

Public health risk profile: Wildfires in Canada, 2023

Version: 1.0

Date of this assessment: June 23, 2023

Reason for the assessment: Increasing wildfire activity in Canada

Completed by: Public Health Agency of Canada (PHAC)-Corporate Data and Surveillance Branch (CDSB)-Centre for Integrated Risk Assessment (CIRA)

Key Messages

- Canada is experiencing an unprecedented wildfire season. Large areas in Canada are impacted and it is expected that conditions conducive to wildfires will continue.
- Wildfires are considered a public health risk in Canada, due to their impacts on physical health, mental health, and well-being.
- Acute public health risks associated with wildfires are explored here by characterizing the exposures of wildfire smoke and evacuations, and their impacts on exposed populations.
- Populations geographically closest to wildfires have the highest exposure to wildfire smoke. However, wildfire smoke can travel large distances and can affect the air quality for extended periods of time, meaning populations across Canada have the potential for exposure.
- Acute symptoms of wildfire smoke exposure include eye, nose and throat irritation, headache, cough, and shortness of breath, which can be more serious. Exposure to wildfire smoke also leads to more serious outcomes such as acute bronchitis, worsening of chronic respiratory conditions and an increase in all-cause mortality.
- Most evacuations occur due to the danger of fire. Rural and remote areas and Indigenous communities are most often evacuated due to wildfires. Wildfire evacuations can impact the health, well-being, and social stability of evacuees and the impacts of wildfires can be worse for many key populations, including those experiencing inequities.
- Planning for and responding to wildfires is a shared responsibility between many organizations and governmental departments at all levels. This risk profile describes the major short-term public health risks associated with the 2023 wildfire season in Canada. It is intended to assist those responsible to understand, prepare for, respond to, and communicate about public health risks associated with the 2023 Canadian wildfire season.



Event Summary

Canada is experiencing an unprecedented wildfire season. As of June 19, 2023, there have been 2,619 fires reported nationally in 2023, and an estimated 5.3 million hectares burned.¹ The area burned to date is over 15 times larger than the 10-year average for this time of year.¹ The geographic extent is also unusual for this time of year, with 12 provinces and territories affected by wildfires to date across the country¹, as opposed to more typical seasons when regionalized activity usually occurs.² Wildfire severity for June to August is forecasted to be well above average for most of the country, due to ongoing drought and warm temperatures.²

Current fire activity in Canada remains high and widespread: as of June 19, there are 415 active wildfires, with 203 out of control.^{1,3} As of June 13, affected provinces include British Columbia, Alberta, Ontario, Quebec, and Nova Scotia. An estimated 20,994 people remain evacuated across the country.⁴

Smoke migrating from the fires is impacting air quality across North America, with historical records for poor air quality being broken in cities across Canada and the United States.⁵ As of June 14, Special Air Quality Statements were in effect for parts of British Columbia, Alberta, Saskatchewan, Ontario and Quebec, including several major cities.⁴

Wildfires can be started by a weather event such as lightning strikes, or by humans. The likelihood of wildfires depends on a variety of factors, including environmental conditions-including weather, rain, land cover, and human activity in the area.⁶ Areas of wildfire activity are often at the intersection of infrastructure, human activity, and flammable land cover (trees, shrubs, grassland, and other vegetation).⁶ Wildfire season in Canada typically runs from early April to mid-October.⁷

Public Health Risk Considerations

Wildfires are considered a public health risk in Canada due to their impacts on physical health, mental health, and well-being. It is expected that conditions conducive to wildfires will continue, suggesting ongoing and likely increased exposures and impacts for 2023. This risk is explored here by characterizing the short-term exposures of wildfire smoke and evacuations, and their acute impacts on exposed populations.

Additional public health risks, such as those faced by individuals remaining in place or those being repatriated, risks that may be caused by wildfires spreading and causing other public health events, or the long-term exposures and impacts from wildfire smoke and evacuation are not included in the scope of this document.

