



CAREX
CANADA

Exposure surveillance of environmental and occupational carcinogens for cancer prevention

Occupational Exposure Summary

Lung Carcinogens

This report serves as a summary of CAREX Canada's results on priority exposures to known or suspected lung carcinogens in Canada. Assembling various CAREX Canada data, tools, and resources, it provides an overview of the most prevalent exposures for those working in the sector, including gasoline engine exhaust, diesel engine exhaust, polycyclic aromatic hydrocarbons, crystalline silica, and second-hand smoke. Our aim is to provide a useful guide for those looking to better understand – and help reduce or eliminate – common carcinogenic exposures associated with lung cancer.

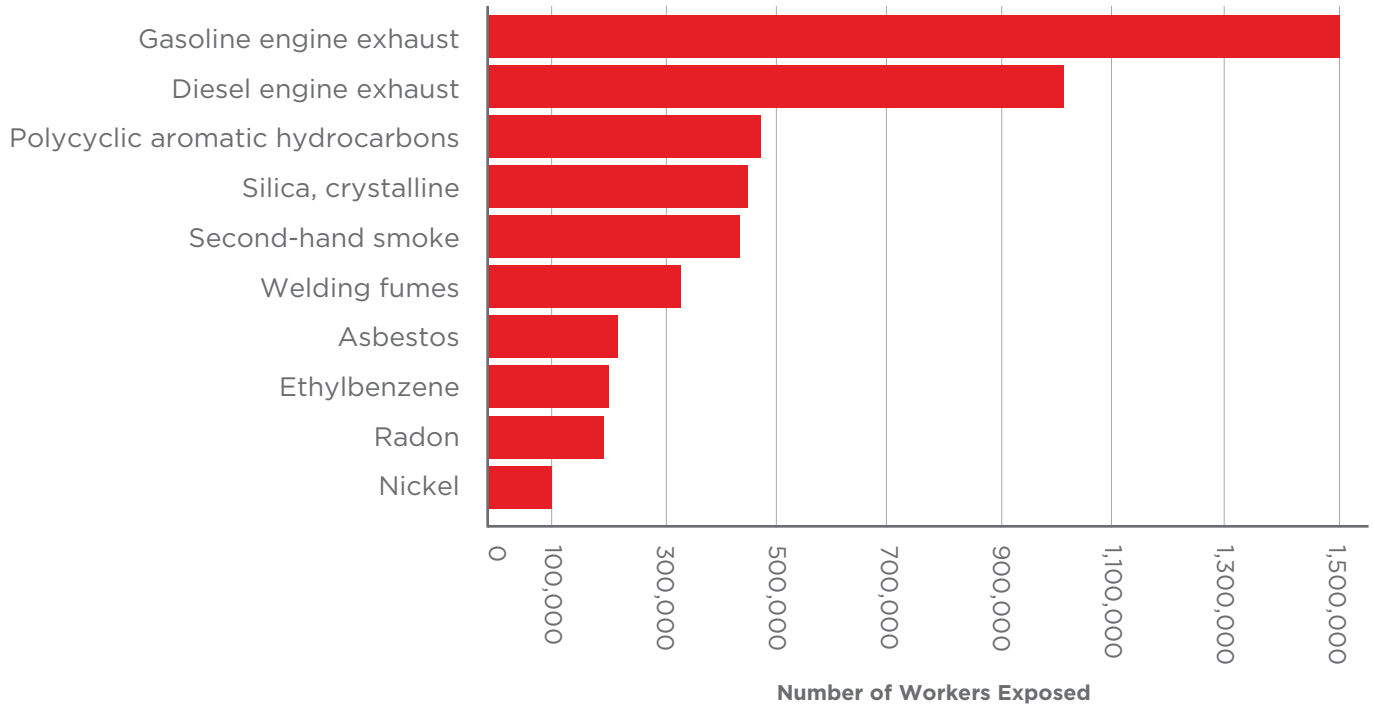
Lung cancer in Canada

Lung cancer is the second most common type of cancer among Canadians behind breast cancer in women and prostate cancer in men (this excludes non-melanoma skin cancers). According to the Canadian Cancer Statistics, an estimated 29,600 Canadians were diagnosed with lung cancer and approximately 21,000 Canadians died of the disease in 2021. Lung cancer is the leading cause of cancer mortality in Canada, resulting in approximately 25% of all cancer deaths.

