UK Health Security Agency

The effectiveness of N95 masks as wearer protection against COVID-19 in community settings in people at higher risk from becoming seriously ill from COVID-19

A rapid review

Contents

Main messages

1. The purpose of this rapid review was to identify and assess the available evidence for the effectiveness of N95 and equivalent face masks as wearer protection against coronavirus (COVID-19) when used in the community by people at higher risk of becoming seriously ill from COVID-19 (search date: up to 26 September 2022).
2. The review did not identify any studies for inclusion, and so could provide no evidence to answer the research question.
3. Note that this review focussed on a specific type of face mask and population; in a previous review, we concluded the evidence predominantly suggested that face coverings (of any type) can reduce the spread of COVID-19 in the community, through both source control and wearer protection, as well as universal masking.

Purpose

The purpose of this rapid review was to identify and assess the available evidence for the effectiveness of N95 and equivalent face masks as wearer protection against COVID-19 when used in the community by people at higher risk of becoming seriously ill from COVID-19.

Methods

A rapid review was conducted, following streamlined systematic methodologies to accelerate the review process (1). Primary studies were identified through 2 different sources.

1. Our previous rapid review looking at the effectiveness of all face coverings in all people against transmission of COVID-19 (2) was used as a source for primary studies published up to 14 September 2021.
2. A literature search was undertaken to look for primary studies related to the COVID-19 pandemic to supplement the studies identified in the previous review, published (or available as preprint) up to 26 September 2022.

For the literature search, title and abstract screening of records was completed in duplicate for 10% of the studies. Full text screening and screening of included studies from our previous review of the effectiveness of face coverings (2) were conducted by one reviewer and checked by a second.

For inclusion, the N95 and equivalent masks did not need to be fit tested, and equivalent masks included KN95, FFP2, and any other masks with a similar level of filtration (around 95% of airborne particles at least 0.3 microns in diameter).

People at higher risk of becoming seriously ill from COVID-19 were defined as per NHS guidance, and included:

- people with Down's syndrome
- certain types of cancer (such as blood cancer like leukaemia or lymphoma)
- sickle cell disease
- certain conditions affecting the blood
- chronic kidney disease stages 4 or 5
- severe liver disease
- organ or bone marrow transplant

- certain autoimmune or inflammatory conditions (such as rheumatoid arthritis or inflammatory bowel disease)
- HIV or AIDS and a weakened immune system
- conditions affecting the immune system
- rare conditions affecting the brain or nerves (multiple sclerosis, motor neurone disease, Huntington's disease, myasthenia gravis)
- a severe problem with the brain or nerves (such as cerebral palsy)
- severe or multiple learning disabilities (or being on the learning disability register)
- a weakened immune system due to a medical treatment (such as steroid medication, biological therapy, chemotherapy, or radiotherapy)

Full details on the methodology are provided in Annexe A.

Evidence

Despite screening 4,371 primary studies, as well as all studies included in our previous review of the effectiveness of face coverings (2), no studies were found that examined the effectiveness of N95 and equivalent face masks as wearer protection against COVID-19 when used in the community by people at higher risk of becoming seriously ill from COVID-19.

Limitations

Our review was limited to evidence from the COVID-19 pandemic; we did not include evidence from other infectious diseases (including influenza). Sources of evidence searched included databases of peer-reviewed and preprint articles and our previous review of the effectiveness of face coverings, but we did not conduct an extensive search of other sources (such as websites of public health organisations).

Conclusion

No studies matching the inclusion criteria were found, so no evidence could be presented.

Note that this review focussed on a specific type of face mask and population; in a previous review (2), we concluded the evidence predominantly suggested that face coverings (of any type) can reduce the spread of COVID-19 in the community, through both source control and wearer protection, as well as universal masking.

Acknowledgment

We would like to thank colleagues within the Public Health Clinical Response Function who either reviewed or input into aspects of the review, especially Renu Bindra. We would like to thank colleagues from the South West Critical Thinking Unit (NHS England), including Dr Nevila Kallfa.

