HUMAN HEALTH EFFECTS OF WILDFIRE SMOKE

Health Canada Santé Canada

Canada

Health Canada is the federal department responsible for helping the people of Canada maintain and improve their health. Health Canada is committed to improving the lives of all of Canada's people and to making this country's population among the healthiest in the world as measured by longevity, lifestyle and effective use of the public health care system.

Également disponible en français sous le titre :
Les effets de la fumée des feux de forêt sur la santé humaine

To obtain additional information, please contact:

Health Canada
Address Locator 0900C2
Ottawa, ON K1A 0K9
Tel.: 613-957-2991
Toll free: 1-866-225-0709
Fax: 613-941-5366
TTY: 1-800-465-7735

E-mail: publications-publications@hc-sc.gc.ca

Publication date: May 2024

Cat.: H144-123/2024E-PDF
ISBN: 978-0-660-71379-3
Pub.: 240056

ACKNOWLEDGEMENTS

This report was reviewed by the following external scientific experts:

Tarik Benmarhnia, PhD (University of California San Diego)

Angela Yao, PhD (British Columbia Centre for Disease Control)

TABLE OF CONTENTS

1.0 INTRODUCTION

Wildfires, the uncontrolled burning of natural vegetation, are a major natural hazard and an important part of many ecosystems. Smoke from wildfires is a complex mixture of water vapour, gases, and particles, with many of the individual components associated with adverse health effects. The chemical composition of wildfire smoke is highly variable and determined by many factors including the type and composition of the vegetation burning (e.g., wet or green vegetation versus dead or dry vegetation; forests versus grasslands; hardwood versus softwood; etc.), the physical and chemical combustion processes (e.g., flaming versus smoldering), and weather conditions (e.g., temperature, humidity) (Andreae and Merlet 2001; Black et al., 2017).

Wildfires are a major source of air pollution around the world. They are sources of primary emissions (i.e., emitted directly into the environment) of particulate matter (PM), carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NOx), methane, volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs) and of secondary pollutants (i.e., pollutants formed through atmospheric chemistry), such as ozone (O_3) and secondary organic aerosols (Urbanski et al., 2008). Wildfire smoke can impact air quality in areas in close proximity to the wildfire activity and regionally or continentally due to long-range transport and transformation of the fire emissions (Urbanski et al., 2008; Matz et al., 2020).

As wildfires are a global issue, the health effects of wildfire smoke exposure are an active and growing area of research. Furthermore, there is growing interest in wildfires and the associated health effects as climate change is anticipated to increase wildfire activity by increasing the fire season length and frequency of fires (Wotton et al., 2017; Sun et al., 2019). Given this context and to better inform federal Health Portfolio guidance and actions related to wildfire smoke, there is a need to evaluate the scientific literature on the health effects of wildfire smoke.

The objective of this document is to provide a concise weight-of-evidence review of health outcomes associated with exposure to wildfire smoke. Specifically, the goal is to characterize the strength of the evidence for individual health endpoints rather than quantifying the risk level of each outcome. The approach consisted of a review of published systematic reviews, including meta-analyses, of primary studies examining the association between exposure to wildfire smoke and mortality and morbidity outcomes. The primary studies captured in the reviews were conducted in North America, South America, Australia, Europe and Asia. Systematic reviews provide a robust synthesis of available scientific evidence, and are leveraged here to provide a rapid evidence synthesis. Details of the methodology used for this evidence synthesis are provided in the Appendix.

Evaluation of air pollution from wildfires presents unique challenges, compared to air pollution from other sources, such as traffic or industrial point sources, as smoke exposure is seasonal and episodic in nature (Gould et al., 2023). Also, as the number and size of wildfires impacting an area are variable and as smoke production from wildfires is not constant or steady, the concentration of

smoke experienced by populations can vary considerably, and can include high levels of exposure for short time periods or moderate exposure levels lasting for several days or longer. Additionally, to evaluate the health effects of wildfire smoke, it is necessary to distinguish the contribution of wildfire smoke from that of other sources of air pollution within the mixture that people are exposed to. To address this, researchers have employed a variety of methods to assess exposure to wildfire smoke for use in health studies including use of land-based PM monitors, satellite imagery, air quality modelling, comparison of fire versus non-fire periods, proximity to wildfire burn area, and self-reports. In these studies, the most commonly used surrogates for wildfire smoke exposure are $PM_{2.5}$ (particles with a diameter of 2.5 micrometres or less) and PM_{10} (particles with a diameter of 10 micrometres or less). For the primary investigations included in the systematic reviews considered here, the health outcome data were based on administrative sources (e.g., mortality registries, health care utilization data), surveys, or self-reports. In addition, most of the primary studies focused on short-term or episodic exposure to wildfire smoke (i.e., daily exposure), while some of the studies assessing mental health impacts considered health effects in years following the wildfires, and studies of reproductive or developmental impacts considered wildfire smoke exposure during the gestational period. It is noted that the health effects of $PM_{2.5}$, a key pollutant in wildfire smoke, have been extensively studied and Health Canada has evaluated the health risks of ambient $PM_{2.5}$ (i.e., $PM_{2.5}$ from all sources combined) (Health Canada 2022).

2.0 HEALTH EFFECTS OF WILDFIRE SMOKE

2.1 MORTALITY

Most reviews of the epidemiological evidence identified a consistent association between wildfire smoke exposure and increased risk of all-cause mortality, while in comparison, the evidence for respiratory- or cardiovascular-specific mortality is mixed and less conclusive (Youssouf et al., 2014; Adetona et al., 2016; Liu et al., 2016; Reid et al., 2016; Black et al., 2017; Chen et al., 2021; Karanasiou et al., 2021; Barros et al., 2023; Gao et al., 2023; Gould et al., 2023; Jiao et al., 2024). From the two systematic reviews that included meta-analysis, the pooled analyses identified significant associations between daily all-cause mortality and various measures of wildfire smoke exposure (summarized in Table 1) (Karanasiou et al., 2021; Gould et al., 2023). The recent reviews of the cardiovascular (Chen et al., 2021) and respiratory (Jiao et al., 2024) effects of wildfire smoke concluded that while a majority of the primary studies of cause-specific mortality have observed positive associations, only a few studies had statistically significant risk estimates, and null associations have also been reported in some of the studies. However, the meta-analysis by Karanasiou et al. (2021) identified a significant increase in risk of cardiovascular mortality for smoky compared to non-smoky days (Table 1); in comparison, there were insufficient data for a pooled analysis based on pollutant concentration, which are more refined exposure metrics.

TABLE 1: Summary of pooled analyses of wildfire smoke exposure and mortality

Reference	Number of studies	Pooled risk estimate (95% confidence interval [CI])	Wildfire smoke exposure metric
All-cause mortality			
Gould et al., 2023	8	**0.15%**[a] (0.01-0.28)	per 1 μg/m^3 wildfire-$PM_{2.5}$
Karanasiou et al., 2021	4	**2.61%** (1.02-4.20)	Smoky vs Non-smoky days
	5	**1.31%** (0.91-1.71)	per 10 μg/m^3 wildfire-PM_{10}
Cardiovascular mortality			
Karanasiou et al., 2021	3	**4.45%** (0.96-7.95)	Smoky vs Non-smoky days

[a] Bold represents significant pooled estimates

2.2 RESPIRATORY MORBIDITY

From a large number of primary studies, there is consistent and significant evidence of an association between wildfire smoke exposure and an increased risk of emergency room visits (ERVs), hospital admissions (HAs), physician visits, or medication dispensations for respiratory conditions (Youssouf et al., 2014; Adetona et al., 2016; Liu et al., 2016; Reid et al., 2016; Black et al., 2017; Borchers Arriagada et al., 2019; Henry et al. 2021; Karanasiou et al., 2021; Skinner et al., 2022; Barros et al., 2023; Gao et al., 2023; Gould et al., 2023; Zhang et al., 2023; Jiao et al., 2024). From the four systematic reviews that included meta-analysis, the pooled analyses considered different wildfire smoke exposure metrics and determined significant increases in all-cause respiratory HAs and ERVs (summarized in Table 2) (Borchers Arriagada et al., 2019; Karanasiou et al., 2021; Barros et al., 2023; Gould et al., 2023).

Regarding specific respiratory endpoints, there is consistent and significant evidence supporting an association between wildfire smoke exposure and asthma- and chronic obstructive pulmonary disease (COPD)-related healthcare utilization; however, there is less evidence of an increased risk of HAs or ERVs for other respiratory illnesses (e.g., pneumonia, bronchitis) and these results are inconsistent (Youssouf et al., 2014; Adetona et al., 2016; Reid et al., 2016; Black et al., 2017; Skinner et al., 2022; Zhang et al., 2023; Jiao et al., 2024). These general observations are supported by the pooled analyses which have consistently determined significant associations for asthma and COPD, while the pooled associations for other respiratory illnesses are weaker and mixed or non-significant (summarized in Table 2) (Karanasiou et al., 2021; Barros et al., 2023).

Although the various pooled analyses summarized in this report mainly focused on same-day associations between wildfire smoke exposure and the health endpoint, there is evidence that increased healthcare utilization may be lagged by up to 3 days (Skinner et al., 2022). Additionally, increased risks for respiratory morbidity were commonly noted for women, children, and seniors compared to the risks observed for the general population (Borchers Arriagada et al., 2019; Kondo et al., 2019; Henry et al., 2021; Karanasiou et al., 2021; Skinner et al., 2022; Jiao et al., 2024).

