:<br>Single-layer homemade masks:<br>• t-shirt: 11% to 14%<br>• fleece sweater: 5% to 6%<br>• hairy tea towel: 22% to 24%<br>• granular tea towel: 11% to 13%<br>• non-woven shopping bag: 12% to 17%<br>• pillowcase: 0%<br>• medical non-woven fabric: 42%<br>• medical gauze 4 layers: 2% to 3%<br>• medical gauze 16 layers: 12% to 15%<br>Double-layer homemade masks:<br>• fleece sweater and T-shirt: 19% t o21%<br>• non-woven shopping bag and T-shirt: 24% to 27%<br>• medical non-woven fabric and T-shirt: 50% to 53%<br>• medical non-woven fabric and Fleece sweater: 48% to 52%<br>• medical non-woven fabric 2-layer: 24% to 27% |

| Reference | Method and materials | Experiment characteristics | Findings |
|---|---|---|---|
| Zhao and others, 2020 (35)<br>Just accepted<br><br>'Household materials selection for homemade cloth face coverings and their filtration efficiency enhancement with triboelectric charging' | Mask types: cloth or homemade.<br>Mask materials: common household materials of natural and synthetic origin, such as cotton, polyester, silk, nylon and cellulose. PPE material (respirator media and 2 medical face mask media) tested for comparison.<br>Objective: to evaluate the filtration efficiency and pressure drop of natural and synthetic materials using a modified procedure for N95 respirator approval.<br>Author-defined limitations:<br>The testing did not account for real-world scenarios where the leakage around the edges of the face cover may significantly impact the actual effectiveness. | Experimental set-up: modified version of the NIOSH standard test procedure, using Automated Filter Tester 8130A. Fabric samples were not preconditioned in any way.<br>Aerosol Simulation Details: 0.075 plus and minus 0.02 µm (count median diameter) NaCl aerosols.<br>Flow rate: 32L/min<br>3 samples were tested for each material (except for cotton, only twice).<br>Optical images obtained by SEM to assess the microscopic structure of the materials. (not reported here).<br>Testing was also performed after triboelectric charging (by rubbing the sample for 30s using latex gloves) to positively impact the filtration properties of the materials. | Filtration efficiency:<br>• respirator media: 96%<br>• medical face mask media: 19% to 33%<br>• polypropylene spunbond: 6%<br>• polypropylene spunbond 5 layers: 24%<br>• cotton T-shirt: 5% if woven, 22% if knit<br>• cotton sweater (knit): 26%<br>• polyester (knit, toddler wrap): 18%<br>• silk (napkin, woven): 5%<br>• nylon (exercise pants, woven): 23%<br>• cellulose (paper towel, bonded): 10%<br>• cellulose (tissue paper, bonded): 20%<br>• cellulose (copy paper, bonded): 99.8%<br>Authors' comments:<br>• some of the cotton materials had similar filtering properties to some grades of medical face masks.<br>• the cotton should be woven/knit at a high density. If a lower density cotton is used, it may be best to use multilayers.<br>• paper towel or tissue paper may be suitable to use as a disposable media in some homemade facial coverings, such as between cotton for an increase in filtration efficiency<br>Tribolelectric charging: all 3 cotton samples had a decreased or unchanged filtration efficiency, while all other samples had an increase in filtration efficiency.<br>The authors commented that the differences in results compared to (34) may arise from differences in instrumentation, testing method, and source of material. |

# Annexe D. Protocol

Face covering in the community and COVID-19: rapid review protocol

## Review questions

1. What is the effectiveness of face covering to reduce the spread of COVID-19 in the community?
2. What is the efficacy of different types of masks?

## Eligibility criteria

| | **Included** | **Excluded** |
|---|---|---|
| Population | Human | Non-humans studies |
| Settings | All community settings, including households | Healthcare settings |
| Context | COVID-19 disease | Other diseases |
| Intervention / exposure | All types of face covering, including (but not limited to) handmade and commercial cloth masks (cloth, cotton, gauze, etc), and medical masks | Studies comparing effectiveness of surgical masks to N95 respirators |
| Outcomes | • transmission of SARS-CoV-2<br>• SARS-CoV-2 infection<br>• basic reproduction number<br>• mask filtration capacity / droplet transmissions | |
| Language | English | |
| Date of publication | 25 March 2020 to 5 June 2020 | |
| Study design | • experimental or observational studies<br>• modelling studies<br>• laboratory studies | • systematic reviews<br>• guidelines<br>• opinion pieces |
| Publication type | Published and pre-print | |

# Sources of evidence

Medline, Embase, medRxiv preprints, WHO COVID-19 Research Database

**Search terms**

1. mask*.tw,kw.
2. face?mask*.tw,kw.
3. ((face or head) adj2 cover*).tw,kw.
4. face?cover*.tw,kw.
5. (cloth* adj2 (cover* or protect*)).tw,kw.
6. physical barrier*.tw,kw.
7. physical intervention*.tw,kw.
8. non-pharmaceutical.tw,kw.
9. (mouth adj2 (cover* or protect*)).tw,kw.
10. (nose adj2 (cover* or protect*)).tw,kw.
11. Masks/
12. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11
13. exp coronavirus/
14. exp Coronavirus Infections/
15. ((corona* or corono*) adj1 (virus* or viral* or virinae*)).ti,ab,kw.
16. (coronavirus* or coronovirus* or coronavirinae* or CoV or HCoV*).ti,ab,kw.
17. (2019-nCoV or 2019nCoV or nCoV2019 or nCoV-2019 or COVID-19 or COVID19 or CORVID-19 or CORVID19 or WN-CoV or WNCoV or HCoV-19 or HCoV19 or 2019 novel* or Ncov or n-cov or SARS-CoV-2 or SARSCoV-2 or SARSCoV2 or SARS-CoV2 or SARSCov19 or SARS-Cov19 or SARSCov-19 or SARS-Cov-19 or Ncovor or Ncorona* or Ncorono* or NcovWuhan* or NcovHubei* or NcovChina* or NcovChinese* or SARS2 or SARS-2 or SARScoronavirus2 or SARS-coronavirus-2 or SARScoronavirus 2 or SARS coronavirus2 or SARScoronovirus2 or SARS-coronovirus-2 or SARScoronovirus 2 or SARS coronovirus2).ti,ab,kw.
18. (respiratory* adj2 (symptom* or disease* or illness* or condition*) adj10 (Wuhan* or Hubei* or China* or Chinese* or Huanan*)).ti,ab,kw.
19. ((seafood market* or food market* or pneumonia*) adj10 (Wuhan* or Hubei* or China* or Chinese* or Huanan*)).ti,ab,kw.
20. ((outbreak* or wildlife* or pandemic* or epidemic*) adj1 (Wuhan* or Hubei or China* or Chinese* or Huanan*)).ti,ab,kw.
21. or/13-20
22. 12 and 21
23. limit 22 to dt=20200325-20200605

# Screening

Depending on number of hits, screening on title and abstract will be undertaken in duplicate by 2 reviewers for at least 10% of the eligible studies (up to 100% depending on resources). Disagreement will be resolved by discussion. Screening on full text will be undertaken by one reviewer and checked by a second.

# Data extraction

Summary information for each study will be extracted and reported in tabular form. This will be undertaken by one reviewer.

# Risk of bias assessment

The risk of bias for each included review will be assessed by one reviewer using AMSTAR-2. Due to the rapid nature of the work, validated tools will not be used for primary studies; however, papers will be evaluated based on study design and main source of bias (mainly population, selection, exposure and outcome).

# Synthesis

A narrative synthesis will be provided.

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