Wildfire smoke

Exposure considerations

Wildfire smoke consists primarily of a mix of particulate matter (PM), ozone, ammonia, carbon monoxide, nitrogen dioxide, polycyclic aromatic hydrocarbons, volatile organic compounds, water vapour, and trace metals.^{7,8,9,10} Historically, wildfires have often been near remote areas, limiting the exposure of densely populated areas to elevated levels of smoke.⁶ Recent expansions of the wildland-human interface, however, have increased the size of the exposed population.^{6,9}

Populations geographically closest to wildfires have the highest exposure to wildfire smoke pollutants.¹⁰ In addition, wildfire smoke can travel large distances and affect the air quality for extended periods of time^{11,12} meaning populations across Canada could be exposed, depending on weather patterns.

Populations with higher acute exposure to wildfire smoke include those living or working in close proximity to wildfire activity, evacuees, emergency responders, frontline workers, and outdoor workers.¹³ People active outdoors also have increased exposure due to higher breathing rates.¹⁴ Wildfire smoke can enter homes through openings such as windows, doors, and ventilation openings, resulting in indoor exposure.¹⁵ Additionally, those populations experiencing inequities (e.g., lower socioeconomic status, those who are unhoused, and those in shared homes) may have greater exposure to wildfire smoke due to lack of access to measures that reduce particulate pollution indoors, such as air purifiers.^{13,16}

The level of uncertainty is low based on timely and representative air quality monitoring nationally^{17,18}; however, there are some gaps in the evidence of factors that lead to differential exposure and the effectiveness of measures to reduce exposures at an individual level.

Impact considerations

There is no safe level of exposure for some of the pollutants associated with wildfire smoke, and as smoke levels increase, the health impacts also increase.⁷ The primary component of wildfire smoke impacting public health is PM_{2.5}, fine particulate matter which can be inhaled deep into the lungs and enter the bloodstream.^{7,12} While the health impacts of wildfire smoke exposure are greatest in those closest to the source of the smoke¹⁰, wildfire smoke can travel large distances, and many studies have documented the adverse health impacts of wildfire smoke or wildfire-PM_{2.5} in populations at great distance from wildfires.^{9,10,11}

Symptoms of exposure to wildfire smoke include headache, and eye, nose and throat irritation; less common symptoms include cough, shortness of breath, dizziness, wheezing, and heart palpitations.⁷ Short-term exposure to wildfire smoke or wildfire-PM_{2.5} has been strongly associated with all-cause mortality, acute bronchitis, exacerbation of chronic respiratory conditions such as asthma and chronic obstructive pulmonary disease, as well as increases in respiratory emergency room visits and hospitalizations.^{8,9,10} Increasing evidence also suggests an association between wildfire smoke exposure and respiratory infections and adverse birth outcomes.^{8,9,19} There is some evidence for associations between wildfire smoke exposure and adverse cardiovascular outcomes and mental health impacts; however, the evidence is mixed and inconclusive.^{8,9,11,13}

The evidence for the susceptibility of specific subpopulations to wildfire smoke is limited and inconclusive.⁸ However, extensive literature indicates that several populations are at disproportionate risk from the impacts of PM_{2.5}. Based on this research, populations expected to be at greater risk for the adverse health impacts of wildfire smoke include those with underlying cardiovascular and respiratory conditions, fetuses, children, pregnant people, middle-aged and older adults, and those of lower socioeconomic status.^{8,9,20} While evidence is unavailable or scarce, other populations that may experience greater impacts of wildfire smoke include those with other chronic conditions^{9,21} and those with specific genetic polymorphisms⁹.

The current impact of wildfire smoke on the health of the population is unknown but would be expected to be similar to or exceed estimates from previous years in Canada. These estimated 54-240 premature mortalities attributable to short-term exposure to wildfire-related PM_{2.5} annually and 570-2500 premature mortalities attributable to long-term exposure annually, as well as many non-fatal cardiorespiratory health outcomes.¹⁰ Evaluation of the current impacts of the wildfires on people living in Canada would require representative surveillance of health outcomes and reasons for healthcare visits, as well as an ability to link these outcomes to wildfire smoke exposure.

