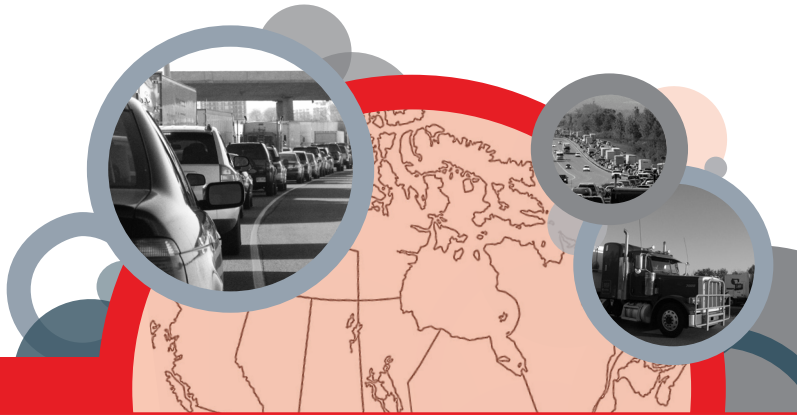
CAREX CANADA

Surveillance of environmental and occupational exposures for cancer prevention

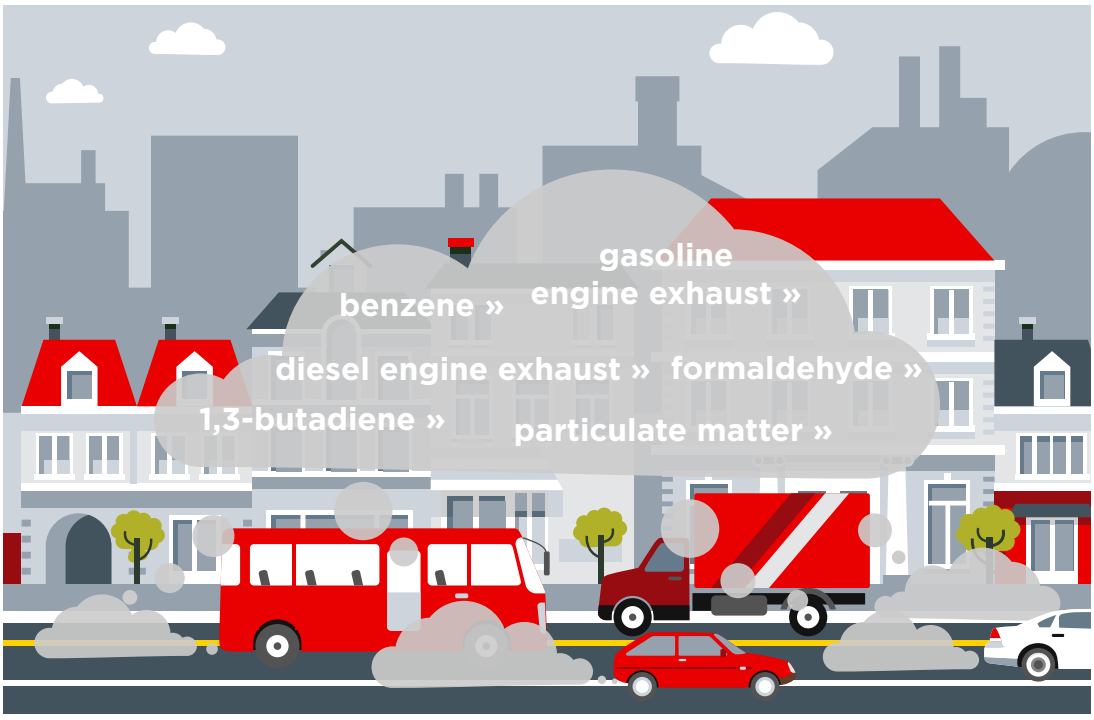


Carcinogens in traffic-related air pollution

Environmental Exposure Summary Package

This package serves as a summary of CAREX Canada's results on priority exposures to known or suspected carcinogens in traffic-related air pollution (TRAP) in Canada. Assembling various CAREX Canada data, tools, and resources, it provides an overview of exposures to traffic-related air pollutants that are linked to cancer, including diesel engine exhaust, gasoline engine exhaust, particulate matter, 1,3-butadiene, benzene, and formaldehyde. Our aim is to provide a useful guide for those looking to better understand – and help reduce or eliminate – common carcinogenic exposures associated with traffic-related air pollution.