TABLE 2: Summary of pooled analyses of wildfire smoke exposure and respiratory morbidity

Reference	Number of studies	Pooled risk estimate (95% CI)	Wildfire smoke exposure metric
All-respiratory ERVs and HAs (combined unless specified)			
Borchers Arriagada et al., 2019	8 9	HAs: **1.06**[a] (1.02-1.09) ERVs: **1.07** (1.04-1.09)	per 10 μg/m^3 wildfire-$PM_{2.5}$
Gould et al., 2023	10 5	HAs: **0.25%** (0.09-0.42) ERVs: **0.36%** (0.19-0.53)	per 1 μg/m^3 wildfire-$PM_{2.5}$
Karanasiou et al., 2021	7 13 5	**10.52%** (3.87-17.18) **4.10%** (2.86-5.34) **4.83%** (0.06-9.60)	Smoky vs Non-smoky days per 10 μg/m^3 wildfire-$PM_{2.5}$ per 10 μg/m^3 wildfire-PM_{10}
Barros et al., 2023	6 8	**1.03** (1.01-1.05) **1.07** (1.03-1.11)	per 10 μg/m^3 wildfire-$PM_{2.5}$ Smoky vs Non-smoky days
Asthma-related ERVs and HAs			
Karanasiou et al., 2021	6 13 6	**38.26%** (7.91-68.60) **9.19%** (5.71-12.68) **10.35%** (4.44-16.26)	Smoky vs Non-smoky days per 10 μg/m^3 wildfire-$PM_{2.5}$ per 10 μg/m^3 wildfire-PM_{10}
Barros et al., 2023	8	**1.08** (1.06-1.11)	per 10 μg/m^3 wildfire-$PM_{2.5}$
COPD-related ERVs and HAs			
Karanasiou et al., 2021	4 12 4	**13.33%** (7.31-19.34) **3.92%** (1.13-6.70) **3.95%** (1.65-6.24)	Smoky vs Non-smoky days per 10 μg/m^3 wildfire-$PM_{2.5}$ per 10 μg/m^3 wildfire-PM_{10}
Barros et al., 2023	5	1.03 (0.98-1.09)	per 10 μg/m^3 wildfire-$PM_{2.5}$
Pneumonia-related ERVs and HAs			
Karanasiou et al., 2021	6	1.72% (-0.09-3.53)	per 10 μg/m^3 wildfire-$PM_{2.5}$ or -PM_{10}
Barros et al., 2023	5	1.02 (0.98-1.07)	per 10 μg/m^3 wildfire-$PM_{2.5}$
Bronchitis-related ERVs and HAs			
Barros et al., 2023	5	1.03 (0.99-1.08)	per 10 μg/m^3 wildfire-$PM_{2.5}$

[a] Bold represents significant pooled estimates

ERVs: Emergency room visits; HAs: Hospital admissions; COPD: Chronic obstructive pulmonary disease

2.3 CARDIOVASCULAR MORBIDITY

The evidence base for cardiovascular morbidity is largely mixed and inconsistent (Youssouf et al., 2014; Adetona et al., 2016; Liu et al., 2016; Reid et al., 2016; Black et al., 2017; Chen et al., 2021; Karanasiou et al., 2021; Barros et al., 2023; Gould et al., 2023). Null or non-significant associations have generally been observed in the primary studies that have evaluated all-cardiovascular morbidity. However, significant associations have been reported for seniors (≥65 years) indicating an increased risk for this age group. Additionally, positive associations are more commonly reported for specific endpoints (e.g., ischemic heart disease [IHD], hypertension, congestive heart disease [CHD], heart failure, and myocardial infarction [MI]), than for the aggregate outcome, though the pooled analyses do not consistently identify an association for the individual outcomes. From the three systematic reviews that included meta-analysis, the pooled analyses for cardiovascular morbidity for the various health endpoints and different measures of wildfire smoke exposure are summarized in Table 3, and largely considered same-day associations (Karanasiou et al., 2021; Barros et al., 2023; Gould et al., 2023). The null associations observed in many of the primary studies may be due to the lower occurrence of cardiovascular cases (or outcomes), especially among children and younger adults, compared to respiratory cases, limiting the ability to detect an association (Chen et al., 2021).

TABLE 3: Summary of pooled analyses of wildfire smoke exposure and cardiovascular morbidity

Reference	Number of studies	Pooled risk estimate (95% CI)	Wildfire smoke exposure metric
All-cardiovascular ERVs and HAs (combined unless specified)			
Gould et al., 2023	9	HAs: 0.06% (0.00-0.12)	per 1 μg/m^3 wildfire-PM$_{2.5}$
	4	ERVs: -0.03% (-0.18-0.12)	
Karanasiou et al., 2021	7	4.84% (-0.44-10.11)	Smoky vs Non-smoky days
	10	3.68% (-1.73-9.09)	per 10 μg/m^3 wildfire-PM$_{2.5}$
	7	0.93% (-0.18-2.05)	per 10 μg/m^3 wildfire-PM$_{10}$
Barros et al., 2023	5	1.00 (0.99-1.01)	per 10 μg/m^3 wildfire-PM$_{2.5}$
	5	≥65 years: **1.05**[a] (1.01-1.09)	Smoky vs Non-smoky days
IHD-related ERVs and HAs			
Karanasiou et al., 2021	3	**5.45%** (0.80-10.10)	Smoky vs Non-smoky days
	5	0.66% (-0.73-2.04)	per 10 μg/m^3 wildfire-PM$_{2.5}$
	3	0.23% (-1.16-1.62)	per 10 μg/m^3 wildfire-PM$_{10}$
Barros et al., 2023	4	0.99 (0.96-1.02)	per 10 μg/m^3 wildfire-PM$_{2.5}$

Reference	Number of studies	Pooled risk estimate (95% CI)	Wildfire smoke exposure metric
Arrhythmia-related ERVs and HAs			
Barros et al., 2023	5	1.00 (0.98-1.03)	per 10 μg/m^3 wildfire-$PM_{2.5}$
MI-related ERVs and HAs			
Barros et al., 2023	5	0.99 (0.96-1.02)	per 10 μg/m^3 wildfire-$PM_{2.5}$
Heart failure-related ERVs and HAs			
Barros et al., 2023	5	1.01 (0.98-1.04)	per 10 μg/m^3 wildfire-$PM_{2.5}$
Cerebrovascular disease-related ERVs and HAs			
Barros et al., 2023	5	1.02 (0.99-1.04)	per 10 μg/m^3 wildfire-$PM_{2.5}$

[a] Bold represents significant pooled estimates

ERVs: Emergency room visits; HAs: Hospital admissions; IHD: Ischemic heart disease; MI: Myocardial infarction

2.4 REPRODUCTIVE AND DEVELOPMENTAL EFFECTS

The effects of wildfires on reproductive and developmental outcomes are an active area of research. Recent systematic reviews identified that the most consistent evidence is for low birth weight and preterm birth, with most of the primary studies reporting positive associations with exposure to wildfire smoke or wildfire occurrences (Amjad et al., 2021; Evans et al., 2022; Gould et al., 2023; Zhang et al., 2023; Foo et al., 2024). From the two systematic reviews that included meta-analysis, there is some evidence for an association with low birth weight, which is summarized in Table 4 (Zhang et al., 2023; Foo et al., 2024). Notably, Foo et al. (2024) included more recent primary studies and did not observe significant associations. Additionally, there is evidence that timing of exposure, especially during the second or third trimesters, severity of the wildfires, and proximity to the wildfires may be influential factors in the observed adverse birth outcomes. The certainty in the evidence is limited due to a lack of information on maternal health status (e.g., pre-existing conditions, nutritional status) for many of the primary studies, as these are known confounders for the endpoints. The primary investigations were also highly varied in terms of study design and exposure assessment methods, which limited the number of studies in the pooled analyses. Notably, the reproductive or developmental effects were associated with wildfire occurrence and not specifically limited to wildfire smoke exposure. This is an important consideration, as increased maternal stress leading to the adverse birth outcomes could result from both wildfire smoke exposure and occurrence. For other reproductive and developmental endpoints, such as size for gestational age, birth defects, gestational diabetes or hypertension, sex ratio, neonatal intensive care unit admission, or stillbirth, the systematic reviews identified that a small number of primary studies have been conducted per endpoint and the associations are inconsistent with most studies reporting non-significant or null associations (Amjad et al., 2021; Evans et al., 2022; Zhang et al., 2023; Foo et al., 2024).

TABLE 4: Summary of pooled analyses of wildfire smoke exposure and birth weight

Reference	Number of studies	Pooled risk estimate (95% CI)	Wildfire smoke exposure metric
Birth weight reduction			
Zhang et al., 2023	3	**-21.71**[a] g (-32.92- -10.50)	per 10 µg/m^3 wildfire-$PM_{2.5}$
Foo et al., 2024	5	-16.18 g (-44.37-12.02)	per 5 µg/m^3 wildfire-$PM_{2.5}$
Low birth weight			
Foo et al., 2024	4	1.21 (0.84-1.58)	per 5 µg/m^3 wildfire-$PM_{2.5}$

[a] Bold represents significant pooled estimates

2.5 MENTAL HEALTH

Given the potentially disruptive effects of wildfires and wildfire smoke on communities, a number of primary studies have evaluated mental health impacts and have identified increased rates of post-traumatic stress disorder (PTSD), anxiety, and depression in both children and adults with impacts that may persist months to years following a wildfire (Cianconi et al., 2020; Eisenman and Galway, 2022; Gao et al., 2023; Gould et al., 2023; Walinski et al., 2023). This evidence base is largely drawn from primary studies relying on surveys or self-reporting, as primary studies that have evaluated administrative data (e.g., ERVs or physician visits for mental health conditions) have not detected associations (Reid et al., 2016; Eisenman and Galway, 2022). In addition, the evidence is inconsistent and limited for associations with wildfire smoke specifically, given the difficulties in differentiating the impacts attributable to smoke from those due to trauma associated with the wildfire occurrence (e.g., potential loss of property or livelihood, physical threat, evacuation). Several possible pathways leading to mental health impacts from wildfires have been identified, including sleep disturbance, reduced physical activity, increased perceived risk, social isolation, evacuation or relocation, and loss of access to nature (Eisenman and Galway, 2022; Gould et al., 2023).