Disclaimer

UKHSA'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 preprint 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.

In the event that this review is shared externally, please note additionally, to the greatest extent possible under any applicable law, that UKHSA accepts no liability for any claim, loss or damage arising out of, or connected with the use of, this review by the recipient and/or any third party including that arising or resulting from any reliance placed on, or any conclusions drawn from, the review.

References

1. World Health Organization (WHO) and others. 'Rapid reviews to strengthen health policy and systems: a practical guide'. 2017
2. UK Health Security Agency. 'The effectiveness of face coverings to reduce transmission of COVID-19 in community settings. A rapid review [Update 2] '. 2021
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4. Academy of Nutrition and Dietetics. 'Evidence Analysis Manual: Steps in the Academy Evidence Analysis Process'. 2016
5. Public Health England. 'Effectiveness of face coverings/masks in non-healthcare settings '. 2020
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Annexe A: Methods

This report employed a rapid review approach to address the following research question:

- what is the effectiveness of N95 and equivalent face masks as wearer protection against COVID-19 when used in the community by people at higher risk of becoming seriously ill from COVID-19 to reduce COVID-19 infections?

Our rapid review approach follows streamlined systematic methodologies (1). In particular, our previous review of the effectiveness of all face coverings was used as a source for primary studies published before 14 September 2021, and a literature search was undertaken for primary studies published between 14 September 2021 and 26 September 2022. A total of 10% of the screening on title and abstract for records identified though the literature search were screened in duplicate, and full text screening and screening of studies from previous reviews were performed by one reviewer and checked by another. The review has been reported according to PRISMA guidelines (3).

Our previous review looked at all face coverings in all populations as either wearer protection, source control, and universal masking. Only studies with results of the effectiveness of N95 or equivalent masks as wearer protection in the community by people at higher risk of becoming seriously ill from COVID-19 were searched for in this review.

Protocol

A protocol was produced before the literature search began, specifying the review question and the inclusion and exclusion criteria. A protocol was produced a priori and is available in Annexe B.

Sources searched

Primary studies were identified through 2 different sources:

- searching through the included studies in our previous review of the effectiveness of face coverings (2) (for studies published before 14 September 2021)
- literature search of OVID Medline, OVID Embase, and preprint servers (medRxiv, bioRxiv, aRxiv, and Research Square, via COVID-19 portfolio) (for studies published between 14 September 2021 and 26 September 2022)

Search strategy

Search terms for primary studies published between 14 September 2021 and 26 September 2022 covered key aspects of the review question. The search strategies used for all databases are presented below.

Search strategy Ovid Medline

1. (surgical face mask* or surgical face-mask*).tw,kf.
2. surgical mask*.tw,kf.
3. (N95 adj3 respirator*).tw,kf.
4. (N95 adj2 facepiece*).tw,kf.
5. (N95 adj2 mask*).tw,kf.
6. respirator mask*.tw,kf.
7. facepiece respirator*.tw,kf.
8. P100 respirator*.tw,kf.
9. gas mask*.tw,kf.
10. (full face respirator or full-face respirator*).tw,kf.
11. face shield*.tw,kf.
12. medical mask*.tw,kf.
13. medical face-mask*.tw,kf.
14. KN95 respirator*.tw,kf.
15. filtering facepiece*.tw,kf.
16. (FFP1 or FFP2 or FFP3).tw,kf.
17. masks/ or n95 respirators/
18. exp Respiratory Protective Devices/
19. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18
20. exp SARS-CoV-2/
21. exp COVID-19/
22. (corona* adj1 (virus* or viral*)).tw,kw,kf.