Figure 1: Priority known or suspected carcinogens in traffic-related air pollution



Traffic-related air pollution in Canada

Approximately one third of the Canadian population is exposed to traffic-related air pollution (TRAP) where they live (defined as areas located 500m from a highway or 100m from a major urban road), according to Brauer et al. (2012). Concentrations of air pollution can vary widely within a geographical area, but people living near major roads and traffic corridors can be exposed to higher levels of TRAP. The main route of exposure to TRAP carcinogens is inhalation via outdoor and indoor air (traffic emissions can infiltrate buildings and homes).

The International Agency for Research on Cancer (IARC) classifies outdoor air pollution as carcinogenic to humans, and exhaust from motor vehicles, or TRAP, is a major contributor to outdoor air pollution. Exhaust from gasoline and diesel engines is a complex mixture of substances that are formed as by-products of fuel combustion. This includes a number of known or suspected carcinogens, as well as substances such as nitrogen oxides, sulphur dioxide, carbon monoxide, and ozone, which are linked to other health effects. The focus of this package is carcinogens in TRAP, but non-cancer health effects, such as respiratory and cardiovascular diseases, are also important outcomes associated with TRAP exposure.

Tools and resources for exploring TRAP carcinogens

CAREX Canada offers various tools and resources to explore exposures across jurisdictions and gain a better understanding of how to interpret the information that CAREX provides. These include:

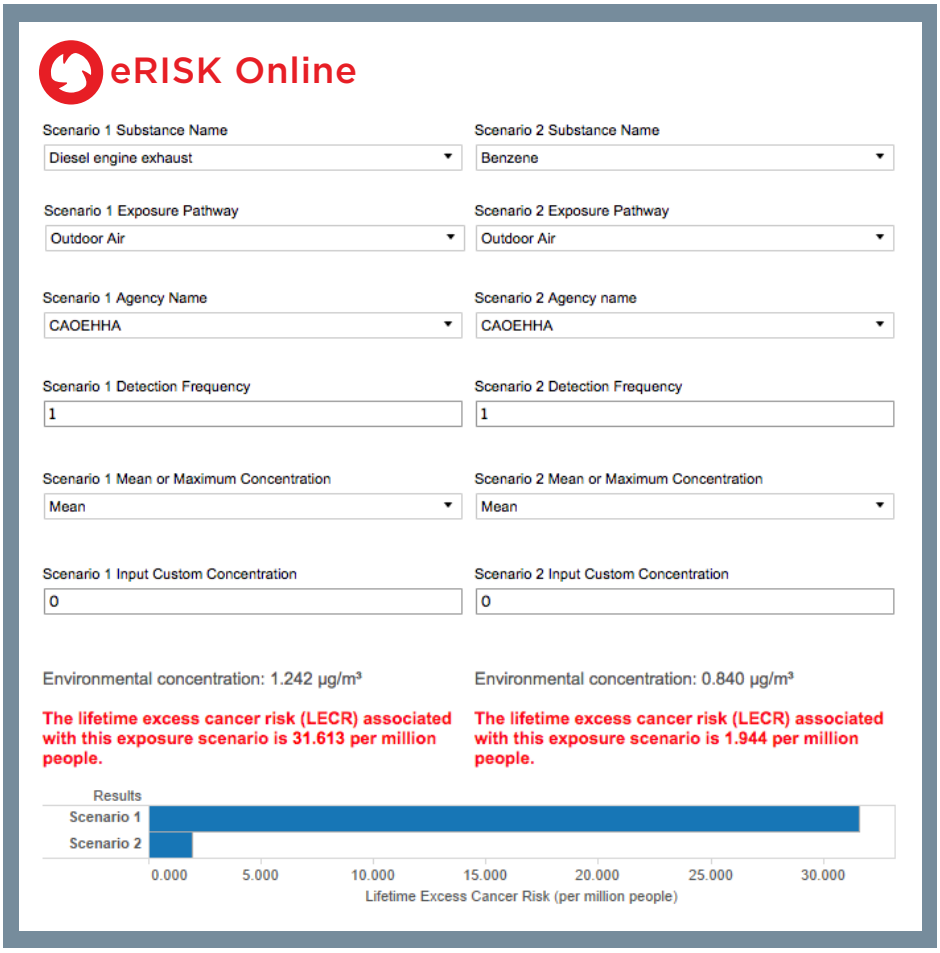
eRISK Tool

eRISK

Allows users to explore estimates of excess cancer risk associated with exposures to known and suspected carcinogens in the environment. Cancer risk is measured at a population level using Lifetime Excess Cancer Risk (LECR) or the expected number of additional cancer cases above the national average. Users can explore CAREX Canada's data, or use local data (ex. air monitoring data from traffic corridors) to develop custom estimates and make comparisons. Note that these risk estimates capture exposures from total emissions in outdoor air, not just those from TRAP.

eRISK is available on the Tools page under the Resources section on our website. Information on data sources and strengths and limitations can be found on page 5 of this document.

Figure 2: Sample of eRISK Online results for diesel engine exhaust and benzene in outdoor air, using cancer potency factors from the California Office of Environmental Health Hazard Assessment (CAOEHHA)



Videos

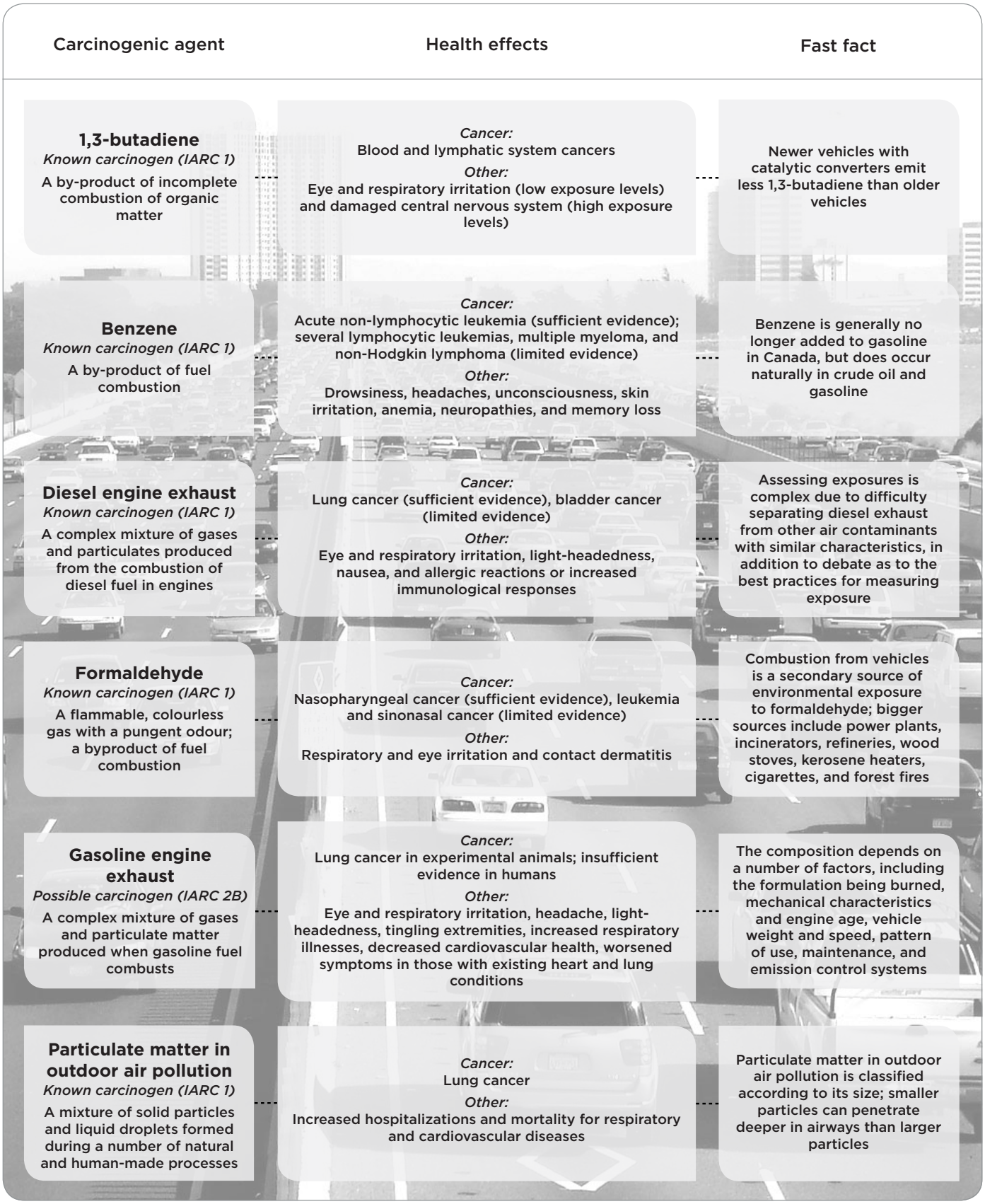
Webinar and tutorial videos provide detailed background on estimates and methods, training on how to use CAREX resources and tools such as eRISK, and special topics such as outdoor air exposures.