2.6 MECHANISMS OF TOXICITY OF WILDFIRE SMOKE

The exact mechanisms of how wildfire smoke causes health effects are not fully understood, although the evidence suggests they may be similar to those identified for ambient PM. Based on studies in humans and animals exposed to wildfire or wood smoke, several pathways have been proposed as mechanisms of toxicity underlying the adverse health effects (Adetona et al., 2016; Reid et al., 2016; Black et al., 2017; Cascio, 2018; Chen et al., 2021). Oxidative stress and systemic inflammation have been identified as key mechanisms, as many components of wildfire smoke are capable of activating the oxidative stress pathway. Inhalation of wildfire smoke induces production of reactive oxygen species (ROS) and elicits inflammatory responses in the lung, which can lead to

systemic inflammation and other biochemical changes (e.g., lipid peroxidation, depletion of antioxidants, cell cycle alteration, platelet activation, DNA damage). Additionally, inhaled wildfire smoke particles can interact with the receptors in the lung and activate the autonomous nervous system, resulting in changes in blood pressure and heart rhythm. Ultrafine particles (particles with a diameter less than 0.1 micrometres) and gases in the smoke may translocate through alveolar membranes and enter systemic circulation, which can result in biochemical and physiological changes, including endothelial dysfunction and injury. Lastly, wildfire smoke may compromise immune system function, including immune responses in the lung, increasing the risk of infection.

2.7 DISPROPORTIONATELY IMPACTED POPULATIONS

Although few studies have been designed to directly evaluate differential impacts or susceptibilities to wildfires and wildfire smoke, several groups have been identified as potentially being disproportionately impacted, including seniors, children, women, pregnant people, Indigenous populations, people living in remote areas, people with pre-existing health conditions, people with lower socio-economic status (SES), and wildland firefighters (Youssouf et al., 2014; Adetona et al., 2016; Liu et al., 2016; Reid et al., 2016; Borchers Arriagada et al., 2019; Kondo et al., 2019; Chen et al., 2021; Karanasiou et al., 2021; Thomas et al., 2022; Melton et al., 2023). Various factors contribute to these disproportionate risks, including biological and physiological differences due to lifestage and/or presence of a comorbidity, and increased likelihood of exposure to wildfires due to location or occupation. From an analysis of studies of wildfire smoke conducted in North America, increased risks of respiratory morbidity outcomes were identified for children, seniors, women and those with lower SES (Kondo et al., 2019). Studies in wildland firefighters have identified cardiorespiratory effects (e.g., reduced lung function, airway and systemic inflammation) associated with short-term exposures to wildfire smoke (Yousouff et al., 2014; Black et al., 2017; Groot et., 2019; Chen et al., 2021), and there is an indication of increased risk of mental health impacts (e.g., PTSD) in this occupational group (Groot et al., 2019; Walinski et al., 2023).

3.0 CONCLUSIONS AND CONSIDERATIONS

As wildfires are projected to increase in frequency and severity, the health effects of wildfire smoke will continue to be an active area of research. Based on published systematic reviews of the literature, there is strong and consistent evidence that wildfire smoke exposure is associated with an increased risk of premature mortality and adverse respiratory effects, including exacerbation of asthma and COPD. There is some evidence of an association between wildfire smoke exposure and increased risk of cardiovascular mortality and morbidity, including an increased risk of non-fatal effects in seniors. For reproductive and developmental effects and mental health impacts, further

studies are needed to differentiate the effects attributable to wildfire smoke versus the effects resulting from the occurrence of wildfires. At present, there is some evidence of an association between wildfire smoke and reproductive and developmental effects (e.g., low birth weight) and limited evidence on the mental health impacts of wildfire smoke specifically. With respect to other health outcomes, there is emerging evidence of potential associations between exposure to wildfire smoke and wildfires and risk of neurological effects (e.g., cognitive deficits), cancer, and skin and eye conditions (Gould et al., 2023; Zhang et al., 2023). Also, there is limited evidence of the long-term effects of wildfire smoke exposure, which is attributable to the episodic nature of wildfires, seasonal and spatial variability in wildfire smoke exposure, and the difficulties in differentiating wildfire-$PM_{2.5}$ from $PM_{2.5}$ from all sources (Gao et al., 2023; Gould et al., 2023). There is a need for a better characterization of the lagged effects of wildfire smoke exposure that have been observed, which will help to better understand the cumulative impacts on health care utilization (Skinner et al., 2022; Gould et al., 2023). As such, additional, well-designed studies are needed to address these knowledge gaps and to more fully understand the totality of the health effects of wildfire smoke. Since this evidence synthesis is based on published systematic reviews, it may not include the most recent primary studies of the health effects of wildfire smoke.

The literature base identified some groups that may be disproportionately impacted by wildfires and wildfire smoke, including seniors, children, women, pregnant people, Indigenous populations, people living in remote areas, people with pre-existing health conditions, people with lower SES, and wildland firefighters. Additional research will also help to better understand the groups that may be disproportionately impacted by wildfires and wildfire smoke.

As the understanding of the health effects of wildfire smoke develops, there are a few considerations that should be taken into account. With respect to exposure assessment, there are numerous challenges; for example, monitoring methods cannot distinguish between sources of PM, methods based on proximity to wildfires may not represent smoke exposure, and use of smoky versus non-smoky days is a coarse metric that cannot be used to quantify the risk per unit of exposure. Furthermore, the diverse approaches to exposure assessment can limit the ability to quantitatively synthesize the results from the primary studies. Additionally, behaviour changes associated with exposure to wildfire smoke (e.g., remaining indoors, wearing masks, relocation) will alter individual exposures and, if unaccounted for, would bias the exposure-response relationship. Other important areas of investigation include an understanding of the differential effects of ambient $PM_{2.5}$ and wildfire-$PM_{2.5}$, the health effects of the other components of wildfire smoke, and the combined effects of wildfire smoke and heat, as smoke and heat events may occur simultaneously.

REFERENCES

Adetona O, Reinhardt TE, Domitrovich J, et al. Review of the health effects of wildland fire smoke on wildland firefighters and the public. *Inhal Toxicol*. 2016;28(3):95-139. doi:10.3109/08958378.2016.1145771

Amjad S, Chojecki D, Osornio-Vargas A, Ospina MB. Wildfire exposure during pregnancy and the risk of adverse birth outcomes: A systematic review. *Environ Int*. 2021;156:106644. doi:10.1016/j.envint.2021.106644

Andreae MO, Merlet P. Emission of trace gases and aerosols from biomass burning, *Global Biogeochem. Cycles* 2001;15:955-966. doi:10.1029/2000GB001382.

Barros B, Oliveira M, Morais S. Continent-based systematic review of the short-term health impacts of wildfire emissions. *J Toxicol Environ Health B Crit Rev*. 2023;26(7):387-415. doi:10.1080/10937404.2023.2236548

Black C, Tesfaigzi Y, Bassein JA, Miller LA. Wildfire smoke exposure and human health: Significant gaps in research for a growing public health issue. *Environ Toxicol Pharmacol*. 2017;55:186-195. doi:10.1016/j.etap.2017.08.022

Borchers Arriagada N, Horsley JA, Palmer AJ, Morgan GG, Tham R, Johnston FH. Association between fire smoke fine particulate matter and asthma-related outcomes: Systematic review and meta-analysis. *Environ Res*. 2019;179(Pt A):108777. doi:10.1016/j.envres.2019.108777

Cascio WE. Wildland fire smoke and human health. *Sci Total Environ*. 2018;624:586-595. doi:10.1016/j.scitotenv.2017.12.086

Chen H, Samet JM, Bromberg PA, Tong H. Cardiovascular health impacts of wildfire smoke exposure. *Part Fibre Toxicol*. 2021;18(1):2. Published 2021 Jan 7. doi:10.1186/s12989-020-00394-8

Cianconi P, Betrò S, Janiri L. The Impact of Climate Change on Mental Health: A Systematic Descriptive Review. *Front Psychiatry*. 2020;11:74. Published 2020 Mar 6. doi:10.3389/fpsyt.2020.00074

Eisenman DP, Galway LP. The mental health and well-being effects of wildfire smoke: a scoping review. *BMC Public Health*. 2022;22(1):2274. Published 2022 Dec 5. doi:10.1186/s12889-022-14662-z

Evans J, Bansal A, Schoenaker DAJM, Cherbuin N, Peek MJ, Davis DL. Birth Outcomes, Health, and Health Care Needs of Childbearing Women following Wildfire Disasters: An Integrative, State-of-the-Science Review. *Environ Health Perspect*. 2022;130(8):86001. doi:10.1289/EHP10544

Foo D, Stewart R, Heo S, et al. Wildfire smoke exposure during pregnancy and perinatal, obstetric, and early childhood health outcomes: A systematic review and meta-analysis. *Environ Res*. 2024;241:117527. doi:10.1016/j.envres.2023.117527

Gao Y, Huang W, Yu P, et al. Long-term impacts of non-occupational wildfire exposure on human health: A systematic review. *Environ Pollut*. 2023;320:121041. doi:10.1016/j.envpol.2023.121041

Gould CF, Heft-Neal S, Prunicki M, et al. Health Effects of Wildfire Smoke Exposure. *Annu Rev Med*. Published online September 22, 2023. doi:10.1146/annurev-med-052422-020909

Groot E, Caturay A, Khan Y, Copes R. A systematic review of the health impacts of occupational exposure to wildland fires. *Int J Occup Med Environ Health*. 2019;32(2):121-140. doi:10.13075/ijomeh.1896.01326

Health Canada. 2022. Canadian health science assessment for fine particulate matter ($PM_{2.5}$). Ottawa, Ontario: Health Canada. Cat. No. H144-100/2022E-PDF. www.publications.gc.ca/pub?id=9.907208&sl=0

Henry S, Ospina MB, Dennett L, Hicks A. Assessing the Risk of Respiratory-Related Healthcare Visits Associated with Wildfire Smoke Exposure in Children 0-18 Years Old: A Systematic Review. *Int J Environ Res Public Health*. 2021;18(16):8799. Published 2021 Aug 20. doi:10.3390/ijerph18168799

Jiao A, Headon K, Han T, et al. Associations between short-term exposure to wildfire particulate matter and respiratory outcomes: A systematic review. *Sci Total Environ*. 2024;907:168134. doi:10.1016/j.scitotenv.2023.168134.