23. (CoV not (Coefficien* or "co-efficien*" or covalent* or Covington* or covariant* or covarianc* or "cut-off value*" or "cutoff value*" or "cut-off volume*" or "cutoff volume*" or "combined optimi?ation value*" or "central vessel trunk*" or CoVR or CoVS)).tw,kw,kf.
24. (coronavirus* or 2019nCoV* or 19nCoV* or "2019 novel*" or Ncov* or "n-cov" or "SARS-CoV-2*" or "SARSCoV-2*" or SARSCoV2* or "SARS-CoV2*" or "severe acute respiratory syndrome*" or COVID*2).tw,kw,kf.
25. exp COVID-19 Vaccines/
26. exp COVID-19 Testing/
27. or/20-26
28. 19 and 27
29. limit 28 to dt=20210913-20220926

Search strategy Ovid Embase

1. (surgical face mask* or surgical face-mask*).tw,kf.
2. surgical mask*.tw,kf.
3. (N95 adj3 respirator*).tw,kf.
4. (N95 adj2 facepiece*).tw,kf.
5. (N95 adj2 mask*).tw,kf.
6. respirator mask*.tw,kf.
7. facepiece respirator*.tw,kf.
8. P100 respirator*.tw,kf.
9. gas mask*.tw,kf.
10. (full face respirator or full-face respirator*).tw,kf.
11. face shield*.tw,kf.
12. medical mask*.tw,kf.
13. medical face-mask*.tw,kf.
14. KN95 respirator*.tw,kf.
15. filtering facepiece*.tw,kf.
16. (FFP1 or FFP2 or FFP3).tw,kf.
17. mask/ or face mask/ or surgical mask/
18. respiratory protection/

19. exp filtering facepiece respirator/
20. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
21. exp severe acute respiratory syndrome coronavirus 2/ or coronavirus disease 2019/ or experimental coronavirus disease 2019/
22. (corona* adj1 (virus* or viral*)).ti,ab,kf.
23. (CoV not (Coefficien* or co-efficien* or covalent* or covington or covariant* or covarianc* or "cut-off value*" or "cutoff value*" or "cut-off volume*" or "cutoff volume*" or "combined optimi?ation value*" or "central vessel trunk" or CoVR or CoVS)).ti,ab,kf.
24. (coronavirus* or 2019nCoV* or 19nCoV* or "2019 novel*" or Ncov* or "n-cov" or "SARSCoV-2*" or "SARSCoV-2*" or SARSCoV2* or "SARS-CoV2*" or "severe acute respiratory syndrome*" or COVID*2).ti,ab,kf.
25. or/21-24
26. 20 and 25
27. limit 26 to dc=20210913-20220926
28. limit 27 to conference abstracts
29. 27 not 28

Search strategy for COVID-19 portfolio

1. "surgical mask*" OR "surgical face-mask*" OR "surgical face mask*" OR "medical mask*" OR " medical face-mask*" OR N95 OR "filtering facepiece*" OR "respirator mask*" OR FFP1 OR FFP2 OR FFP3 OR "respiratory protective device*" OR "facepiece respirator*"
2. limited to: 13 September 2021 to 28 September 2022

Inclusion and exclusion criteria

Article eligibility criteria are summarised in Table A.1.

Table A.1. Inclusion and exclusion criteria

	Included	Excluded
Population	People at higher risk from becoming seriously ill from COVID-19, as defined in the notes	
Settings	All community settings, including households	Healthcare settings
Context	COVID-19 pandemic	Other infectious diseases
Intervention or exposure	N95 and equivalent face masks (not fit tested)	Other face coverings
Outcomes	COVID-19 infection in mask wearers (wearer protection) Measures: Incidence of COVID-19 Prevalence of COVID-19 Attack rate and/or secondary attack rate	Deaths associated with COVID-19 Disease progression Prevalence and/or rates of asymptomatic, pre-symptomatic or symptomatic COVID-19
Language	English	
Date of publication	14 September 2021 to 26 September 2022	
Study design	Interventional studies Observational studies (cohorts, case controls and cross-sectional studies)	Systematic or narrative reviews Guidelines Opinion pieces Modelling studies Laboratory studies Ecological studies Descriptive studies
Publication type	Published and preprint	

Screening

Searching of bibliographies

The primary studies included our previous rapid review were screened by one reviewer and checked by a second to identify studies that reported on the effectiveness of N95 and equivalent face masks as wearer protection against COVID-19 when used in the community by people at higher risk of becoming seriously ill from COVID-19.