The level of uncertainty for the short-term health impacts of wildfire smoke is moderate. While the overall evidence is reliable, as we consider additional sub-populations the evidence becomes more limited. While the impacts on cardiovascular, reproductive, developmental, and neurological outcomes are unclear, there is consistent evidence for the impacts of wildfire PM_{2.5} on all-cause mortality and respiratory morbidity. Although the impact of other wildfire smoke pollutants on health have not been evaluated in the context of wildfire events, the health effects of these other pollutants individually (e.g., polyaromatic hydrocarbons, nitrogen dioxide, ozone) are well understood. In addition, while much of the understanding of susceptible sub-populations is derived not from studies of wildfire smoke but from PM_{2.5} literature more broadly, wildfire PM_{2.5} is a major contributor to ambient PM_{2.5} in Canada²², making it reasonable to identify these same groups as susceptible to wildfire smoke. However, further evidence is required regarding the risk of other populations, such as those with other chronic conditions and persons with disabilities.

Evacuations

Exposure considerations

Most evacuations occur due to danger of fire proximity (engulfment) and not due to smoke. Evacuation due to smoke may be useful for those more susceptible to air pollution health risks.^{23,24} However, evacuation due to wildfire smoke may not be possible in larger population centers, and rapidly changing wildfire smoke conditions can render movement unnecessary or offer little improvement.²⁴

Because most wildfires occur in rural and remote areas, populations outside of dense urban settings are most likely to experience evacuations.⁶ Indigenous peoples are disproportionately affected by wildfire evacuations compared to other people living in Canada, with First Nations and communities with a primarily Indigenous population experiencing 42% of wildfire evacuation events but making up 5% of people living in Canada.⁶ The same communities can be exposed again and again, with some Indigenous communities experiencing repeat evacuations over recent decades.⁶

The level of uncertainty is moderate, based on the evidence gaps that limit our understanding of impacts on other populations that are most exposed to evacuations and the factors that can influence repeated evacuations.

Impact considerations

Wildfires have a disproportionate impact on children, the elderly, people with disability, and Indigenous communities.⁶ Wildfire evacuations can impact the health, well-being, and social stability of evacuees and can be long and disruptive to daily life. Evacuees can experience mental health impacts such as post-traumatic stress disorder, depression, insomnia, generalized anxiety

and/or substance use disorder, and these conditions can be exacerbated in individuals with pre-existing mental health conditions.^{6,25}

Evacuation centres may be crowded, and individuals often share living spaces and sanitary facilities which increases the risk of respiratory illness and diarrheal disease transmission between residents.²⁶ Evacuations can have increased social, mental, and health impacts for populations experiencing inequities for example, Indigenous people, where culturally unsafe public health responses can be more detrimental to communities than the direct effects of wildfires.^{6,27} Indigenous communities may experience impacts such as overcrowded accommodations, lack of familiar language, and lack of social structure and cohesion, which can be experienced multiple times in a season.^{6,27} Evacuations may exacerbate pre-existing socio-economic conditions and inequities in some Indigenous communities, such as insufficient housing, lack of infrastructure, lack of emergency planning, and access to amenities.⁶

Continuity of health services, including access to medication and required treatment or medical appointments, and access to commodities such as food and potable water can be difficult to access during a wildfire evacuation, especially for Indigenous and remote communities or those with chronic conditions or disability.^{6,24,27} In the process of evacuation, evacuees may be unable to bring medications or essential medical aids; replacing these can be challenging due to a lack of personal identification and medical information.²⁸ The lack of medication can have severe impacts for evacuees, including exacerbation of infections and chronic conditions, and can potentially lead to loss of life.²⁸ Power supplies and communications may be disrupted due to wildfires and thus, have compounding effects on local populations, including evacuees with disabilities who often rely on power and elevators.^{6,24,29} People who use substances may have difficulty accessing a safe drug supply and equipment during natural disasters, along with the social services they may access for social support.³⁰

It is not possible to evaluate the current impact of evacuations on the well-being of people living in Canada. Evaluation of the current impacts of wildfire evacuation on people living in Canada would require information on the services being accessed by evacuees, information from evacuees on their experiences and administrative data to better describe and understand the fulsome impact.