Karanasiou A, Alastuey A, Amato F, et al. Short-term health effects from outdoor exposure to biomass burning emissions: A review. *Sci Total Environ*. 2021;781:146739. doi:10.1016/j.scitotenv.2021.146739

Kondo MC, De Roos AJ, White LS, et al. Meta-Analysis of Heterogeneity in the Effects of Wildfire Smoke Exposure on Respiratory Health in North America. *Int J Environ Res Public Health*. 2019;16(6):960. Published 2019 Mar 18. doi:10.3390/ijerph16060960

Liu JC, Pereira G, Uhl SA, Bravo MA, Bell ML. A systematic review of the physical health impacts from non-occupational exposure to wildfire smoke. *Environ Res*. 2015;136:120-132. doi:10.1016/j.envres.2014.10.015

Matz CJ, Egyed M, Xi G, et al. Health impact analysis of $PM_{2.5}$ from wildfire smoke in Canada (2013-2015, 2017-2018). *Sci Total Environ*. 2020;725:138506. doi:10.1016/j.scitotenv.2020.138506

Melton CC, De Fries CM, Smith RM, Mason LR. Wildfires and Older Adults: A Scoping Review of Impacts, Risks, and Interventions. *Int J Environ Res Public Health*. 2023;20(13):6252. Published 2023 Jun 29. doi:10.3390/ijerph20136252

Reid CE, Brauer M, Johnston FH, Jerrett M, Balmes JR, Elliott CT. Critical Review of Health Impacts of Wildfire Smoke Exposure. *Environ Health Perspect*. 2016;124(9):1334-1343. doi:10.1289/ehp.1409277

Skinner R, Luther M, Hertelendy AJ, et al. A Literature Review on the Impact of Wildfires on Emergency Departments: Enhancing Disaster Preparedness. *Prehosp Disaster Med*. 2022;37(5):657-664. doi:10.1017/S1049023X22001054

Sun Q, Miao C, Hanel M, et al. Global heat stress on health, wildfires, and agricultural crops under different levels of climate warming. *Environ Int*. 2019;128:125-136. doi:10.1016/j.envint.2019.04.025

Thomas AS, Escobedo FJ, Sloggy MR, Sánchez JJ. A burning issue: Reviewing the socio-demographic and environmental justice aspects of the wildfire literature. *PLoS One*. 2022;17(7):e0271019. Published 2022 Jul 28. doi:10.1371/journal.pone.0271019

Urbanski SP, Hao WM, Baker S. Chemical Composition of Wildland Fire Emissions. In *Developments in Environmental Science*, Bytnerowicz, A.; Arbaugh, M. J.; Riebau, A. R.; Andersen, C., Eds.; Elsevier, 2008; Chapter 4, Vol. 8, pp 79–107.

Walinski A, Sander J, Gerlinger G, Clemens V, Meyer-Lindenberg A, Heinz A. The Effects of Climate Change on Mental Health. Dtsch Arztebl Int. 2023;120(8):117-124. doi:10.3238/arztebl.m2022.0403

Wotton BM, Flannigan MD, Marshall GA. Potential climate change impacts on fire intensity and key wildfire suppression thresholds in Canada. *Environ. Res. Lett.* 2017;12:095003. doi: 10.1088/1748-9326/aa7e6e

Youssouf H, Liousse C, Roblou L, et al. Non-accidental health impacts of wildfire smoke. *Int J Environ Res Public Health*. 2014;11(11):11772-11804. Published 2014 Nov 14. doi:10.3390/ijerph111111772

Zhang Y, Tingting Y, Huang W, et al. Health Impacts of Wildfire Smoke on Children and Adolescents: A Systematic Review and Meta-analysis. *Curr Environ Health Rep*. Published online December 1, 2023. doi:10.1007/s40572-023-00420-9

APPENDIX—METHODOLOGY

APPROACH

The objective of the report is to provide a concise weight-of-evidence review of health outcomes associated with exposure to wildfire smoke. To facilitate this, an umbrella review approach was taken. Umbrella reviews systematically search, organize, and evaluate existing evidence from systematic reviews with or without meta-analyses (Aromataris et al., 2015).

SEARCH STRATEGY AND ARTICLE SELECTION

Literature searches were conducted by a Health Canada librarian in three databases – Ovid Embase, Ovid MEDLINE, and Global Health – and covered the period from January 1, 2013 to November 6, 2023. The detailed search strategy is provided in Table A1. There were no limitations based on language of publication, though only articles in English were retrieved. The references identified from the literature search were screened first by title and abstract, and then underwent full-text screening for eligibility. The review process was managed using DistillerSR (Evidence Partners, Ottawa, ON).

To be considered for inclusion in the report, the review articles needed to employ systematic review techniques and evaluate the health effects of wildfires or wildfire smoke. Narrative reviews (i.e., non-systematic reviews) were excluded. Review articles that considered non-wildfire smoke (e.g., burning of built environment or agricultural waste; indoor biomass burning) were excluded. Of the full-text review articles that were screened, articles were excluded for: not being specific to wildfires or wildfire smoke (n = 10), narrative reviews (n = 6), review was not based on epidemiological studies (n = 2), and record was correspondence (n = 1). Additionally, for the quantitative syntheses, pooled risk estimates that combined wildfire smoke with non-wildfire smoke were excluded.

The study selection process is outlined in Figure A1. Overall, 26 review articles were included within the evidence synthesis, which included three articles identified by peer-reviewers that were not captured by the initial literature search but otherwise met the inclusion criteria.

DATA EXTRACTION

For the systematic reviews with meta-analysis that met the inclusion criteria, the following data was extracted: first author's name, year of publication, number of studies included in meta-analysis, health outcome, wildfire smoke exposure, and summary risk estimate with corresponding 95% confidence interval.

TABLE A1: Search Strategy

Embase

Database(s): **Embase** 1974 to 2023 November 06
Search Strategy:

#	Searches	Results
1	wildfire/	2505
2	(brushfire* or bushfire* or forestfire* or peatfire* or wildfire* or wildlandfire*).tw,kw,kf. or (fire* adj4 (brush* or bush* or forest* or peat* or vegetation* or wild*)).tw,kf.	6980
3	(fire* adj4 (crown* or canop* or foliage)).tw,kf.	158
4	or/1-3 [Wildfire]	7398
5	exp "air and air related phenomena"/	370838
6	air*.tw,kw,kf.	728646
7	(smoke* or particulate* or particle* or PM* or volatiliz* or volatilis* or vapor* or evapor* or wind* or downwind* or AQHI or AQI).tw,kw,kf.	1379865
8	or/5-7 [Smoke, Air Quality]	2142964
9	exp Human/ or exp human development/ or human embryo/ or exp "named groups of persons"/	26433646
10	(human or humans or people or person* or patient? or inpatient* or volunteer* or participant* or man or men or woman or women or child* or pediatric* or paediatric* or newborn* or new born* or baby or babies or infant* or toddler* or youth* or teen* or adolescen* or preteen* or preadolescen* or girl* or boy* or school age* or schoolage* or senior* or elderly or homeless* or worker* or employee* or aboriginal? or general population* or smoker? or nonsmoker? or public or citizen? or Inuit* or First Nation* or Metis).tw,kw,kf. or ((urban or rural or vulnerab* or low income or indigenous or high risk) adj4 (population? or group?)).tw,kf.	19845168
11	9 or 10 [Human]	28439332
12	exp health/	900950
13	public health/	236968
14	diseases/	148704
15	exp mental disease/	2663132
16	physical disease/ or exp physical disease by anatomical structure/ or exp physical disease by body function/ or exp "physical disease by composition of body fluids, excreta and secretions"/ or exp physical disease by developmental age/	21010887

#	Searches	Results
17	"physical disease by etiology and pathogenesis"/ or acute disease/ or exp aplasia/ or exp ascites/ or exp atrophy/ or exp bleeding/ or exp calcification/ or exp channelopathy/ or chemically induced disorder/ or exp chronic disease/ or exp complication/ or critical illness/ or exp cyst/ or exp deformity/ or exp degeneration/ or exp diverticulosis/ or exp dysplasia/ or exp dystrophy/ or exp ectopic tissue/ or exp edema/ or exp effusion/ or exp emphysema/ or endemic disease/ or environmental disease/ or epidemic/ or exp fibrosis/ or exp fistula/ or exp healing impairment/ or exp hernia/ or exp hyperplasia/ or exp hypertrophy/ or exp hypoplasia/ or exp hypotrophy/ or idiopathic disease/ or exp infection/ or exp inflammation/ or exp ischemia/ or exp "lesions and defects"/ or exp malnutrition/ or exp metaplasia/ or exp necrosis/ or neglected disease/ or neointima/ or exp neoplasm/ or exp "neovascularization (pathology)"/ or non communicable disease/ or exp occupational disease/ or pandemic/ or exp pseudotumor/ or rare disease/ or recurrent disease/ or relapse/ or reversal reaction/ or exp sclerosis/ or exp "stenosis, occlusion and obstruction"/ or exp stone formation/ or exp storage disease/ or exp swelling/ or syndrome/ or systemic disease/ or terminal disease/ or exp thromboembolism/ or exp torsion/ or exp "toxicity and intoxication"/ or exp ulcer/	16503505
18	exp mortality/ or mortality risk/	1403855
19	exp epidemiology/ or exp epidemiological monitoring/ or exp epidemiological data/	5456834
20	hospitalization/ or hospital admission/ or hospitalized adolescent/ or hospitalized child/ or hospitalized infant/	780687
21	exp medical care/	1223033
22	exp ambulatory care/	54094
23	health care facility/ or air medical transport/ or exp ambulance/ or health center/ or exp hospital/ or exp isolation facility/ or pain clinic/ or exp pharmacy/ or secondary care center/ or tertiary care center/	1648532
24	environmental health/ or environmental stress/	47186
25	genotoxicity/ or genetic damage/ or mutagenic activity/ or mutagenicity/	60384
26	exp toxicity/	789474
27	exp biological functions/	27770904
28	exp postnatal development/	79567
29	"quality of life"/	632049
30	(IQR or interquartile range* or inter quartile range* or mortalit* or morbidit* or epidemiolog* or death* or dead* or fatal* or lethal*).tw,kw,kf.	3999917
31	(health* or disease* or illness* or mortalit* or morbidit* or disorder* or sick*).tw,kw,kf.	12324181
32	or/12-31 [Broad-level Health Outcomes]	35867534
33	exp lung function/ or exp lung function test/ or exp respiratory tract allergy/	647967

