McMaster University | HEALTH FORUM

Rapid Evidence Profile

Effectiveness of masks to reduce exposure and health impacts of wildfire smoke, combined heat-wildfire smoke events, and other pollutants associated with wildfires

7 June 2024

[MHF product code: REP 73]

Appendices

1) Methodological details (Appendix 1)
2) Details about each identified synthesis (Appendix 2)
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Appendix 1: Methodological details

We use a standard protocol for preparing rapid evidence profiles (REP) to ensure that our approach to identifying research evidence is as systematic and transparent as possible in the time we were given to prepare the profile.

Identifying research evidence

For this REP, we searched PubMed, Scopus, Social Systems Evidence, Health Systems Evidence, and Health Evidence index evidence syntheses for:
1) evidence syntheses
2) protocols for evidence syntheses that are underway
3) single studies.

We searched PubMed, Scopus, Social Systems Evidence, Health Systems Evidence and Health Evidence index evidence syntheses. Links provide access to the full search strategy. In Scopus, we searched for evidence using (TITLE-ABS-KEY (mask*)) AND (TITLE-ABS-KEY (fire*) OR TITLE-ABS-KEY (wildfire*)). In Social Systems Evidence, Health Systems Evidence, and Health Evidence index evidence syntheses, we used the following combination of terms: ((wildfire*) OR (fire*)) AND (mask*). All these databases' searches were combined with a filter that limited the publication date to reviews from the past 10 years and all other publications from the past five years.

Each source for these documents is assigned to one team member who conducts hand searches (when a source contains a smaller number of documents) or keyword searches to identify potentially relevant documents. A final inclusion assessment is performed both by the person who did the initial screening and the lead author of the rapid evidence profile, with disagreements resolved by consensus or with the input of a third reviewer on the team. The team uses a dedicated virtual channel to discuss and iteratively refine inclusion/exclusion criteria throughout the process, which provides a running list of considerations that all members can consult during the first stages of assessment.

During this process we include published, pre-print, and grey literature. We do not exclude documents based on the language of a document. However, we are not able to extract key findings from documents that are written in languages other than Chinese, English, French, or Spanish. We provide any documents that do not have content available in these languages in an appendix containing documents excluded at the final stages of reviewing. We excluded documents that did not directly address the research questions and the relevant organizing framework.

Assessing relevance and quality of evidence

We assess the relevance of each included evidence document as being of high, moderate, or low relevance to the question.

Two reviewers independently appraised the quality of the guidelines we identified as being highly relevant using AGREE II. We used three domains in the tool (stakeholder involvement, rigour of development, and editorial independence) and classified guidelines as high quality if they were scored as 60% or higher across each of these domains.

Two reviewers independently appraise the methodological quality of evidence syntheses that are deemed to be highly relevant using the first version of the AMSTAR tool. Two reviewers independently appraise each synthesis, and disagreements are resolved by consensus with a third reviewer if needed. AMSTAR rates overall methodological quality on a scale of 0 to 11, where 11/11 represents a review of the highest quality. High-quality evidence syntheses are those with scores of eight or higher out of a possible 11, medium-quality evidence syntheses are those with scores between four and seven, and low-quality evidence syntheses are those with scores less than four. It is important to note that the AMSTAR tool was developed to assess evidence syntheses focused on clinical interventions, so not all criteria apply to those pertaining to health-system arrangements or implementation strategies. Furthermore, we apply the AMSTAR criteria to evidence syntheses addressing all types of questions, not just those addressing questions about effectiveness, and some of these evidence syntheses addressing other types of questions are syntheses of qualitative studies. While AMSTAR does not account for some of the key attributes of syntheses of qualitative studies, such as whether and how citizens and subject-matter experts were involved, researchers' competency, and how reflexivity was approached, it remains the best general quality-assessment tool of which we're aware. Where the denominator is not 11, an aspect of the tool was considered not relevant by the raters. In comparing ratings, it is therefore important to keep both parts of the score (i.e., the numerator and denominator) in mind. For example, an evidence synthesis that scores 8/8 is generally of comparable quality to another scoring 11/11; both ratings are considered 'high scores.' A high score signals that readers of the evidence synthesis can have a high level of confidence in its findings. A low score, on the other hand, does not mean that the evidence synthesis should be discarded, merely that less confidence can be placed in its findings and that it needs to be examined closely to identify its limitations. (Lewin S, Oxman AD, Lavis JN, Fretheim A. SUPPORT Tools for evidence-informed health Policymaking (STP): 8. Deciding how much confidence to place in a systematic review. *Health Research Policy and Systems* 2009; 7(Suppl1): S8).

Identifying experiences from other countries and from Canadian provinces and territories

For each REP, we work with the requestors to collectively decide on what countries (and/or states or provinces) to examine based on the question posed. While we do not exclude content based on language. Where information is not available in English, Chinese, French, or Spanish, we attempt to use site-specific translation functions or Google Translate. A full list of websites and organizations searched is available upon request.