Estimates of prevalent exposures


CAREX Canada estimates of the number of workers exposed to lung carcinogens at work are summarized in Figure 1. They include gasoline engine exhaust, diesel engine exhaust, polycyclic aromatic hydrocarbons, crystalline silica, and second-hand smoke. Exposure level estimates, where available, are summarized in the Carcinogen Profiles below.

Figure 1. Top 10 prevalent lung carcinogen exposures for Canadian workplaces, CAREX Canada, 2016



Note: High prevalence does not necessarily indicate a high cancer risk. For more information or assistance interpreting the data in this table, please contact us at info@carexcanada.ca.

We classify carcinogens based on evaluations made by the [International Agency for Research on Cancer \(IARC\)](#). Many of the agents listed in Figure 1 are classified as known carcinogens (IARC 1), where there is sufficient evidence linking the agent with cancer in humans.

 More information, including detailed carcinogen information, exposure estimates, methods, and references, is available under the Carcinogen Profiles tab of our website

Carcinogen profiles

The CAREX Canada website contains detailed information on use, regulations and guidelines, production and trade, exposure routes, and health effects for the top lung carcinogen exposures listed above. A sample of these are summarized below.

Gasoline Engine Exhaust

KNOWN CARCINOGEN
(IARC 2B)



What is gasoline engine exhaust?

Gasoline engine exhaust, produced when gasoline fuel combusts, is a **complex mixture of gases** (e.g. carbon monoxide, nitrogen oxides, and volatile organic compounds) and **particulate matter** (e.g. elemental and organic carbon, ash, sulfate, and metals).

What are its health effects?

Cancer: IARC has classified gasoline engine exhaust as possibly carcinogenic to humans, based on inadequate evidence of carcinogenicity in humans and sufficient evidence of **lung cancer** in experimental animals.

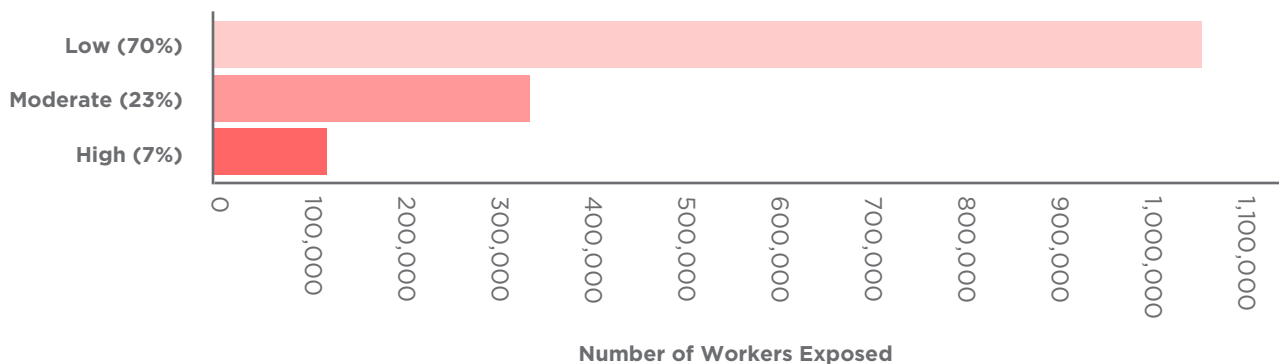
Non-cancer: Short-term exposure to gasoline engine exhaust may irritate the eyes, nose, or throat, aggravate allergies, and lead to headache, light-headedness, or tingling extremities. Long-term health effects include impacts to the respiratory and cardiovascular systems.