#	Searches	Results
34	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula*) adj3 (health or symptom* or infect* or disease* or disorder* or dysfunction* or syndrome* granuloma* or neoplas* or cancer* or tumor* or tumour* or ischemia* or mortal* or morbid* or fatal* or death? or admission* or hospital* or emergency or emergencies)).tw,kf.	1168773
35	((chronic obstructive adj2 (pulmonary or airway or lung)) or chronic airflow obstruction or "COPD" or "COAD" or "AECOPD" or ("OPD" or obstructive pulmonary)).tw,kf.	161569
36	(pleural empyema or whooping cough or pertussis or bronchiectasis or ((bronchial adj2 (fistula* or hyperreactiv* or neoplasm* or spasm*)) or bronchitis or bronchiolitis or bronchogenic cyst* or bronchopneumonia* or bronchiectas?s or bronchospasm*) or ((laryng* adj2 (edema* or neoplasm* or nerve injur*)) or laryngitis or croup or supraglottitis or tuberculos* or laryngotracheobronchit*) or acute chest syndrome* or cystic fibrosis or lung abcess* or blastomycos* or pneumonia* or pulmonary aspergillos* or alveolitis or pneumonitis or pulmonary edema* or pulmonary embolism* or respiratory distress syndrome* or bronchiogenic carcinoma* or pulmonary nodule* or pulmonary sclerosing hemangioma*).tw,kf.	865357
37	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula* or inhal*) adj4 (hyperresponsiv* or hyper-responsiv* or hypersensitiv* or hyper-sensitiv* or sensitiz* or sensitis* or inflam* or allerg* or obstruct* or spasm* or mast cell* or immunoglobulin E or immunoglobulin epsilon or IgE or eosinophil*)).tw,kf.	330365
38	airway responsiveness.tw,kw,kf.	3710
39	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula*) adj4 (function* or disfunction* or dysfunction* or mechanic?)).tw,kf.	266207
40	(asthma* or alveolitis* or wheez* or "shortness of breath" or dyspnea* or dyspnoea* or rhinitis or mucociliary clearance*).tw,kw,kf.	437557
41	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula*) adj3 (remodel* or resist* or compliance or circulation or clearance* or diffus* or perfus* or eliminat* or ventilat* or absorb* or absorp* or volum* or exchang* or ventialt*)).tw,kf.	290617
42	(forced expiratory or maximal voluntary ventilation or maxim* expirat* or peak expirat*).tw,kw,kf.	42774
43	(respir* adj3 (rate* or transport* or dead space* or sound*)).tw,kf.	50426
44	(total lung capacit* or closing volume* or functional residual capacit* or vital capacit* or valsalva maneuver* or valsalva manoeuver* or ventilation perfusion ratio? or "work of breathing").tw,kw,kf.	46165
45	(blood-gas analys* or blood-gas monitor* or oximetr* or bronch* provocation* or capnograph* or exercise test* or maxim* respiratory or spirometr* or bronchospiro* or hydrogen breath test* or nitrogen washout* or nitrogen test* or pneumograph* or pneumatotachygraph* or spirograph* or plethysmograph* or bronchodilation test*).tw,kw,kf.	144685
46	or/33-45 [Lung Function and Hypersensitivity]	2713384

#	Searches	Results
47	cardiovascular disease/ or exp cardiovascular infection/ or exp cardiovascular inflammation/ or cardiovascular symptom/ or exp cardiovascular system tumor/ or exp heart disease/ or exp vascular disease/	4409864
48	(cardio* or cardia* or heart? or vascula* or atria* or ventric* or myocard* or coronary).tw,kw,kf.	4172966
49	(cerebrovasc* or aneurysm* or stroke*).tw,kw,kf.	753724
50	(((heart or cardiac or myocardia*) adj3 (failure or decompensat*)) or cardiac edema or paroxysmal dyspnea or cardio-renal syndrome* or cardiorenal syndrome*).tw,kf.	394056
51	(NSTEMI or STEMI or CVD or infarct* or "MI" or fibrillation).tw,kw,kf.	781273
52	(paroxysmal dyspnea or arrhythmia* or dysrhythmia* or bradycard* or brugada syndrome* or commotio cordis or long QT syndrome or parasystole or pre-excitation syndrome* or tachycardia* or conduction disturbance*).tw,kw,kf. or ((atrial or ventricular) adj2 (fibrillation* or flutter)).tw,kf.	427020
53	(atherosclero* or hypertensi* or vasomotor* or blood vessel*).tw,kw,kf.	1146867
54	or/47-53 [Cardio and Vascular Outcomes]	6600371
55	((complicat* or risk*) adj3 (pregnan* or natal* or prenatal* or postnatal* or gestat* or gravid* or trimester* or childbear* or deliver* or birth* or intrauterine or maternal*)).tw,kf.	148027
56	((preterm* or premature* or pre term or pre mature or low birth weight low birthweight or VLBW or LBW or "small for date" or underweight) adj3 (baby or babies or neonate* or child* or infant* or newborn*)).tw,kf.	103909
57	(intrauterine growth adj3 retard*).tw,kf.	8343
58	(stillbirth* or stillborn*).tw,kw,kf. or ((antepartum or prenatal* or intrauterine or endouterine or fetus* or foetus* or fetal* or foetal*) adj3 (death* or die or dying or mortal*)).tw,kf.	47575
59	or/55-58 [Pregnancy Complications]	285556
60	(diabet* or (glucose adj2 (toler* or intoler*)) or Wolfram syndrome* or donahue syndrome* or prediabet*).tw,kf.	1234911
61	((metabolic adj3 syndrome*) or (dysmetabolic adj3 syndrome*) or insulin resistance syndrome*).tw,kf.	108273
62	((metabolic* or metabolism) adj3 (disease* or disorder*)).tw,kf.	130442
63	(autism* or autistic* or neuro* or dementia* or alzheimer* or cognitive).tw,kw,kf.	3531395
64	(((bio or biological*) adj3 mark*) or biomark*).tw,kf.	656260
65	gene?.tw,kw,kf.	3213294

#	Searches	Results
66	(immune* or immunity).tw,kw,kf.	1327718
67	(inflammat* or oxidative stress* or oxidative potential*).tw,kw,kf.	2035979
68	(medication* or medicine* or prescription* or pharmaceutical*).tw,kw,kf.	2033689
69	or/60-68 [Additional Health KW]	11433865
70	sensitization/ or contact sensitization/ or skin sensitization/ or skin test/ or patch test/ or exp skin disease/ or skin absorption/ or exp hypersensitivity/ or case report/ or exp allergenicity/	4794566
71	exp toxicology/ or exp "toxicity and intoxication"/ or exp toxicological parameters/ or exp mutagenesis/ or exp toxic substance/ or exp toxicity testing/ or exp toxicity assay/ or exp health/ or exp genetic disorder/ or mutagenic activity/ or exp mutagen testing/ or reactive oxygen metabolite/ or exp genetic damage/ or exp cell damage/ or exp developmental toxicity/ or oxidative stress/ or endocrine system/ or androgenic receptor/ or endocrine disrupter/	5688735
72	exp neoplasm/ or exp carcinogenicity/ or exp health hazard/	6017476
73	risk assessment/ or adverse outcome/ or risk/	1298715
74	(toxic* or poison* or neurotox* or embryotox* or cytotox* or hepatotox* or fetotox* or genotox* or maternotox* or immunotox* or dermatotox* or cardiotoxic* or nephrotoxic* or fatal* or lethal* or safety or mortal* or hazard* or adverse* or ototoxic* or mutagen* or carcinog* or malign* or teratogen* or (risk adj2 asses*) or (health adj2 (effect? or impact* or implicat* or human?)) or ames test* or microtox* test* or micronucleus test* or reactive oxygen species or reactive oxygen metabolite? or oxidative stress or endocrine disrupt* or ((gene* or genomic* or dna or chromosom*) adj3 (damag* or repair* or adduct? or aberrat* or break* or fragment*))).tw,kf.	7080777
75	(risk or risks or ((side* or negative*) adj2 (react* or event* or effect*))).tw,kf.	4759731
76	(anaphylax* or urticaria or dermatitis or hypersensitive* or skin absorption or sensitization or skin test* or patch test* or skin disease or allerg* or case report? or symptom?).tw,kw,kf.	2836493
77	or/70-76 [Tox, Risk]	18934596
78	32 or 46 or 54 or 59 or 69 or 77 [Health Outcomes]	36688569
79	(systematic review or meta-analysis).pt.	0
80	meta-analysis/ or systematic review/ or systematic reviews as topic/ or meta-analysis as topic/ or "meta analysis (topic)"/ or "systematic review (topic)"/ or exp technology assessment, biomedical/ or network meta-analysis/	641768

#	Searches	Results
81	((systematic* adj3 (review* or overview*)) or (methodologic* adj3 (review* or overview*)) or ((quantitative adj3 (review* or overview* or synthes*)) or (research adj3 (integrati* or overview*))) or ((integrative adj3 (review* or overview*)) or (collaborative adj3 (review* or overview*)) or (pool* adj3 analy*)) or (data synthes* or data extraction* or data abstraction*) or (handsearch* or hand search*) or (mantel haenszel or peto or der simonian or dersimonian or fixed effect* or latin square*) or (met analy* or metanaly* or technology assessment* or HTA or HTAs or technology overview* or technology appraisal*) or (meta regression* or metaregression*)).ti,ab,kf. or (meta-analy* or metaanaly* or systematic review* or biomedical technology assessment* or bio-medical technology assessment*).mp,hw. or (medline or cochrane or pubmed or medlars or embase or cinahl).ti,ab,hw. or (cochrane or (health adj2 technology assessment) or evidence report).jw. or (comparative adj3 (efficacy or effectiveness)).ti,ab,kf. or (outcomes research or relative effectiveness).ti,ab,kf. or ((indirect or indirect treatment or mixed-treatment or bayesian) adj3 comparison*).ti,ab,kf. or (meta-analysis or systematic review).tw,kw,kf. or (multi* adj3 treatment adj3 comparison*).ti,ab,kf. or (mixed adj3 treatment adj3 (meta-analy* or metaanaly*)).ti,ab,kf. or umbrella review*.ti,ab,kf. or (multi* adj2 paramet* adj2 evidence adj2 synthesis).ti,ab,kf. or (multiparamet* adj2 evidence adj2 synthesis).ti,ab,kf. or (multi-paramet* adj2 evidence adj2 synthesis).ti,ab,kf.	1020204
82	review*.ti.	832474
83	or/79-82 [Reviews]	1470351
84	4 and 8 and 11 and 78 and 83	123
85	limit 84 to yr="2013 -Current"	109