Webinar and tutorial videos are available on the Videos page under the Resources section on our website.

Profile overviews

The CAREX Canada website contains detailed information on use, production and trade, exposure routes, and health effects for priority carcinogens linked to TRAP. A sample of these is summarized below.

More information, including regulations and guidelines for each agent, methods for calculating exposure level estimates, and a list of references, is available on the Carcinogen Profiles page on our website.



Carcinogenic agent	Health effects	Fast fact
1,3-butadiene *Known carcinogen (IARC 1)* A by-product of incomplete combustion of organic matter	*Cancer:* Blood and lymphatic system cancers *Other:* Eye and respiratory irritation (low exposure levels) and damaged central nervous system (high exposure levels)	Newer vehicles with catalytic converters emit less 1,3-butadiene than older vehicles
Benzene *Known carcinogen (IARC 1)* A by-product of fuel combustion	*Cancer:* Acute non-lymphocytic leukemia (sufficient evidence); several lymphocytic leukemias, multiple myeloma, and non-Hodgkin lymphoma (limited evidence) *Other:* Drowsiness, headaches, unconsciousness, skin irritation, anemia, neuropathies, and memory loss	Benzene is generally no longer added to gasoline in Canada, but does occur naturally in crude oil and gasoline
Diesel engine exhaust *Known carcinogen (IARC 1)* A complex mixture of gases and particulates produced from the combustion of diesel fuel in engines	*Cancer:* Lung cancer (sufficient evidence), bladder cancer (limited evidence) *Other:* Eye and respiratory irritation, light-headedness, nausea, and allergic reactions or increased immunological responses	Assessing exposures is complex due to difficulty separating diesel exhaust from other air contaminants with similar characteristics, in addition to debate as to the best practices for measuring exposure
Formaldehyde *Known carcinogen (IARC 1)* A flammable, colourless gas with a pungent odour; a byproduct of fuel combustion	*Cancer:* Nasopharyngeal cancer (sufficient evidence), leukemia and sinonasal cancer (limited evidence) *Other:* Respiratory and eye irritation and contact dermatitis	Combustion from vehicles is a secondary source of environmental exposure to formaldehyde; bigger sources include power plants, incinerators, refineries, wood stoves, kerosene heaters, cigarettes, and forest fires
Gasoline engine exhaust *Possible carcinogen (IARC 2B)* A complex mixture of gases and particulate matter produced when gasoline fuel combusts	*Cancer:* Lung cancer in experimental animals; insufficient evidence in humans *Other:* Eye and respiratory irritation, headache, light-headedness, tingling extremities, increased respiratory illnesses, decreased cardiovascular health, worsened symptoms in those with existing heart and lung conditions	The composition depends on a number of factors, including the formulation being burned, mechanical characteristics and engine age, vehicle weight and speed, pattern of use, maintenance, and emission control systems
Particulate matter in outdoor air pollution *Known carcinogen (IARC 1)* A mixture of solid particles and liquid droplets formed during a number of natural and human-made processes	*Cancer:* Lung cancer *Other:* Increased hospitalizations and mortality for respiratory and cardiovascular diseases	Particulate matter in outdoor air pollution is classified according to its size; smaller particles can penetrate deeper in airways than larger particles