The level of uncertainty is moderate, based on the literature which has growing evidence for the impacts of evacuations on the mental health, well-being, and social stability of evacuees, and these impacts specifically for equity-deserving populations including Indigenous communities.

Contextual Factors Affecting Risk

- Climate change is expected to increase the frequency, duration, severity, and season length of wildfires³¹, and thus increase exposure to wildfire smoke and evacuations. Such changes will put increasing strain on those who live and work in the impacted areas; those working in public health, healthcare, and response services; and on other populations who are impacted by smoke and/or evacuations.
- Individuals with exposure to wildfire smoke and who have evacuated their homes may be more impacted and may experience additional impacts if they are part of a population that is socially or economically marginalized and experiencing inequity. For example, people with disabilities may face unique challenges such as accessing a wheelchair-adapted vehicle for evacuation, lack of accessible shelters post-evacuation, and obtaining necessary medications and aids for their health and well-being during their displacement.
- For those experiencing inequities, the long-term impacts of wildfire can also be significant and would require further review to characterize the risk.
- Heat is often correlated with wildfires, which may interact with wildfire smoke or evacuation exposures and affect impacts. Longer and more intense wildfire seasons may lead to more communities and individuals experiencing the combined effects of heat and wildfire smoke and evacuation or additional public health risks.
- Wildfire smoke from Canada has impacted air quality in the US and vice versa. We assume the factors that impact wildfires and exposure will impact multiple communities across many geographic locations.
- Wildfires may cause downstream impacts as they spread, such as in industrial areas, and affect gas or oil lines. In these situations, the fire may cause additional risks due to different types of pollutants being released into the air or surrounding environment. Risk may increase or change as fire moves towards other infrastructure, for example roadways.
- Wildfires are cyclical events and a shared responsibility between many organizations and departments at all government levels as well as in the private and non-governmental sector. Collaboration is required to support health priorities but also economic, societal and infrastructure impacts.
- There is variability across Canada in the existence of jurisdiction-specific wildfire guidance documents for public health professionals.

Next Steps for Public Health Authorities

Public health authorities at all levels of government can use this risk profile to prepare for, respond to and communicate about acute public health risks associated with the 2023 Canadian wildfire season. The information is intended to support locally available guidance and other resources for community and population needs.

Limitations and Knowledge Gaps

This risk profile describes the public health risks associated with wildfires and is based on evidence known to the Public Health Agency of Canada at the time of production and has several important limitations. Areas that would improve our knowledge and reduce our limitations in the characterizations of the risks described include:

- Improved understanding of the factors that lead to differential wildfire smoke or evacuation exposure and impact (e.g., people experiencing inequities).
- Additional information on specific populations that may be more susceptible to wildfire smoke or evacuations, as well as the longer, broader impacts of fires on physical, mental, social or cultural health and safety including those with chronic diseases or disabilities.
- Additional information on the impact of repeated exposures (smoke or evacuation) or varying levels of smoke exposure on a population to better understand the short and long-term health impacts.
- Improved understanding of the health impacts of wildfire smoke for lesser-studied conditions (adverse cardiovascular, reproductive, developmental, neurological, and oncological outcomes).
- Improved understanding of the effectiveness of mitigating measures (E.g., air filtration, clean air shelters, effective sealing of openings) and equity impacts.
- Identification of best practices and guidance to support populations impacted by these risks (decision for evacuation and return, use of masks, communication, considerations for supporting key populations).

Disclaimer

The risk profile was primarily informed by professional knowledge on wildfires and the impact therein. Where appropriate, some references have been provided, but this is not intended as a literature review.

Acknowledgements

During the preparation of this risk profile experts from the following areas were consulted:

- Emergency Management Branch, Public Health Agency of Canada
- Health Canada
- Environment and Climate Change Canada
- Indigenous Services Canada.