Occupational exposure to gasoline engine exhaust

Inhalation is the primary route of occupational exposure to gasoline engine exhaust. Assessing exposures to gasoline engine exhaust is complex because it is difficult to separate the effects of diesel and gasoline engine exhaust.

Approximately **1.5 million Canadians are exposed to gasoline engine exhaust at work**. The industries with the largest number of exposed workers include transportation and warehousing, construction, and public administration. The occupations with the largest number of exposed workers include transport truck drivers, delivery and courier service drivers, and bus drivers, subway operators and other transit operators.

Workers exposed to gasoline engine exhaust by exposure level



Diesel Engine Exhaust

KNOWN CARCINOGEN (IARC 1)



What is diesel engine exhaust?

The combustion of diesel fuel in engines produces diesel engine exhaust, a **complex mixture of gases and particulates** that can contain other known and suspected carcinogens such as benzene, polycyclic aromatic hydrocarbons (PAHs), metals, and particulate matter. The composition of the mixture depends on a number of factors including the type of engine (heavy or light duty), the type of fuel and oil, sulphur levels, speed and load of operation, and emission control systems.

What are its health effects?

Cancer: There is sufficient evidence linking diesel engine exhaust to **lung cancer**, and limited evidence for bladder cancer in humans

Non-cancer: Short-term exposure to diesel engine exhaust can cause irritation of the eyes, throat, and bronchi, as well as lightheadedness, nausea, and respiratory symptoms such as cough and phlegm. Diesel exhaust may initiate allergic reactions or increase immunological response to other allergens.

Occupational exposure to diesel engine exhaust

Inhalation is the most common route of exposure. Assessing exposures to diesel engine exhaust is complex because it is difficult to separate diesel exhaust from other air contaminants with similar characteristics.

Approximately **966,000 Canadians are exposed to diesel engine exhaust at work**. Of those exposed to diesel engine exhaust, the transportation and warehousing, construction, and public administration sectors have the largest number of exposed workers in Canada. Occupations with the largest number of exposed workers include transport truck drivers; bus drivers, subway operators and other transit operators; and heavy equipment operators.

Workers exposed to diesel engine exhaust by exposure level



Polycyclic Aromatic Hydrocarbons

MULTIPLE CLASSIFICATIONS
IARC 1 (KNOWN CARCINOGEN),
IARC 2A (PROBABLE CARCINOGEN),
IARC 2B (POSSIBLE CARCINOGEN)



What are polycyclic aromatic hydrocarbons?

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 chemicals **formed during the incomplete burning of wood, coal, oil, gas, garbage, and other organic substances**. PAHs occur naturally or can be individually manufactured, and generally exist as complex mixtures.

What are their health effects?

Cancer: Because PAHs are often found in complex mixtures, the carcinogenic effects of individual PAHs are difficult to assess. Evidence from workplace studies shows that exposure to PAH-containing mixtures is associated with **lung and skin cancer**. Animal studies also show that a number of pure PAHs are carcinogenic.

Non-cancer: PAH exposure is associated with reduced lung and immune function, and skin inflammation and lesions.

Occupational exposure to polycyclic aromatic hydrocarbons

Inhalation and dermal contact are the main routes of exposure to PAHs. Approximately **467,000 Canadians are exposed to PAHs at work**. The industries with the largest number of exposed workers include accommodation and food services, and retail trade. Occupations with the largest number of exposed workers include cooks; automotive service technicians, truck and bus mechanics and mechanical repairers; and chefs.



Exploring the CAREX Canada estimates

Our eWORK Tool allows users to explore CAREX exposure data by carcinogen, sector, occupation, province, sex, and exposure level. We offer two versions of the eWORK Tool: eWORK Online and eWORK Excel. eWORK Online is for users who prefer quick, accessible, yet high-quality statistics on occupational exposures to various carcinogens. eWORK Excel uses a Microsoft Excel PowerPivot interface that allows users to search for – and visualize – exposures of interest.

 eWORK Online and eWORK Excel are available under the Resources tab of our website.