Exposure reduction strategies

A number of strategies may help reduce environmental exposure to TRAP. A report prepared for Health Canada (Brauer et al., 2012) summarizes the main exposure reduction strategies from a Canadian perspective. These include:

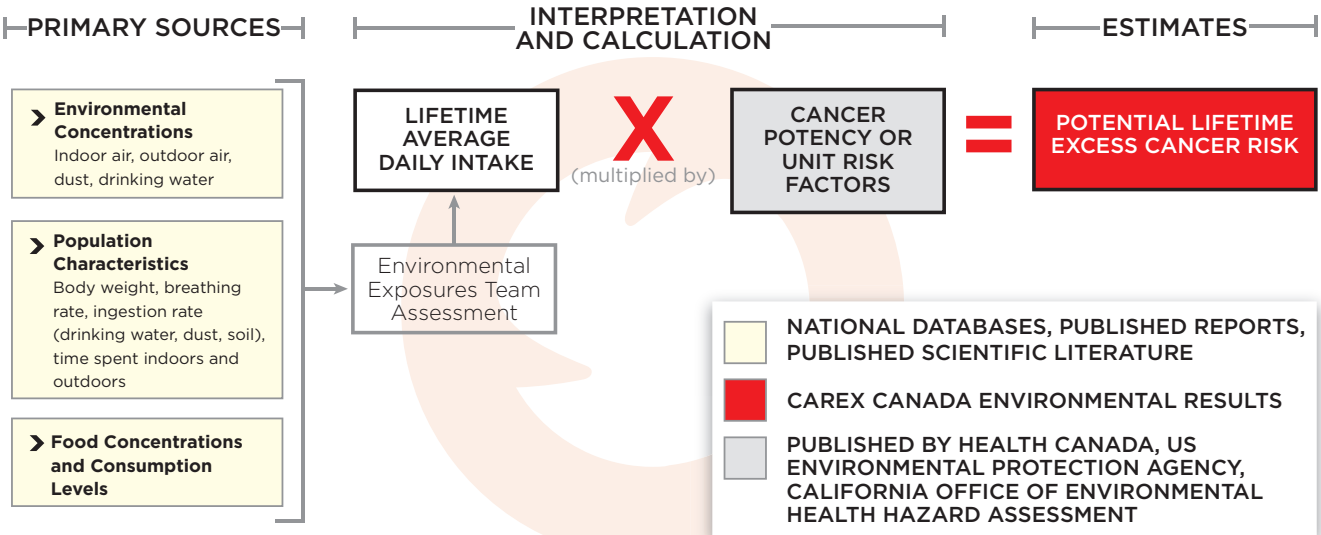
1. Land-use planning and transportation management. For example:
   - Site new buildings that house susceptible populations away from busy roads
   - Develop low emission zones and anti-idling bylaws
   - Improve infrastructure for active commuting
2. Reduce vehicle emissions. For example:
   - Develop new vehicle emission regulations and improve fuel quality standards
   - Develop inspection and maintenance programs for existing vehicles
   - Reduce age of vehicle fleet
3. Modify existing structures. For example:
   - Create separated bicycle lanes
   - Install air filtration in indoor environments
4. Encourage behaviour change. For example:
   - Offer alternatives to private vehicles such as car sharing and improved public transport
   - Educate people on the impact of their transportation choices and exposure to TRAP

A compilation of exposure reduction resources, including the Canadian Partnership Against Cancer's Prevention Policies Directory and the Canadian Cancer Society's Cancer Information portal, is available on our website.

Methods

One of the main goals of the CAREX Canada project is to estimate Canadians' potential exposures to the most common known or suspected carcinogens in community settings outside of work ("environmental exposures"), including exposures via outdoor air. Carcinogens are classified based on evaluations made by IARC. Our population-level, risk-based screening approach produces estimates of potential lifetime excess cancer risk (LECR) (Figure 3). These estimates show the number of additional cases of cancer expected to occur in a group of people exposed to a specific known or suspected carcinogen through their entire life.