Appendix: Methods

Table A1. Criteria for estimating level of uncertainty

Uncertainty	Criteria
Very High	Lack of data or reliable information; results based on crude speculation only
High	Limited data or reliable information available; results based on educated guess
Moderate	Some gaps in availability or reliability of data and information, or conflicting data; results based on limited consensus
Low	Reliable data and information available but may be limited in quantity, or be variable; results based on expert consensus
Very low	Reliable data and information are available in sufficient quantity; results strongly anchored in empiric data or concrete information

References

- ¹ Natural Resources Canada. Canadian wildland fire information system. <https://cwfis.cfs.nrcan.gc.ca/report/graphs#gr1> . Accessed June 20, 2023.
- ² Natural Resources Canada. (June 2, 2023). The 2023 Wildland Fire Season Update. [Unpublished internal Report]
- ³ Canadian Interagency Forest Fire Centre Inc. (CIFFC). <https://ciffc.net/>. Accessed June 20, 2023.
- ⁴ Health Portfolio Operations Centre. (June 13, 2023). Health Portfolio Operations Centre (HPOC) Daily Report. [Unpublished Report]
- ⁵ New Maps: Tracking Air Quality and Smoke from Canada Wildfires. The New York Times. <https://www.nytimes.com/interactive/2023/us/smoke-maps-canada-fires.html>. Updated June 19, 2023. Accessed June 19, 2023.
- ⁶ Public Safety Canada. The First Public Report of the National Risk Profile. www.publicsafety.gc.ca/cnt/rsrscs/pblctns/2023-nrp-pnr/index-en.aspx. Published May 11, 2023. Accessed June 19, 2023.
- ⁷ Government of Canada. Wildfire smoke, air quality and your health. <https://www.canada.ca/en/environment-climate-change/services/air-quality-health-index/wildfire-smoke.html>. Published June 15, 2023. Accessed June 19, 2023.
- ⁸ Reid, C. E., Brauer, M., Johnston, F. H., Jerrett, M., Balme, J. R., & Elliott, C. T. (2016). Critical review of health impacts of wildfire smoke exposure. In *Environmental Health Perspectives* (Vol. 124, Issue 9). <https://doi.org/10.1289/ehp.1409277>
- ⁹ Cascio, W. E. (2018). Wildland fire smoke and human health. *Science of the Total Environment*, 624. <https://doi.org/10.1016/j.scitotenv.2017.12.086>
- ¹⁰ Matz, C. J., Egyed, M., Xi, G., Racine, J., Pavlovic, R., Rittmaster, R., Henderson, S. B., & Stieb, D. M. (2020). Health impact analysis of PM_{2.5} from wildfire smoke in Canada (2013–2015, 2017–2018). *Science of the Total Environment*, 725. <https://doi.org/10.1016/j.scitotenv.2020.138506>
- ¹¹ Eisenman, D. P., & Galway, L. P. (2022). The mental health and well-being effects of wildfire smoke: a scoping review. *BMC Public Health*, 22(1). <https://doi.org/10.1186/s12889-022-14662-z>
- ¹² Aguilera, R., Corringham, T., Gershunov, A., & Benmarhnia, T. (2021). Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. *Nature Communications*, 12(1). <https://doi.org/10.1038/s41467-021-21708-0>
- ¹³ United States Environmental Protection Agency (US EPA). Public Health Impacts of Wildfire Smoke Exposure. <https://www.epa.gov/wildfire-smoke-course/public-health-impacts-wildfire-smoke-exposure>. Published October 20, 2022. Accessed June 19, 2023.

¹⁴ Centers for Disease Control and Prevention (CDC). Outdoor Workers Exposed to Wildfire Smoke. <https://www.cdc.gov/niosh/topics/firefighting/wffsmoke.html>. Published May 10, 2023. Accessed June 19, 2023.

¹⁵ Government of Canada. Wildfire smoke 101: Using an air purifier to filter wildfire smoke <https://www.canada.ca/en/health-canada/services/publications/healthy-living/using-portable-air-cleaner-wildfire-smoke.html>. Published June 15, 2023. Accessed June 19, 2023.

¹⁶ Health Canada. Guidance for Cleaner Air Spaces during Wildfire Smoke Events. <https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidance-cleaner-air-spaces-during-wildfire-smoke-events.html>. Published September 2020. Accessed June 20, 2023.

¹⁷ Environment and Climate Change Canada. Canada's Wildfire Smoke Prediction System (FireWork). https://weather.gc.ca/firework/index_e.html. Accessed June 22, 2023

¹⁸ Government of Canada. Air quality Health Index. https://weather.gc.ca/airquality/pages/index_e.html Accessed June 22, 2023.