Reducing exposures

CAREX Canada’s resources and estimates can be used to inform programs, policies, and practices related to carcinogen exposures. Identifying the priority exposure scenarios and substances for exposure reduction can help guide agenda- and priority-setting for cancer prevention.

As outlined by the **Canadian Centre for Occupational Health and Safety** (CCOHS), a variety of strategies can help protect workers from exposures to harmful substances such as carcinogens. These strategies are listed in order of effectiveness in controlling a risk.



Elimination is the most effective way to control a risk; it involves removing the hazard from the workplace. This process may also involve substitution. *An example of substitution is using lead-free paints and glazes instead of those that contain lead.*



Engineering controls minimize risk of exposure through strategic designs or modifications, which include process controls, enclosure/isolation of the source, and ventilation. *An example of a process control is using wet methods instead of dry when grinding or drilling to reduce dust.*



Administrative controls alter the way the work is done through rules or policies. *An example of an administrative control is shorter work times in areas where exposure may occur.*



Personal protective equipment (PPE) provides a barrier between the worker and the hazard. *Examples of PPE include respirators, eye protection, face shields, gloves, and footwear.*

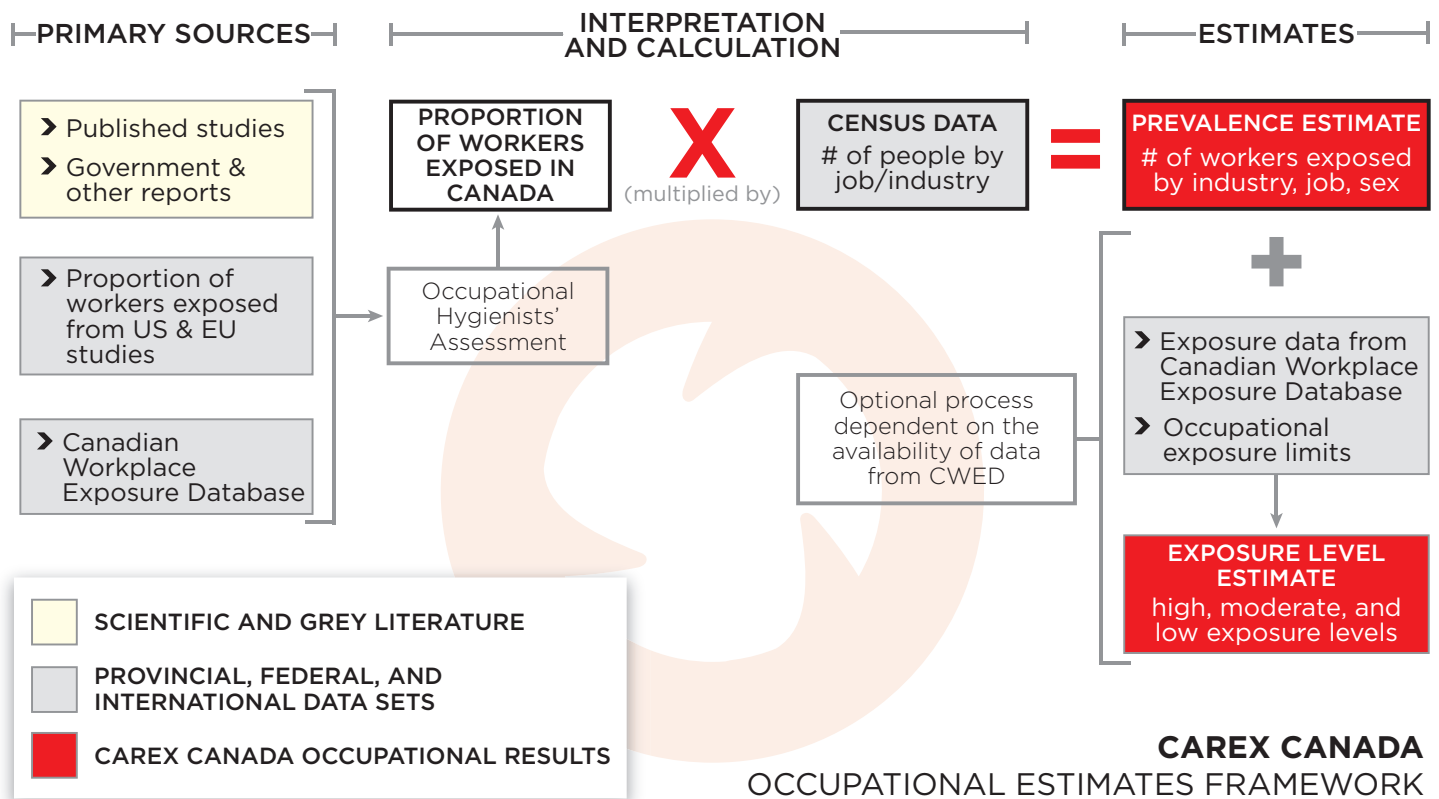
 A compilation of additional exposure reduction resources, including the Canadian Partnership Against Cancer’s Prevention Policies Directory and the Canadian Cancer Society’s Cancer Information portal, is available on our website.

