

Context

- In 2023, Canada experienced an unprecedented wildfire season and predictions for 2024 are similar.
- Wildfires pose a significant public health risk in Canada due to their impacts on physical health, mental health, and well-being.
- This rapid evidence profile builds on [previous work](#) and examines the effectiveness of masks and respirators at reducing exposure and health impacts due to wildfire smoke, combined heat-wildfire smoke events, and other pollutants associated with wildfires.

Questions

- What is the evidence for the effectiveness of masks, including respirators, surgical, and cloth, to reduce the exposure and health impacts of wildfire and fire smoke (e.g., fine particulate matter (PM2.5)), combined heat-wildfire smoke events, and other pollutants (e.g., polycyclic aromatic hydrocarbons, nitrogen oxides, benzene, acid gases) associated with wildfires, and how do these vary by groups and contexts?

High-level summary of key findings

- We identified seven evidence documents (two evidence syntheses and five single studies) relevant to the question
- Overall, respirator masks (e.g., N95, P95, P100) are highly effective at reducing exposure to airborne particulate matter from wildfire smoke, with a filtration efficiency rate of 80–99.5% when worn properly.
 - N95 masks can reduce absorption of harmful pollutants such as polycyclic aromatic hydrocarbons and self-reported fewer respiratory symptoms like coughing and throat discomfort.
- Based on a low-quality evidence synthesis and one modelling study, surgical masks show moderate effectiveness (68–81% efficiency) in reducing particulate matter exposure, while cloth masks demonstrate limited effectiveness (9–33% efficiency) against wildfire smoke particles.

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]

Box 1: Evidence and other types of information

+ Global evidence drawn upon



Evidence syntheses selected based on relevance, quality, and recency of search

+ Forms of domestic evidence used (= Canadian)



Evaluation



Modeling



Behavioural/
Implementation
research

* Additional notable features

Prepared in the equivalent of three business days using an 'all hands on deck' approach

- Proper mask application, fit, seal checks, and maintenance are crucial for maximizing the effectiveness of all mask types in reducing wildfire smoke exposure; however, user discomfort and adherence remain potential barriers, especially for certain groups like firefighters.
- No evidence was found on mask effectiveness during combined heat-wildfire smoke events, its variation across different population groups (e.g., those with chronic conditions) and contexts, or the impact of mask wearing on mental health.

Framework to organize what we looked for

- Type of exposure
 - Wildfire/fire smoke
 - Combined wildfire smoke and heat
 - Pollutants
 - Particulate matter (e.g., PM2.5 or smaller)
 - Other chemicals (e.g., polycyclic aromatic hydrocarbons, nitrogen oxides, benzene, acid gases)
- Type of exposure
 - Short term/immediate
 - Repeated short term
 - Long term
- Masks
 - Respirators, including N95 masks
 - With valves
 - Without valves
 - Surgical masks
 - Cloth masks
 - Other
- Priority populations
 - Children
 - People living in areas directly affected by wildfires
 - Occupations directly affected by wildfires
 - Individuals with pre-existing conditions that could be exacerbated by wildfires (e.g., respiratory or cardiac)
 - Asthma
 - Chronic obstructive pulmonary disorder
 - Chronic heart failure
 - Pregnant women
 - People with disabilities

Box 2: Approach and supporting materials

We identified evidence addressing the question by searching Health Systems Evidence, Social Systems Evidence, Health Evidence, PubMed, and Scopus. All searches were conducted on 24 May 2024. The search strategies used are included in Appendix 1. In contrast to synthesis methods that provide an in-depth understanding of the evidence, this profile focuses on providing an overview and key insights from relevant documents.

We searched for full evidence syntheses (or synthesis-derived products such as overviews of evidence syntheses), protocols for evidence syntheses, and single studies.

We appraised the methodological quality of evidence syntheses that were deemed to be highly relevant using the first version of the [AMSTAR](#) tool. AMSTAR rates overall quality on a scale of 0 to 11, where 11/11 represents a review of the highest quality, medium-quality evidence syntheses are those with scores between four and seven, and low-quality evidence syntheses are those with scores less than four. The AMSTAR tool was developed to assess reviews focused on clinical interventions, so not all criteria apply to evidence syntheses pertaining to delivery, financial, or governance arrangements within health systems or implementation strategies.

A separate appendix document includes:

- 1) methodological details (Appendix 1)
- 2) details about each identified evidence synthesis (Appendix 2)
- 3) details about each identified single study (Appendix 3)
- 4) documents that were excluded in the final stages of review (Appendix 4).

- Older adults
- Outcomes
 - Physical health outcomes
 - Cardiovascular effects (e.g., heart failure, heart attack, stroke)
 - Effects on pre-existing conditions (e.g., such as those listed above)
 - Obstetric outcomes
 - Respiratory effects (e.g., bronchitis, reduced lung function)
 - Mental health outcomes
 - Anxiety
 - Depression
 - Post-traumatic stress disorder

What we found

We identified seven evidence documents relevant to the question, of which we deemed five to be highly relevant and two to be of low relevance. The identified evidence documents include:

- two evidence synthesis
- five single studies.