For inclusion, the N95 and equivalent masks did not need to be fit tested, and equivalent masks included KN95, FFP2, and any other masks with a similar level of filtration (around 95% of airborne particles at least 0.3 microns in diameter).

People at higher risk of becoming seriously ill from COVID-19 were defined as per NHS guidance, and included:

- people with Down's syndrome
- certain types of cancer (such as blood cancer like leukaemia or lymphoma)
- sickle cell disease
- certain conditions affecting the blood
- chronic kidney disease stages 4 or 5
- severe liver disease
- organ or bone marrow transplant
- certain autoimmune or inflammatory conditions (such as rheumatoid arthritis or inflammatory bowel disease)
- HIV or AIDS and a weakened immune system
- conditions affecting the immune system
- rare conditions affecting the brain or nerves (multiple sclerosis, motor neurone disease, Huntington's disease, myasthenia gravis)
- a severe problem with the brain or nerves (such as cerebral palsy)
- severe or multiple learning disabilities (or being on the learning disability register)
- a weakened immune system due to a medical treatment (such as steroid medication, biological therapy, chemotherapy, or radiotherapy)

Literature search

Title and abstract screening was completed by 2 reviewers: 10% of the eligible studies were screened in duplicate (disagreements were resolved by discussion) and the remainder were screened by one reviewer. Full text screening was conducted by one reviewer and checked by a second.

The PRISMA diagram showing the flow of citations is provided in Figure A.1.

Data extraction and risk of bias assessment

As no studies were included, no studies required data extraction or risk of bias assessment.

However, data extraction would have been completed by one reviewer and checked by a second, with only results directly relevant to the review questions extracted. The risk of bias of studies would have been assessed using the quality criteria checklist (QCC) for primary research (4), and completed by one reviewer and checked by a second.

Variations across populations and subgroups, for example cultural variations or differences between ethnic, social or vulnerable groups would have also been considered, if evidence had been available.