Medline

Database(s): **Ovid MEDLINE(R) ALL** 1946 to November 06, 2023

Search Strategy:

#	Searches	Results
1	Wildfires/	1236
2	(brushfire* or bushfire* or forestfire* or peatfire* or wildfire* or wildlandfire*).tw,kw,kf. or (fire* adj4 (brush* or bush* or forest* or peat* or vegetation* or wild*)).tw,kf.	6505
3	(fire* adj4 (crown* or canop* or foliage)).tw,kf.	161
4	or/1-3 [Wildfire]	6665
5	exp air/ or Air Pollution/	67032
6	air*.tw,kw,kf.	554039

#	Searches	Results
7	(smoke* or particulate* or particle* or PM* or volatiliz* or volatilis* or vapor* or evapor* or wind* or downwind* or AQHI or AQI).tw,kw,kf.	1111052
8	or/5-7 [Smoke, Air Quality]	1589684
9	humans/ or exp human experimentation/ or exp persons/	21713124
10	(human or humans or people or person* or patient? or inpatient* or volunteer* or participant* or man or men or woman or women or child* or pediatric* or paediatric* or newborn* or new born* or baby or babies or infant* or toddler* or youth* or teen* or adolescen* or preteen* or preadolescen* or girl* or boy* or school age* or schoolage* or senior* or elderly or homeless* or worker* or employee* or aboriginal? or general population* or smoker? or nonsmoker? or public or citizen? or Inuit* or First Nation* or Metis).tw,kw,kf. or ((urban or rural or vulnerab* or low income or indigenous or high risk) adj4 (population? or group?)).tw,kf.	15078252
11	9 or 10 [Human]	24356182
12	exp Health/	442148
13	exp Public Health/	9337830
14	exp "diseases (non mesh)"/	17162636
15	exp Mental Disorders/	1449265
16	exp morbidity/ or exp mortality/	1036110
17	exp Epidemiology/ or Epidemiological Monitoring/	36582
18	exp Hospitalization/ or Adolescent, Hospitalized/ or Child, Hospitalized/ or Inpatients/	324135
19	Patient care/ or exp ambulatory care/ or exp critical care/	135921
20	exp hospitals/ or exp Ambulatory Care Facilities/ or health facilities/	388741
21	environmental medicine/ or exp environmental health/	27676
22	exp "growth and development"/	1610767
23	exp Pathologic Processes/	4772785
24	exp Biological Phenomena/	2322608
25	"Quality of Life"/	275698
26	(IQR or interquartile range* or inter quartile range* or mortalit* or morbidit* or epidemiolog* or death* or dead* or fatal* or lethal*).tw,kw,kf.	2839573
27	(health* or disease* or illness* or mortalit* or morbidit* or disorder* or sick*).tw,kw,kf.	9352450
28	or/12-27 [Broad-level Health Outcomes]	24690838

#	Searches	Results
29	Respiratory Physiological Phenomena/ or Respiratory Function Tests/	56046
30	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula*) adj3 (health or symptom* or infect* or disease* or disorder* or dysfunction* or syndrome* granuloma* or neoplas* or cancer* or tumor* or tumour* or ischemia* or mortal* or morbid* or fatal* or death? or admission* or hospital* or emergency or emergencies)).tw,kw,kf.	828860
31	((chronic obstructive adj2 (pulmonary or airway or lung)) or chronic airflow obstruction or "COPD" or "COAD" or "AECOPD" or ("OPD" or obstructive pulmonary)).tw,kw,kf.	91684
32	(pleural empyema or whooping cough or pertussis or bronchiectasis or ((bronchial adj2 (fistula* or hyperreactiv* or neoplasm* or spasm*)) or bronchitis or bronchiolitis or bronchogenic cyst* or bronchopneumonia* or bronchiectas?s or bronchospasm*) or ((laryng* adj2 (edema* or neoplasm* or nerve injur*)) or laryngitis or croup or supraglottitis or tuberculos* or laryngotracheobronchit*) or acute chest syndrome* or cystic fibrosis or lung abcess* or blastomycos* or pneumonia* or pulmonary aspergillos* or alveolitis or pneumonitis or pulmonary edema* or pulmonary embolism* or respiratory distress syndrome* or bronchiogenic carcinoma* or pulmonary nodule* or pulmonary sclerosing hemangioma*).tw,kw,kf.	707560
33	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula* or inhal*) adj4 (hyperresponsiv* or hyper-responsiv* or hypersensitiv* or hyper-sensitiv* or sensitiz* or sensitis* or inflam* or allerg* or obstruct* or spasm* or mast cell* or immunoglobulin E or immunoglobulin epsilon or IgE or eosinophil*)).tw,kw,kf.	231752
34	airway responsiveness.tw,kw,kf.	2899
35	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula*) adj4 (function* or disfunction* or dysfunction* or mechanic?)).tw,kw,kf.	176864
36	(asthma* or alveolitis* or wheez* or "shortness of breath" or dyspnea* or dyspnoea* or rhinitis or mucociliary clearance*).tw,kw,kf.	281520
37	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula*) adj3 (remodel* or resist* or compliance or circulation or clearance* or diffus* or perfus* or eliminat* or ventilat* or absorb* or absorp* or volum* or exchang* or ventialt*)).tw,kw,kf.	210615
38	(forced expiratory or maximal voluntary ventilation or maxim* expirat* or peak expirat*).tw,kw,kf.	32159
39	(respir* adj3 (rate* or transport* or dead space* or sound*)).tw,kw,kf.	36103
40	(total lung capacit* or closing volume* or functional residual capacit* or vital capacit* or valsalva maneuver* or valsalva manoeuver* or ventilation perfusion ratio? or "work of breathing").tw,kw,kf.	31715
41	(blood-gas analys* or blood-gas monitor* or oximetr* or bronch* provocation* or capnograph* or exercise test* or maxim* respiratory or spirometr* or bronchospiro* or hydrogen breath test* or nitrogen washout* or nitrogen test* or pneumograph* or pneumatotachygraph* or spirograph* or plethysmograph* or bronchodilation test*).tw,kw,kf.	96752

#	Searches	Results
42	or/29-41 [Lung Function and Hypersensitivity]	1923681
43	Cardiovascular Diseases/	179395
44	(cardio* or cardia* or heart? or vascula* or atria* or ventric* or myocard* or coronary).tw,kw,kf.	3066713
45	(cerebrovasc* or aneurysm* or stroke*).tw,kw,kf.	511987
46	(((heart or cardiac or myocardia*) adj3 (failure or decompensat*)) or cardiac edema or paroxysmal dyspnea or cardio-renal syndrome* or cardiorenal syndrome*).tw,kw,kf.	240474
47	(NSTEMI or STEMI or CVD or infarct* or "MI" or fibrillation).tw,kw,kf.	513629
48	(paroxysmal dyspnea or arrhythmia* or dysrhythmia* or bradycard* or brugada syndrome* or commotio cordis or long QT syndrome or parasystole or pre-excitation syndrome* or tachycardia* or conduction disturbance* or ((atrial or ventricular) adj2 (fibrillation* or flutter))).tw,kw,kf.	272132
49	(atherosclero* or hypertensi* or vasomotor* or blood vessel*).tw,kw,kf.	777976
50	or/43-49 [Cardio and Vascular Outcomes]	3834691
51	Pregnancy Complications/	97582
52	((complicat* or risk*) adj3 (pregnan* or natal* or prenatal* or postnatal* or gestat* or gravid* or trimester* or childbear* or deliver* or birth* or intrauterine or maternal*)).tw,kw,kf.	117135
53	((preterm* or premature* or pre term or pre mature or low birth weight low birthweight or VLBW or LBW or "small for date" or underweight) adj3 (baby or babies or neonate* or child* or infant* or newborn*)).tw,kw,kf.	84541
54	(intrauterine growth adj3 retard*).tw,kw,kf.	6249
55	(stillbirth* or stillborn* or ((antepartum or prenatal* or intrauterine or endouterine or fetus* or foetus* or fetal* or foetal*) adj3 (death* or die or dying or mortal*))).tw,kw,kf.	36294
56	or/51-55 [Pregnancy Complications]	295072
57	(diabet* or (glucose adj2 (toler* or intoler*)) or Wolfram syndrome* or donahue syndrome* or prediabet*).tw,kw,kf.	820502
58	((metabolic adj3 syndrome*) or (dysmetabolic adj3 syndrome*) or insulin resistance syndrome*).tw,kw,kf.	69544
59	((metabolic* or metabolism) adj3 (disease* or disorder*)).tw,kw,kf.	95708
60	(autism* or autistic* or neuro* or dementia* or alzheimer* or cognitive).tw,kw,kf.	2664675
61	(((bio or biological*) adj3 mark*) or biomark*).tw,kw,kf.	442223
62	gene?.tw,kw,kf.	2599229