We should note that our search strategy primarily focused on publications specifically linked to wildfires and fire-related studies and wildfire smoke. While we did not include publications related to general air pollution that are not specifically linked to fires and wildfire smoke, we acknowledge that this decision may have resulted in omitting some information relevant to the wildfire smoke context. Studies on general air pollution could provide valuable insights applicable to wildfire smoke scenarios, particularly given the similarities in particulate matter composition and health effects. However, for the purposes of this review, we maintained a more focused scope on fire-related pollution. We outline in narrative form below our key findings related to the question.

Coverage by and gaps in existing evidence syntheses and domestic evidence

The identified evidence provides valuable insights into the effectiveness of masks, including respirators, surgical, and cloth masks, in reducing exposure to and health impacts of wildfire smoke and associated pollutants.

However, there are still some gaps in the evidence regarding the effectiveness of masks in reducing exposure and physical and mental health impacts during combined heat-wildfire smoke events. None of the studies specifically addressed this scenario.

While one primary study provides some insight into the limited use of masks and consideration of mask type among individuals with chronic obstructive pulmonary disorder, there is a lack of evidence on how the effectiveness of masks varies across different population subgroups (e.g., children, older adults, individuals with pre-existing health conditions) and contexts.

Key findings from included evidence documents

Identified evidence showed that respirator masks can reduce absorption of specific pollutants like polycyclic aromatic hydrocarbons (PAHs) and reduce self-reported respiratory symptoms. One primary study revealed that wildland firefighters using N95 masks displayed reduced urinary excretion of 1-hydroxypyrene, a key PAH metabolite, compared to those not using the masks.(1) Another primary study found that firefighters who chose to wear N95 masks during wildfires self-reported fewer respiratory symptoms like coughing and throat discomfort.(2)

Several studies demonstrated that respirator masks like N95s are highly effective at reducing exposure to particulate matter from wildfire smoke when worn properly. One recent evidence synthesis recommends that athletes in environments with high levels of particulate matter may consider wearing a face mask that has been verified to remove over 95% of airborne particles (i.e., N95, KN95, FFP2) when outside of training or competition. However, it notes limited evidence on mask effectiveness during exercise in polluted settings, including wildfire smoke, and emphasizes proper fit and wear as critical factors for mask efficacy.(3) One modelling study evaluated mask protection against wildfire smoke and found respirator masks had an efficiency of 0.9 at protecting against wildfire smoke particles, compared to 0.68 for surgical masks and 0.33 for cloth masks.(4) Another laboratory study examined the filtration capabilities of various mask types against simulated wildland fire smoke and concluded N95, P95, and P100 respirators were 98–99.5% efficient, while surgical masks were 81% efficient and cloth bandanas were only 9% efficient at filtering particulate matter from wildland fire smoke, though real-world effectiveness may vary based on fit and usage conditions.(5) One low-quality evidence synthesis reported surgical masks may only decrease exposure in children by around 20% during wildfire events, whereas N95s could decrease effects by 80%.(6)

Proper mask fit, seal checks, and maintenance were consistently highlighted as crucial factors for maximizing the effectiveness of any mask type.(3-5) However, user discomfort and adherence were identified as potential barriers to use, especially for certain groups like firefighters who may avoid masks due to discomfort.(2)

Evidence on specific populations (e.g., children, older adults, individuals with pre-existing health conditions) was limited. One primary study examined wildfire smoke mitigation strategies among individuals with chronic obstructive pulmonary disease (COPD) and discovered limited mask use and consideration among these populations. Instead, COPD patients tended to rely on other mitigation strategies such as closing windows and remaining indoors to avoid smoke exposure.(7) The study further highlighted a lack of emphasis on masks, including high-efficiency types, as a protective tool for COPD patients.

None of the identified studies specifically addressed mask effectiveness in combined heat-wildfire smoke scenarios or the impact of mask wearing on mental health.

In summary, while good evidence demonstrates the high effectiveness of respirators at reducing particulate matter exposure from wildfire smoke, the evidence for surgical and cloth masks was more mixed. Factors like proper fit, comfort, adherence, and population-specific contexts require further research. No studies directly examined combined heat-wildfire scenarios and how their use and effectiveness may vary across different population groups and contexts. Overall, respirator masks showed the strongest evidence for effective protection, but surgical/cloth masks may provide some additional benefit if respirator masks are unavailable.

Next steps based on the identified evidence

- Developing clear guidance and recommendations for the use of respirators, such as N95 or P100, to protect against the harmful effects of wildfire smoke exposure could be beneficial, noting that the evidence strongly supports the effectiveness of these respirators in reducing exposure to airborne particles and associated health risks like respiratory symptoms.
- Promoting the importance of proper respirator use, including correct application, fit, and maintenance, could help maximize the protective effects (and guidelines emphasizing the importance of these factors could be valuable).
- Engaging in educational efforts to increase awareness and adoption of respirators, particularly among high-risk groups like firefighters and those living in wildfire-prone regions, could be worthwhile based on the evidence of their effectiveness.

References

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