Figure A.1. PRISMA diagram

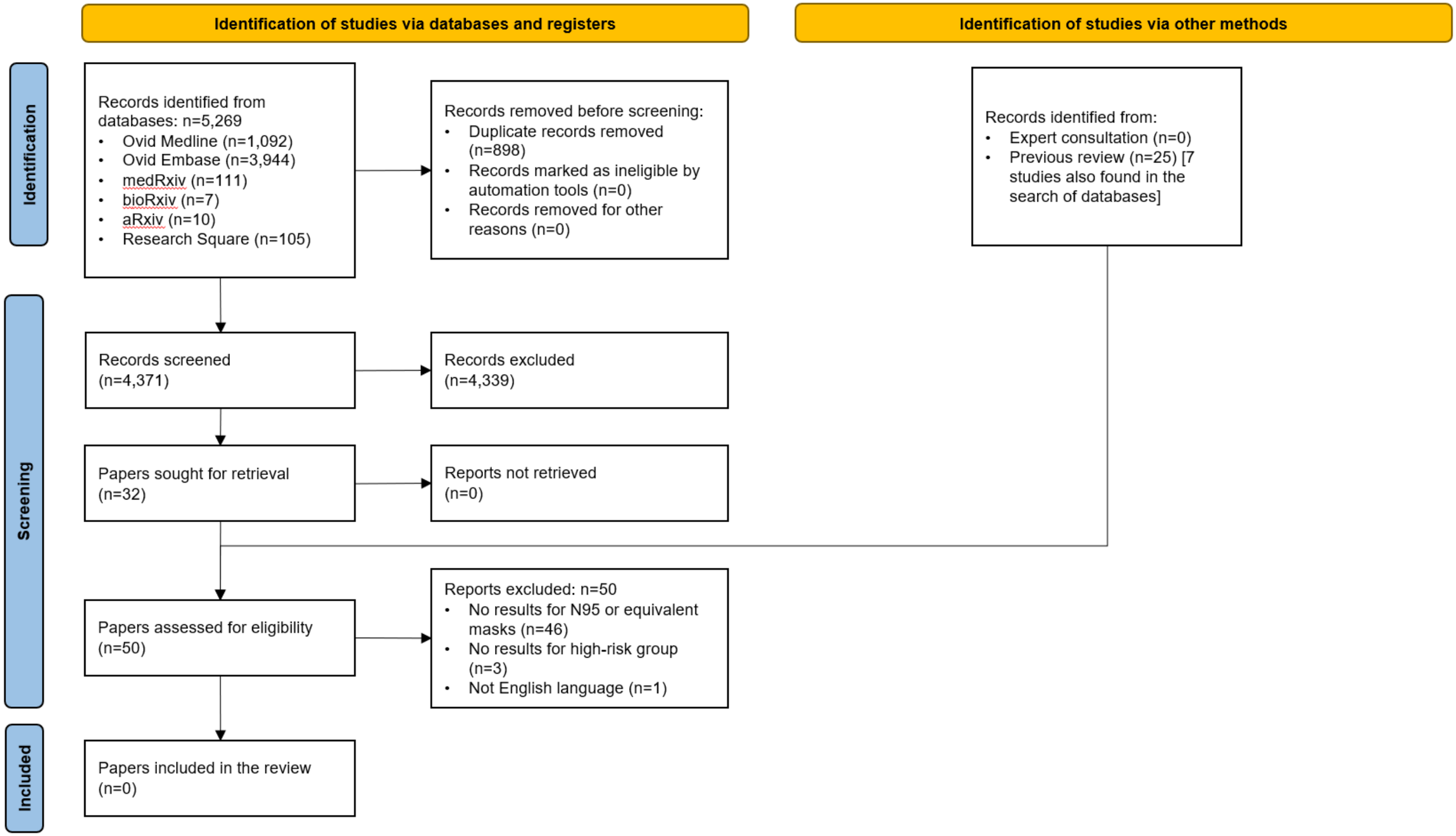

Figure A.1. PRISMA diagram – alt text

A PRISMA diagram showing the flow of studies through this review, ultimately including 0 studies.

From identification of studies via databases and registers, n=5,269 records identified from databases:

- Ovid Medline (n=1,092)
- Ovid Embase (n=3,944)
- medRxiv (n=111)
- bioRxiv (n=7)
- aRxiv (n=10)
- Research Square (n=105)

From these, records removed before screening:

- duplicate records removed (n=898)
- records marked as ineligible by automation tools (n=0)
- records removed for other reasons (n=0)

n=4,371 records screened, of which n=4,339 were excluded, leaving n=32 papers sought for retrieval, all of which were retrieved.

From identification of studies via other methods, n=0 studies were identified from expert consultation, and n=25 studies were found from the previous review (7 of these studies were also found in the search of databases).

Of the n=50 papers assessed for eligibility, n=50 reports were excluded:

- no results for N95 or equivalent masks (n=46)
- no results for high-risk group (n=3)
- not English language (n=1)

n=0 papers included in the review.

Annexe B: Protocol

Review question

What is the effectiveness of N95 and equivalent face masks (not fit tested) when used in the community by people at higher risk of getting seriously ill from COVID-19 to reduce COVID-19 infections in the wearer?