¹⁹ Requia, W. J., Amini, H., Adams, M. D., & Schwartz, J. D. (2022). Birth weight following pregnancy wildfire smoke exposure in more than 1.5 million newborns in Brazil: A nationwide case-control study. *The Lancet Regional Health - Americas*, 11. <https://doi.org/10.1016/j.lana.2022.100229>

²⁰ Holm, S. M., Miller, M. D., & Balmes, J. R. (2021). Health effects of wildfire smoke in children and public health tools: a narrative review. In *Journal of Exposure Science and Environmental Epidemiology* (Vol. 31, Issue 1). <https://doi.org/10.1038/s41370-020-00267-4>

²¹ Mahsin, M. D., Cabaj, J., & Saini, V. (2022). Respiratory and cardiovascular condition-related physician visits associated with wildfire smoke exposure in Calgary, Canada, in 2015: A population-based study. *International Journal of Epidemiology*, 51(1). <https://doi.org/10.1093/ije/dyab206>

²² Meng, J., Martin, R. v., Li, C., van Donkelaar, A., Tzompa-Sosa, Z. A., Yue, X., Xu, J. W., Weagle, C. L., & Burnett, R. T. (2019). Source Contributions to Ambient Fine Particulate Matter for Canada. *Environmental Science and Technology*, 53 (17). <https://doi.org/10.1021/acs.est.9b02461>

²³ US EPA. Wildfire smoke, a guide for public health officials https://www.airnow.gov/sites/default/files/2021-09/wildfire-smoke-guide_0.pdf. Published September 2021. Accessed June 20, 2023

²⁴ National Collaborating Centre for Environmental Health. Public Health Responses to Wildfire Smoke Events. <https://ncceh.ca/documents/evidence-review/public-health-responses-wildfire-smoke-events> Published August 2018. Accessed June 20, 2023

²⁵ Belleville, G., Ouellet, M. C., Lebel, J., Ghosh, S., Morin, C. M., Bouchard, S., Guay, S., Bergeron, N., Campbell, T., & MacMaster, F. P. (2021). Psychological Symptoms Among Evacuees From the 2016 Fort McMurray Wildfires: A Population-Based Survey One Year Later. *Frontiers in Public Health*, 9. <https://doi.org/10.3389/fpubh.2021.655357>

²⁶ Centers for Disease Control and Prevention (CDC). Infection Control After a Disaster. <https://www.cdc.gov/disasters/infectioncontrol.html>. Published September 5, 2017. Accessed June 19, 2023.

²⁷ National Collaborating Centres for Public Health. Health and social impacts of long-term evacuation due to natural disasters in First Nations communities: a summary of lessons for public health. https://nccid.ca/wp-content/uploads/sites/2/2021/08/Long-term-Evacuation-and-Recovery-Series-Summary-EN-Aug_24.pdf. Published 2021.

²⁸ Ochi S., Hodgson S., Landeg O., Mayner L., and Murray, V. (2014). Disaster-driven evacuation and medication loss: A systematic literature review. PLoS Currents doi: 10.1371/currents.dis.fa417630b566a0c7dfdbf945910edd96.

²⁹ Public Safety Canada. Emergency Preparedness Guide for People with Disabilities/Special Needs. <https://www.getprepared.gc.ca/cnt/rsrscs/pbictns/pplwthdsblts/pplwthdsblts-eng.pdf>. Accessed June 26, 2023

³⁰ National Collaborating Centre for Environmental Health. Post-disaster emergency response: Supporting people who use substances [blog]. <https://ncceh.ca/content/blog/post-disaster-emergency-response-supporting-people-who-use-substances>. Published Nov 3, 2022. Accessed June 22, 2023

³¹ Wotton, B.M., Flannigan, M.D., and Marshall, G.A. (2017). Potential climate change impacts on fire intensity and key wildfire suppression thresholds in Canada. Environ. Res. Lett. 12 (9) <https://iopscience.iop.org/article/10.1088/1748-9326/aa7e6e>