#	Searches	Results
63	(immune* or immunity).tw,kw,kf.	995393
64	(inflammat* or oxidative stress* or oxidative potential*).tw,kw,kf.	1435837
65	(medication* or medicine* or prescription* or pharmaceutical*).tw,kw,kf.	1323611
66	or/57-65 [Specifically Requested KW]	8561865
67	28 or 42 or 51 or 56 or 66 [Health Outcomes]	26799009
68	exp skin diseases/ or exp skin tests/ or exp Hypersensitivity/ or exp allergies/ or allergic reactions/ or skin absorption/ or Central Nervous System Sensitization/ or case reports/ or exp allergens/	3604009
69	exp toxicology/ or toxicogenetics/ or exp Toxicological Phenomena/ or toxicokinetics/ or exp mutagenicity tests/ or exp poisoning/ or Maximum allowable concentration/ or exp toxicity tests/ or exp mutagenesis/ or exp health/ or exp DNA damage/ or exp chromosome aberrations/ or exp reactive oxygen species/ or exp oxidative stress/ or endocrine system/ or endocrine disruptors/ or Receptors, Androgen/ or exp receptors, estrogen/	1973988
70	exp neoplasms/ or exp mutation/ or exp carcinogens/	4634535
71	exp risk assessment/ or safety/ or symptom assessment/ or risk factors/ or risk/	1342782
72	(toxic* or poison* or neurotox* or embryotox* or cytotox* or hepatotox* or fetotox* or genotox* or maternotox* or immunotox* or dermatotox* or cardiotoxic* or nephrotoxic* or fatal* or lethal* or safety or mortal* or hazard* or adverse* or ototoxic* or mutagen* or carcinog* or malign* or teratogen* or (risk adj2 asses*) or (health adj2 (effect? or impact* or implicat* or human?)) or ames test* or microtox* test* or micronucleus test* or reactive oxygen species or reactive oxygen metabolite? or oxidative stress or endocrine disrupt* or ((gene* or genomic* or dna or chromosom*) adj3 (damag* or repair* or adduct? or aberrat* or break* or fragment*))).tw,kf.	5234498
73	(risk or risks or ((side* or negative*) adj2 (react* or event* or effect*))).tw,kf.	3318188
74	(anaphylax* or urticaria or dermatitis or hypersensitive* or skin absorption or sensitization or skin test* or patch test* or skin disease or allerg* or case report? or symptom?).tw,kw,kf.	2030553
75	or/68-74 [Tox, Risk]	14034614
76	28 or 42 or 51 or 56 or 66 or 75 [Health Outcomes]	27855338
77	(systematic review or meta-analysis).pt.	327321
78	meta-analysis/ or "systematic review"/	327321

#	Searches	Results
79	((systematic* adj3 (review* or overview*)) or (methodologic* adj3 (review* or overview*)) or ((quantitative adj3 (review* or overview* or synthes*)) or (research adj3 (integrati* or overview*))) or ((integrative adj3 (review* or overview*)) or (collaborative adj3 (review* or overview*)) or (pool* adj3 analy*)) or (data synthes* or data extraction* or data abstraction*) or (handsearch* or hand search*) or (mantel haenszel or peto or der simonian or dersimonian or fixed effect* or latin square*) or (met analy* or metanaly* or technology assessment* or HTA or HTAs or technology overview* or technology appraisal*) or (meta regression* or metaregression*)).ti,ab,kf. or (meta-analy* or metaanaly* or systematic review* or biomedical technology assessment* or bio-medical technology assessment*).mp,hw. or (medline or cochrane or pubmed or medlars or embase or cinahl).ti,ab,hw. or (cochrane or (health adj2 technology assessment) or evidence report).jw. or (comparative adj3 (efficacy or effectiveness)).ti,ab,kf. or (outcomes research or relative effectiveness).ti,ab,kf. or ((indirect or indirect treatment or mixed-treatment or bayesian) adj3 comparison*).ti,ab,kf. or (meta-analysis or systematic review).tw,kw,kf. or (multi* adj3 treatment adj3 comparison*).ti,ab,kf. or (mixed adj3 treatment adj3 (meta-analy* or metaanaly*)).ti,ab,kf. or umbrella review*.ti,ab,kf. or (multi* adj2 paramet* adj2 evidence adj2 synthesis).ti,ab,kf. or (multiparamet* adj2 evidence adj2 synthesis).ti,ab,kf. or (multi-paramet* adj2 evidence adj2 synthesis).ti,ab,kf.	703659
80	review*.ti.	732019
81	or/77-80 [Reviews]	1119871
82	4 and 8 and 11 and 76 and 81	83
83	limit 82 to yr="2013 -Current"	76

Global Health & CAB Abstracts

Database(s): **CAB Abstracts** 1973 to 2023 Week 44, **Global Health** 1973 to 2023 Week 44
Search Strategy:

#	Searches	Results
1	exp forest fires/ or wildfires/	29508
2	(brushfire* or bushfire* or forestfire* or peatfire* or wildfire* or wildlandfire* or (fire* adj4 (brush* or bush* or forest* or peat* or vegetation* or wild*))).tw.	38801
3	(fire* adj4 (crown* or canop* or foliage)).tw.	1472
4	or/1-3 [Wildfire]	39119
5	exp air/ or exp air pollution/ or exp air pollutants/ or air quality/ or exp dust/	167155
6	air*.ti,ab.	372653

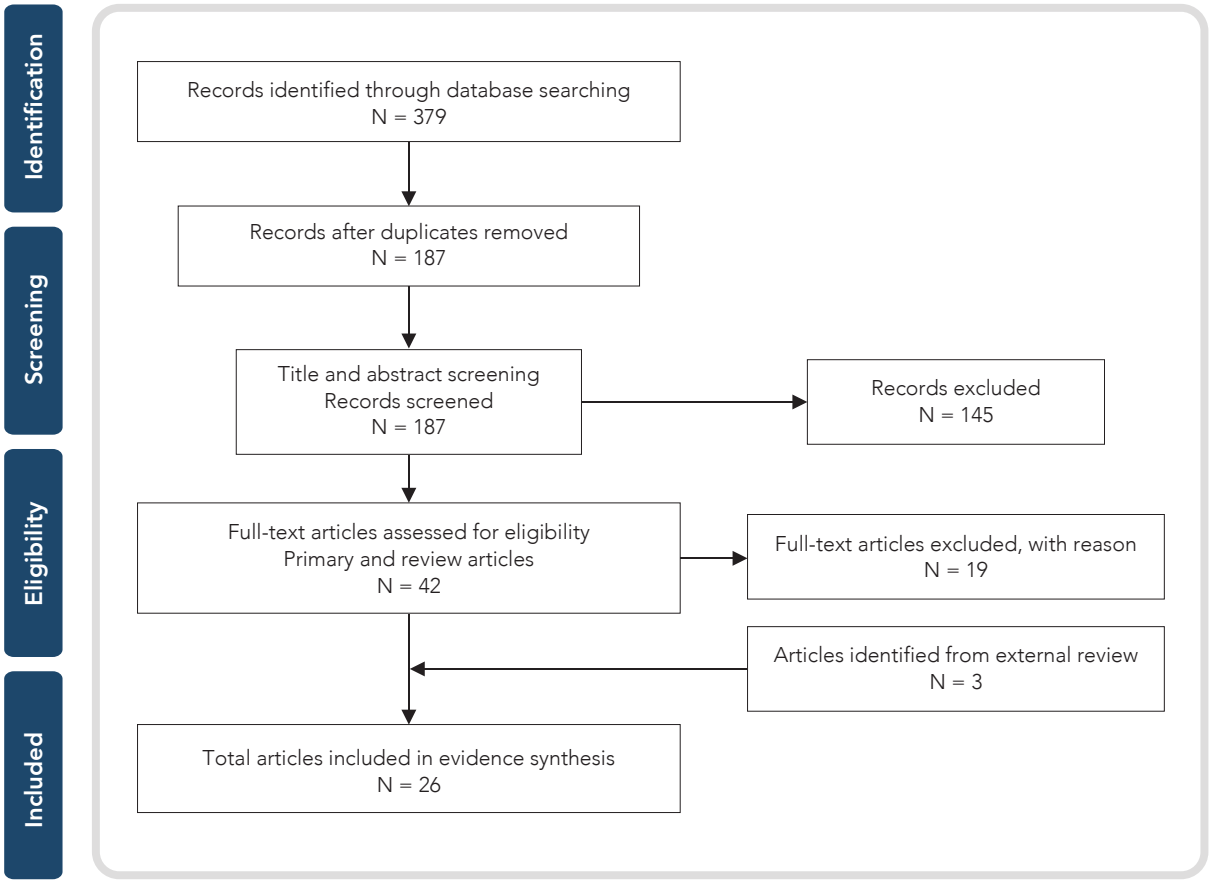
7	(smoke* or particulate* or particle* or PM* or volatiliz* or volatilis* or vapor* or evapor* or wind* or downwind* or AQHI or AQI).ti,ab.	642787
8	or/5-7 [Smoke, Air Quality]	995638
9	man/ or human population/ or exp people/	4228539
10	(human or humans or people or person* or patient? or inpatient* or volunteer* or participant* or man or men or woman or women or child* or pediatric* or paediatric* or newborn* or new born* or baby or babies or infant* or toddler* or youth* or teen* or adolescen* or preteen* or preadolescen* or girl* or boy* or school age* or schoolage* or senior* or elderly or homeless* or worker* or employee* or aboriginal? or general population* or smoker? or nonsmoker? or public or citizen? or Inuit* or First Nation* or Metis or ((urban or rural or vulnerab* or low income or indigenous or high risk) adj4 (population? or group?))).tw.	9838577
11	9 or 10 [Human]	9838577
12	exp health/	820344
13	exp diseases/	5332548
14	morbidity/ or exp mortality/	391542
15	exp epidemiology/ or epidemiological surveys/	699625
16	hospital stay/ or hospital admission/ or hospital care/	56377
17	exp patient care/	69719
18	exp health facilities/	152471
19	environmental health/	30356
20	(growth and development).mp. [mp=ab, ti, ot, bt, hw, id, cc, cw]	963220
21	exp biological development/	713688
22	exp pathogenesis/	807458
23	"quality of life"/	53695
24	(IQR or interquartile range* or inter quartile range* or mortalit* or morbidit* or epidemiolog* or death* or dead* or fatal* or lethal*).tw.	1704894
25	(health* or disease* or illness* or mortalit* or morbidit* or disorder* or sick*).tw.	6372748
26	or/12-25 [Broad-level Health Outcomes]	8157373
27	exp respiratory system/ or exp respiratory diseases/ or lung function/	586383