Notes

We (the COVID-19 Rapid Evidence Service) have conducted 3 rapid reviews on face coverings and transmission of COVID-19 in the community: the original review (search up to 5 June 2020) (5), the first update (search up to 22 September 2020) (6), and the second update (search to 14 September 2021) (2).

These previous reviews focussed on evidence for all face coverings in all populations; this review will focus specifically on N95 and equivalent face masks (not fit tested), compared with any other or no face coverings, in people at higher risk of getting seriously ill from COVID-19. However, the previous will be used as a source of studies up to 14 September 2021.

While the previous reviews looked at face covering use for wearer protection, source control, and universal masking, this review will only consider mask use for wearer protection.

People at higher risk of getting seriously ill from COVID-19 are defined as per NHS guidance, and include people with Down's syndrome, certain types of cancer (such as blood cancer like leukaemia or lymphoma), sickle cell disease, certain conditions affecting the blood, chronic kidney disease stages 4 or 5, severe liver disease, organ or bone marrow transplant, certain autoimmune or inflammatory conditions (such as rheumatoid arthritis or inflammatory bowel disease), HIV or AIDS and a weakened immune system, conditions affecting the immune system, rare conditions affecting the brain or nerves (multiple sclerosis, motor neurone disease, Huntington's disease, myasthenia gravis), a severe problem with the brain or nerves (such as cerebral palsy), severe or multiple learning disabilities (or being on the learning disability register), or a weakened immune system due to a medical treatment (such as steroid medication, biological therapy, chemotherapy, or radiotherapy).

Table B.1: Inclusion and exclusion criteria

	Included	Excluded
Population	People at higher risk from getting seriously ill from COVID-19, as defined in the notes	
Settings	All community settings, including households	Healthcare settings
Context	COVID-19 pandemic	Other infectious diseases
Intervention or exposure	N95 and equivalent face masks (not fit tested)	Other face coverings
Outcomes	• COVID-19 transmission to mask wearers (wearer protection) *Measures:* • incidence of COVID-19 • prevalence of COVID-19 • attack rate and secondary attack rate • Reproduction number	• deaths associated with COVID-19 • disease progression • prevalence and rates of asymptomatic, pre-symptomatic or symptomatic COVID19
Language	English	
Date of publication	14 September 2021 to 26 September 2022	
Study design	• interventional studies • observational studies (cohorts, case controls and cross-sectional studies)	• systematic or narrative reviews • guidelines • opinion pieces • modelling studies • laboratory studies • ecological studies • descriptive studies
Publication type	Published and preprint	

Identification of studies

Our previous reviews on face coverings and COVID-19 will be used to identify studies published up to 14 September 2021 (search date of our last review).

We will also search OVID Medline, OVID Embase, and preprint servers (medRxiv, bioRxiv, aRxiv, and Research Square, via COVID-19 portfolio) for studies published after 14 September 2021.

Screening

Screening on title and abstract will be undertaken in duplicate by 2 reviewers for at least 10% of the eligible studies, with the remainder completed by one reviewer. 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. Information will include country, setting, study design, objective, outcomes measures, participants, study period, results and any relevant contextual data (such as timing or level of community transmission at the time of the study). This will be undertaken by one reviewer and checked by a second.

Risk of bias assessment

Risk of bias will be assessed using the quality criteria checklist (QCC) for primary research which assesses the methodological quality of a study. This tool can be applied quickly to most study designs to consider core areas of potential bias. Risk of bias will be assessed by one reviewer and checked by a second.

Synthesis

A narrative synthesis will be written to describe the results from this review.

Variations across populations and subgroups, for example cultural variations or differences between ethnic or social groups will be considered, where evidence is available.