Preparing the profile

Each included document is cited in the reference list at the end of the REP. For all included guidelines, evidence syntheses, and single studies (when included), we prepare a small number of bullet points that provide a summary of the key findings, which are used to summarize key messages in the text. Protocols and titles/questions have their titles hyperlinked, given that findings are not yet available. For this profile, we only prepared bulleted summaries of key findings for documents deemed to be of medium relevance. For those classified as low relevance, we list the title with a link to the primary source for easy retrieval if needed.

We then draft a summary that highlights the key findings from all highly relevant documents (alongside their date of last search and methodological quality).

Appendix 2: Details about each identified evidence synthesis

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Living status	Quality (AMSTAR)	Last year literature searched	Availability of GRADE profile	Equity considerations

• Type of exposure
  ○ Pollutants
• Type of exposure
  ○ Repeated short term
• Masks
  ○ Respirators, including N95 masks
	Respirator masks can reduce exposure to airborne particles during physical activity if worn and used appropriately
	• This paper summarized strategies to reduce the effects of air pollution during physical activity.
	• Respirators have been found across studies to reduce exposure from over 95% of airborne particles.
	• Cloth and surgical masks show limited efficacy at reducing airborne exposure.
	• The efficacy of face masks at reducing exposure depends on correct application, seal checks, and proper maintenance.
		High	No	2/9	Not stated	Not available	None identified

• Type of exposure
  ○ Wildfire smoke
• Masks
  ○ Respirators, including N95 masks
• Priority populations
  ○ Children
• Outcomes
  ○ Physical health outcomes
  ▪ Respiratory effects (e.g., bronchitis, reduced lung function)
	Surgical masks and respirators can provide limited protection against respiratory effects for children during wildfire events, with expected decreases of roughly 20% and 80% for surgical masks and N95 respirators, respectively	Low	No	1/9	Not stated	Not available	None identified

Appendix 3: Details about each identified single study

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations

• Type of exposure
  ○ Wildfire/fire smoke
  ○ Pollutants
  ▪ Particulate matter (e.g., PM2.5 or smaller)
  ▪ Other chemicals (e.g., polycyclic aromatic hydrocarbons, nitrogen oxides, benzene, acid gases)
• Masks
• Priority populations
  ○ Occupations directly affected by wildfires
	Higher-performing masks (i.e., N95, P95, P100) limit exposure to wildland fire smoke and can be used as guidelines for firefighters and the general public, with lower effectiveness in surgical masks compared to others, and reported ineffectiveness of bandanas
	• A cotton bandana, surgical mask, N95, P95, P100-2097, and P100-2297 were tested to determine the effectiveness of common materials and to assess protection capabilities from wildland fire smoke.
	• Efficiency of filtration was calculated based on particulate matter and gaseous species.
	• Bandanas were ineffective with only 10% Total Particulate Matter (TPM) filtration efficiency.
	• Surgical, N95, P95, and P100 filters were effective at 81%, 98%, 99%, and 99.5%, respectively.
	• N95, P95, and P100 were also effective at filtering some gaseous species.
	• Other parameters such as fit or seal of the masks, face velocity, and pressure drop were different compared to standardized methods.
	• The authors indicated that higher-performing masks limit exposure to wildland fire smoke and can be used as guidelines for firefighters and the general public.
		High	*Focus of study:* Determine the effectiveness of mask materials from wildland fire smoke
			
			Publication date: August 2023
			
			Jurisdiction: Not reported
			
			Methods: Laboratory testing
				None identified

• Type of exposure
  ○ Wildfire/fire smoke
• Type of exposure
  ○ Repeated short term
• Masks
  ○ Respirators, including N95 masks
• Priority populations
  ○ Occupations directly affected by wildfires
• Outcomes
  ○ Physical health outcomes
  ▪ Respiratory effects (e.g., bronchitis, reduced lung function)
	Masks use may decrease throat discomfort and coughing in firefighters who choose to use them during wildfire season
	• This study explored masks usage in firefighters during a repeated short term wildfire season.
	• Firefighters were asked to use masks whenever they felt it was appropriate.
	• Some firefighters chose not to use a mask due to discomfort.
	• Generally, firefighters that wore masks self-reported fewer respiratory symptoms (e.g., throat discomfort and cough).
		High	*Focus of study:* Masks usage in firefighters during wildfire season
			
			Publication date: 21 October 2022
			
			Jurisdiction: Canada
			
			Methods: Longitudinal
				None identified

• Type of exposure ○ Wildfire/fire smoke • Type of exposure	Compared to surgical and cloth masks, respirator masks are the most effective at reducing exposure to airborne particles from wildfires	High	*Focus of study:* Compares mask inhalation protection	None identified