Figure 3: CAREX Canada's risk-based approach to assessing environmental exposure to carcinogens



Methods continued...

The highest priority substances we selected are outdoor air carcinogens found in TRAP that have a LECR of 1 in a million people or above (using maximum intake and the highest potency factor). These include diesel and gasoline engine exhaust, as well as individual components found within this exhaust such as particulate matter, 1,3-butadiene, benzene, and formaldehyde. Note that the risk estimates capture exposures from total emissions in outdoor air, not just those from TRAP. Risk estimates are not available for some of the substances on this list because data is lacking (i.e. particulate matter) or IARC has classified it recently so an estimate has not yet been developed (i.e. gasoline engine exhaust).

More information on our methods is available under the Environmental Approach section on our website.

Data sources

In general, the data source for our lifetime excess cancer risk calculations for outdoor air is the National Air Pollution Surveillance Network (2010, 2011).

More information on data sources is available under the Methods and Data section for each carcinogen on our website.

Strengths and limitations

Our environmental exposure estimates are indicators of environmental quality in Canada and support prioritization of known and suspected carcinogens for exposure reduction. They enable surveillance by establishing a benchmark, allowing users to identify trends over time and compare across substances and pathways. They are national in scope, while incorporating regional variation when appropriate. Users can also input their own local data to create custom exposure risk estimates.

The environmental exposure estimates on the CAREX Canada website and the eRISK tool are population level indicators of risk, meaning they do not represent an actual risk for any specific Canadian. We assume that exposure occurs at the same level, 24 hours per day for 70 years. Although this is not true for any single individual, using a standard set of assumptions allows us to provide a relative ranking across multiple substances and exposure pathways. Uncertainties may also exist around the cancer potency factors used, which are published by various agencies and make a variety of toxicological assumptions such as a linear dose response.

More information on strengths and limitations is available under the Environmental Approach section on our website.

Where can you learn more?

Visit our website at www.carexcanada.ca

Follow us on Twitter @CAREXCanada

Email us at info@carexcanada.ca

Relevant publications and reports

IARC Monographs Volume 109: Outdoor Air Pollution
International Agency for Research on Cancer, 2016.

IARC Monographs Volume 105: Diesel and Gasoline Engine Exhausts and Some Nitroarenes
International Agency for Research on Cancer, 2013.

IARC Monographs Volume 100F: Chemical Agents and Related Occupations
International Agency for Research on Cancer, 2012.

Environmental Burden of Cancer in Ontario
Cancer Care Ontario, Public Health Ontario, 2016.

Air Pollution and Cancer
Canadian Cancer Society, 2019.

Identifying potential exposure reduction priorities using regional rankings based on emissions of known and suspected carcinogens to outdoor air in Canada
Setton E, Veerman B, Erickson A, Deschenes S, Cheasley R, Poplawski P, Demers PA, Keller CP. *Environ Health* 2015;14:69.

Traffic-Related Air Pollution and Health: A Canadian Perspective on Scientific Evidence and Potential Exposure-Mitigation Strategies
Brauer M, Reynolds C, Hystad P. University of British Columbia, 2012.

Risk-based indicators of Canadians' exposures to environmental carcinogens Setton E, Hystad P, Poplawski K, Cheasley R, Cervantes-Larios A, Keller CP, Demers PA. *Environ Health* 2013;12(1):15.

Spatiotemporal air pollution exposure assessment for a Canadian population-based lung cancer case-control study
Hystad P, Demers PA, Johnson KC, Brook J, van Donkelaar A, Lamsal L, Martin M, Brauer M. *Environ Health* 2012;11:22.

Creating National Air Pollution Models for Population Exposure Surveillance in Canada
Hystad P, Setton E, Cervantes A, Poplawski K, Deschenes S, Brauer M, Martin R, van Donkelarr A, Lamsal L, Jerrett M, Demers P. *Environ Health Perspect* 2011;119(8):1123.

Reducing Exposure to Traffic Emissions
Metro Vancouver, 2013.

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