28	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula*) adj3 (health or symptom* or infect* or disease* or disorder* or dysfunction* or syndrome* granuloma* or neoplas* or cancer* or tumor* or tumour* or ischemia* or mortal* or morbid* or fatal* or death? or admission* or hospital* or emergency or emergencies)).tw.	408787
29	((chronic obstructive adj2 (pulmonary or airway or lung)) or chronic airflow obstruction or "COPD" or "COAD" or "AECOPD" or ("OPD" or obstructive pulmonary)).tw.	20646
30	(pleural empyema or whooping cough or pertussis or bronchiectasis or ((bronchial adj2 (fistula* or hyperreactiv* or neoplasm* or spasm*)) or bronchitis or bronchiolitis or bronchogenic cyst* or bronchopneumonia* or bronchiectas?s or bronchospasm*) or ((laryng* adj2 (edema* or neoplasm* or nerve injur*)) or laryngitis or croup or supraglottitis or tuberculos* or laryngotracheobronchit*) or acute chest syndrome* or cystic fibrosis or lung abcess* or blastomycos* or pneumonia* or pulmonary aspergillos* or alveolitis or pneumonitis or pulmonary edema* or pulmonary embolism* or respiratory distress syndrome* or bronchiogenic carcinoma* or pulmonary nodule* or pulmonary sclerosing hemangioma*).tw.	332763
31	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula* or inhal*) adj4 (hyperresponsiv* or hyper-responsiv* or hypersensitiv* or hyper-sensitiv* or sensitiz* or sensitis* or inflam* or allerg* or obstruct* or spasm* or mast cell* or immunoglobulin E or immunoglobulin epsilon or IgE or eosinophil*)).tw.	64716
32	airway responsiveness.tw.	451
33	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula*) adj4 (function* or disfunction* or dysfunction* or mechanic?)).tw.	35682
34	(asthma* or alveolitis* or wheez* or "shortness of breath" or dyspnea* or dyspnoea* or rhinitis or mucociliary clearance*).tw.	88429
35	((airway* or respir* or pulmon* or lung* or bronch* or alveol* or pneumo* or vascula*) adj3 (remodel* or resist* or compliance or circulation or clearance* or diffus* or perfus* or eliminat* or ventilat* or absorb* or absorp* or volum* or exchang* or ventialt*)).tw.	37507
36	(forced expiratory or maximal voluntary ventilation or maxim* expirat* or peak expirat*).tw.	6367
37	(respir* adj3 (rate* or transport* or dead space* or sound*)).tw.	34096
38	(total lung capacit* or closing volume* or functional residual capacit* or vital capacit* or valsalva maneuver* or valsalva manoeuver* or ventilation perfusion ratio? or "work of breathing").tw.	4755
39	(blood-gas analys* or blood-gas monitor* or oximetr* or bronch* provocation* or capnograph* or exercise test* or maxim* respiratory or spirometr* or bronchospiro* or hydrogen breath test* or nitrogen washout* or nitrogen test* or pneumograph* or pneumatotachygraph* or spirograph* or plethysmograph* or bronchodilation test*).tw.	17811
40	or/27-39 [Lung Function and Hypersensitivity]	904249
41	exp cardiovascular diseases/ or exp cardiovascular disorders/	269784
42	(cardio* or cardia* or heart? or vascula* or atria* or ventric* or myocard* or coronary).tw.	597333

43	(cerebrovasc* or aneurysm* or stroke*).tw.	56221
44	(((heart or cardiac or myocardia*) adj3 (failure or decompensat*)) or cardiac edema or paroxysmal dyspnea or cardio-renal syndrome* or cardiorenal syndrome*).tw.	24003
45	(NSTEMI or STEMI or CVD or infarct* or "MI" or fibrillation).tw.	73630
46	(paroxysmal dyspnea or arrhythmia* or dysrhythmia* or bradycard* or brugada syndrome* or commotio cordis or long QT syndrome or parasystole or pre-excitation syndrome* or tachycardia* or conduction disturbance* or ((atrial or ventricular) adj2 (fibrillation* or flutter))).tw.	23909
47	(atherosclero* or hypertensi* or vasomotor* or blood vessel*).tw.	202471
48	or/41-47 [Cardio and Vascular Outcomes]	744188
49	exp pregnancy complications/	29640
50	((complicat* or risk*) adj3 (pregnan* or natal* or prenatal* or postnatal* or gestat* or gravid* or trimester* or childbear* or deliver* or birth* or intrauterine or maternal*)).tw.	55039
51	((preterm* or premature* or pre term or pre mature or low birth weight low birthweight or VLBW or LBW or "small for date" or underweight) adj3 (baby or babies or neonate* or child* or infant* or newborn*)).tw.	37118
52	(intrauterine growth adj3 retard*).tw.	1878
53	(stillbirth* or stillborn* or ((antepartum or prenatal* or intrauterine or endouterine or fetus* or foetus* or fetal* or foetal*) adj3 (death* or die or dying or mortal*))).tw.	21524
54	or/49-53 [Pregnancy Complications]	107046
55	(diabet* or (glucose adj2 (toler* or intoler*)) or Wolfram syndrome* or donahue syndrome* or prediabet*).tw.	323352
56	((metabolic adj3 syndrome*) or (dysmetabolic adj3 syndrome*) or insulin resistance syndrome*).tw.	45017
57	((metabolic* or metabolism) adj3 (disease* or disorder*)).tw.	134061
58	(autism* or autistic* or neuro* or dementia* or alzheimer* or cognitive).tw.	415506
59	(((bio or biological*) adj3 mark*) or biomark*).tw.	136025
60	gene?.tw.	1422388
61	(immune* or immunity).tw.	778156
62	(inflammat* or oxidative stress* or oxidative potential*).tw.	601548
63	(medication* or medicine* or prescription* or pharmaceutical*).tw.	787410
64	or/55-63 [Additional Health KW]	3684091
65	exp skin diseases/ or exp skin tests/ or exp Hypersensitivity/ or exp allergies/ or allergic reactions/ or (skin/ and absorption/) or case reports/	470373

66	exp toxicology/ or exp toxicity/ or lethal dose/ or exp poisoning/ or exp toxic substances/ or exp mutagenesis/ or sublethal effects/ or exp health/ or genetic disorders/ or chromosome aberrations/ or chromosome breakage/ or Reactive oxygen species/ or oxidative stress/ or endocrine system/ or oestrogen receptors/	1694091
67	exp neoplasms/	500740
68	exp risk analysis/ or "quality of life"/ or safety/ or exp symptoms/ or risk/	1257736
69	(toxic* or poison* or neurotox* or embryotox* or cytotox* or hepatotox* or fetotox* or genotox* or maternotox* or immunotox* or dermatotox* or cardiotoxic* or nephrotoxic* or fatal* or lethal* or safety or mortal* or hazard* or adverse* or ototoxic* or mutagen* or carcinog* or malign* or teratogen* or (risk adj2 asses*) or (health adj2 (effect? or impact* or implicat* or human?)) or ames test* or microtox* test* or micronucleus test* or reactive oxygen species or reactive oxygen metabolite? or oxidative stress or endocrine disrupt* or ((gene* or genomic* or dna or chromosom*) adj3 (damag* or repair* or adduct? or aberrat* or break* or fragment*))).tw.	2861414
70	(risk or risks or ((side* or negative*) adj2 (react* or event* or effect*))).tw.	1679701
71	(anaphylax* or urticaria or dermatitis or hypersensitive* or skin absorption or sensitization o r skin test* or patch test* or skin disease or allerg* or case report? or symptom?).tw.	993971
72	or/65-71 [Tox, Risk]	5345498
73	26 or 40 or 48 or 54 or 64 or 72 [Health Outcomes]	10125913
74	reviews/ or literature reviews/ or scoping reviews/ or systematic reviews/	751851
75	((systematic* adj3 (review* or overview*)) or (methodologic* adj3 (review* or overview*)) or ((quantitative adj3 (review* or overview* or synthes*)) or (research adj3 (integrati* or overview*))) or ((integrative adj3 (review* or overview*)) or (collaborative adj3 (review* or overview*)) or (pool* adj3 analy*)) or (data synthes* or data extraction* or data abstraction*) or (handsearch* or hand search*) or (mantel haenszel or peto or der simonian or dersimonian or fixed effect* or latin square*) or (met analy* or metanaly* or technology assessment* or HTA or HTAs or technology overview* or technology appraisal*) or (meta regression* or metaregression*)).ti,ab. or (meta-analy* or metaanaly* or systematic review* or biomedical technology assessment* or bio-medical technology assessment*).mp. or (medline or cochrane or pubmed or medlars or embase or cinahl).ti,ab. or (cochrane or (health adj2 technology assessment) or evidence report).ti,ab. or (comparative adj3 (efficacy or effectiveness)).ti,ab. or (outcomes research or relative effectiveness).ti,ab. or ((indirect or indirect treatment or mixed-treatment or bayesian) adj3 comparison*).ti,ab. or (meta-analysis or systematic review).tw. or (multi* adj3 treatment adj3 comparison*).ti,ab. or (mixed adj3 treatment adj3 (meta-analy* or metaanaly*)).ti,ab. or umbrella review*.ti,ab. or (multi* adj2 paramet* adj2 evidence adj2 synthesis).ti,ab. or (multiparamet* adj2 evidence adj2 synthesis).ti,ab. or (multi-paramet* adj2 evidence adj2 synthesis).ti,ab.	242711
76	review*.ti.	285668
77	or/74-76 [Review]	928549
78	4 and 8 and 11 and 73 and 77	243
79	limit 78 to yr="2013 -Current"	194

FIGURE A1: Study selection process for the evidence review



REFERENCE

Aromataris E, Fernandez R, Godfrey CM, Holly C, Khalil H, Tungpunkom P. Summarizing systematic reviews: Methodological development, conduct and reporting of an umbrella review approach. Int J Evid Based Healthc 2015;13(3):132–40.