Dimension of organizing framework	Declarative title and key findings	Relevance rating	Study characteristic	Equity considerations
○ Repeated short term • Masks ○ Respirators, including N95 masks ○ Surgical with valves ○ Cloth • Priority populations ○ People living in areas directly affected by wildfires • Outcomes ○ Physical health outcomes ▪ Respiratory effects (e.g., bronchitis, reduced lung function)	• This study compared varieties of mask inhalation protection against different airborne particles. • Respirator masks had the highest efficiency (0.8), compared to surgical (0.6) and cloth masks (0.3), at protecting against wildfire particles. ○ All masks are effective at protecting against larger particles (e.g., wildfire ash).		from airborne particles (e.g., wildfire smoke) *Publication date:* 23 November 2022 *Jurisdiction:* United States *Methods:* Cross-sectional	
• Type of exposure ○ Wildfire/fire smoke ○ Pollutants ▪ Other chemicals (e.g., polycyclic aromatic hydrocarbons, nitrogen oxides, benzene, acid gases) • Masks ○ Respirators, including N95 masks • Priority populations ○ Occupations directly affected by wildfires • Outcomes ○ Physical health outcomes ▪ Respiratory effects (e.g., bronchitis, reduced lung function)	Wildland firefighters allocated to discretionary use of an N95 mask had reduced urinary 1-hydroxypyrene excretion • The evidence of reduced polycyclic aromatic hydrocarbon absorption suggests the partial protection offered by a N95 mask may be a worthwhile step while ways are found to overcome the significant barriers to full respiratory protection.	High	*Focus of study:* To evaluate the effect of enhanced skin hygiene and discretionary use of an N95 mask on polycyclic aromatic hydrocarbon absorption *Publication date:* April 2023 *Jurisdiction:* Alberta, Canada *Methods:* Cross-sectional	None identified
• Type of exposure ○ Wildfire/fire smoke • Masks ○ Respirators, including N95 masks ○ Surgical with valves ○ Surgical without valves ○ Cloth ○ Other • Priority populations ○ Individuals with pre-existing conditions that could be exacerbated by wildfires (e.g., respiratory or cardiac) ▪ Chronic obstructive pulmonary disorder	There was limited use of mask and consideration of the type of mask or respirator used among individuals with chronic obstructive pulmonary disorder (COPD), with most individuals relying on other mitigation strategies to avoid wildfire smoke such as closing windows and staying inside	Low	*Focus of study:* Experiences of using masks among individuals with self-reported COPD over the age of 18 in Australia *Publication date:* 2023 *Jurisdiction:* Australia *Methods:* Semi-structured interviews	None identified

Appendix 4: Documents excluded at the final stages of reviewing

Document type	Hyperlinked title
Evidence synthesis	Are facemasks effective against particulate matter pollution? Evidence from the field
	Health risks and mitigation strategies from occupational exposure to wildland fire: A scoping review
	Downsides of face masks and possible mitigation strategies: A systematic review and meta-analysis
	Individual- and household-level interventions to reduce air pollution exposures and health risks: A review of the recent literature
Literature reviews with no systematic searches	Wildfire smoke exposure during pregnancy: A review of potential mechanisms of placental toxicity, impact on obstetric outcomes, and strategies to reduce exposure
	Clearing the air on personal interventions to reduce exposure to wildfire smoke
	Responding to simultaneous crises: communications and social norms of mask behavior during wildfires and COVID-19
	Methodology of assessing the quality of mask filter elements for protection of people, and their vital functions in case of fire
	Low burden, adsorbent and heat absorbing structures for respiratory protection in building fires
	Personal respiratory protective equipment: Development of patenting and structure of inventions in the world (2000-2019)
	The changing climate: Managing health impacts
	Signal enhancement for communication systems used by fire fighters
Single study	Adaptation resources and responses to wildfire smoke and other forms of air pollution in low-income urban settings: A mixed-methods study
	Breathing limited air situational training masks (BlastMask) versus Self-Contained Breathing Apparatus (SCBA) for firefighters: A pilot study
	Mitigating wildfire smoke inside homes: Evidence from Oregon, September 2020
	Quantifying the health benefits of face masks and respirators to mitigate exposure to severe air pollution
	Exposure and absorption of PAHs in wildland firefighters: A field study with pilot interventions
	The effect of firefighter personal protective equipment on static and dynamic balance
	Increased stress for firefighters due to wearing full-face masks?
	Effect of protective filters on fire fighter respiratory health during simulated bushfire smoke exposure

Reference

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6. Holm SM, Miller MD, Balmes JR. Health effects of wildfire smoke in children and public health tools: a narrative review. *Journal of Exposure Science & Environmental Epidemiology* 2021; 31(1): 1-20.
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