Search strategy Ovid Medline

1. (surgical face mask* or surgical face-mask*).tw,kf.
2. surgical mask*.tw,kf.
3. (N95 adj3 respirator*).tw,kf.
4. (N95 adj2 facepiece*).tw,kf.
5. (N95 adj2 mask*).tw,kf.
6. respirator mask*.tw,kf.
7. facepiece respirator*.tw,kf.
8. P100 respirator*.tw,kf.
9. gas mask*.tw,kf.
10. (full face respirator or full-face respirator*).tw,kf.
11. face shield*.tw,kf.
12. medical mask*.tw,kf.
13. medical face-mask*.tw,kf.
14. KN95 respirator*.tw,kf.
15. filtering facepiece*.tw,kf.
16. (FFP1 or FFP2 or FFP3).tw,kf.
17. masks/ or n95 respirators/
18. exp Respiratory Protective Devices/
19. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18
20. exp SARS-CoV-2/
21. exp COVID-19/
22. (corona* adj1 (virus* or viral*)).tw,kw,kf.
23. (CoV not (Coefficien* or "co-efficien*" or covalent* or Covington* or covariant* or covarianc* or "cut-off value*" or "cutoff value*" or "cut-off volume*" or "cutoff volume*" or "combined optimi?ation value*" or "central vessel trunk*" or CoVR or CoVS)).tw,kw,kf.
24. (coronavirus* or 2019nCoV* or 19nCoV* or "2019 novel*" or Ncov* or "n-cov" or "SARS-CoV-2*" or "SARSCoV-2*" or SARSCoV2* or "SARS-CoV2*" or "severe acute respiratory syndrome*" or COVID*2).tw,kw,kf.
25. exp COVID-19 Vaccines/
26. exp COVID-19 Testing/
27. or/20-26
28. 19 and 27
29. limit 28 to dt=20210913-20220926

Search strategy Ovid Embase

1. (surgical face mask* or surgical face-mask*).tw,kf.
2. surgical mask*.tw,kf.
3. (N95 adj3 respirator*).tw,kf.
4. (N95 adj2 facepiece*).tw,kf.
5. (N95 adj2 mask*).tw,kf.
6. respirator mask*.tw,kf.
7. facepiece respirator*.tw,kf.
8. P100 respirator*.tw,kf.
9. gas mask*.tw,kf.
10. (full face respirator or full-face respirator*).tw,kf.
11. face shield*.tw,kf.
12. medical mask*.tw,kf.
13. medical face-mask*.tw,kf.
14. KN95 respirator*.tw,kf.
15. filtering facepiece*.tw,kf.
16. (FFP1 or FFP2 or FFP3).tw,kf.
17. mask/ or face mask/ or surgical mask/
18. respiratory protection/
19. exp filtering facepiece respirator/
20. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
21. exp severe acute respiratory syndrome coronavirus 2/ or coronavirus disease 2019/ or experimental coronavirus disease 2019/
22. (corona* adj1 (virus* or viral*)).ti,ab,kf.
23. (CoV not (Coefficien* or co-efficien* or covalent* or covington or covariant* or covarianc* or "cut-off value*" or "cutoff value*" or "cut-off volume*" or "cutoff volume*" or "combined optimi?ation value*" or "central vessel trunk" or CoVR or CoVS)).ti,ab,kf.
24. (coronavirus* or 2019nCoV* or 19nCoV* or "2019 novel*" or Ncov* or "n-cov" or "SARSCoV-2*" or "SARSCoV-2*" or SARSCoV2* or "SARS-CoV2*" or "severe acute respiratory syndrome*" or COVID*2).ti,ab,kf.
25. or/21-24
26. 20 and 25
27. limit 26 to dc=20210913-20220926
28. limit 27 to conference abstracts
29. 27 not 28

Search strategy COVID-19 portfolio

1. "surgical mask*" OR "surgical face-mask*" OR "surgical face mask*" OR "medical mask*" OR " medical face-mask*" OR N95 OR "filtering facepiece*" OR "respirator mask*" OR FFP1 OR FFP2 OR FFP3 OR "respiratory protective device*" OR "facepiece respirator*"
2. limited to: 13 September 2021 to 28 September 2022

About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation heath secure.

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