Methods

The goal of the CAREX Canada project is to estimate Canadians' potential exposures to known and suspected carcinogens in the workplace, prioritizing agents that are most relevant to Canadians. Estimates of the numbers of workers exposed to these agents are calculated by sector, occupation, province, sex, and level of exposure (where data are available). They are developed using information gathered in a scientific literature review, data included in the Canadian Workplace Exposure Database (CWED), information from previous CAREX projects in Europe, Canadian-specific information on exposure from government and other sources, and CAREX occupational hygienists' expert assessment. Most of our estimates use the 2016 Census of Population, with some exceptions noted in our documentation. CAREX Canada's general approach to producing occupational prevalence and exposure level estimates is summarized in Figure 2.

 More information on our methods and data is available under the Carcinogen Profiles tab on our website

Figure 2. CAREX Canada's occupational estimates framework



Relevant publications and reports

[Setting an Occupational Exposure Limit for Diesel Engine Exhaust in Canada: Challenges and Opportunities](#) | CAREX Canada. 2019.

[CAREX Canada's priority carcinogens – Lung cancer](#) | CAREX Canada, 2017.

[IARC Monographs List of Classifications by Cancer Site](#) | International Agency for Research on Cancer, 2019.

[IARC Monographs Volume 105: Diesel and Gasoline Engine Exhausts and Some Nitroarenes](#) | International Agency for Research on Cancer, 2013.

[IARC Monographs Volume 100C: A Review of Human Carcinogens: Arsenic, Metals, Fibres, and Dusts](#) | International Agency for Research on Cancer, 2012.

[Estimating the burden of lung cancer in Canada attributed to occupational radon exposure using a novel exposure assessment method](#) | Ge CB, Kim J, Labrèche F, Song C, Heer E, Arrandal VH, Pahwa M, Peters CE, Demers PA. Int Arch Occup Environ Health 2020.

[Population-level estimates of workplace exposure to second hand smoke in Canada](#) | Rydz E, Arrandale VH, Peters CE. Can J Public Health 2019;111(1):125-133

[Burden of lung cancer attributable to occupational diesel engine exhaust exposure in Canada](#) | Kim J, Peters CE, Arrandale VH, Labrèche F, Ge CB, McLeod CB, Song C, Lavoué J, Davies HW, Nicol AM, Pahwa M, Demers PA. Occup Environ Med 2018.

[Occupational and environmental causes of lung cancer](#) | Field RW, Withers BL. Clin Chest Med. 2012;33(4):681-703.

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Where can you learn more?

 Visit our website at www.carexcanada.ca

 Follow us on Twitter [@CAREXCanada](https://twitter.com/CAREXCanada)

 Email us at info@carexcanada.ca

