Cancer-causing Agents in the Workplace: What's the Story?

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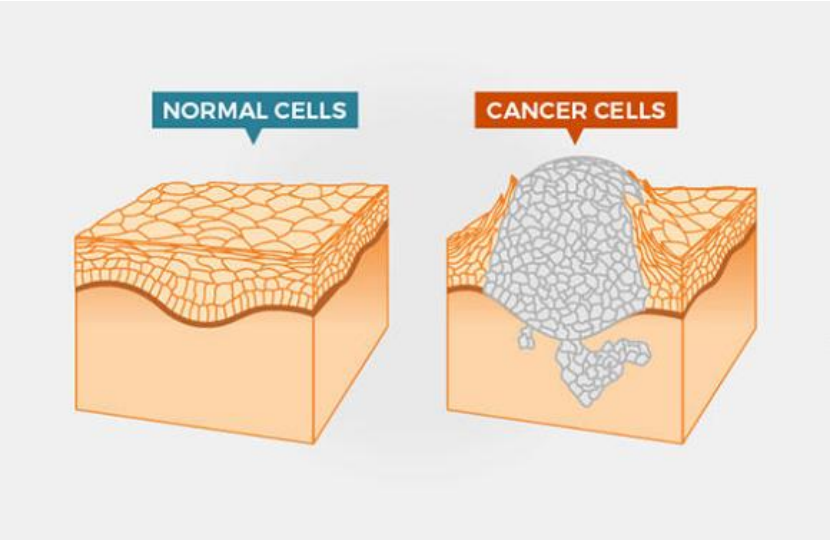
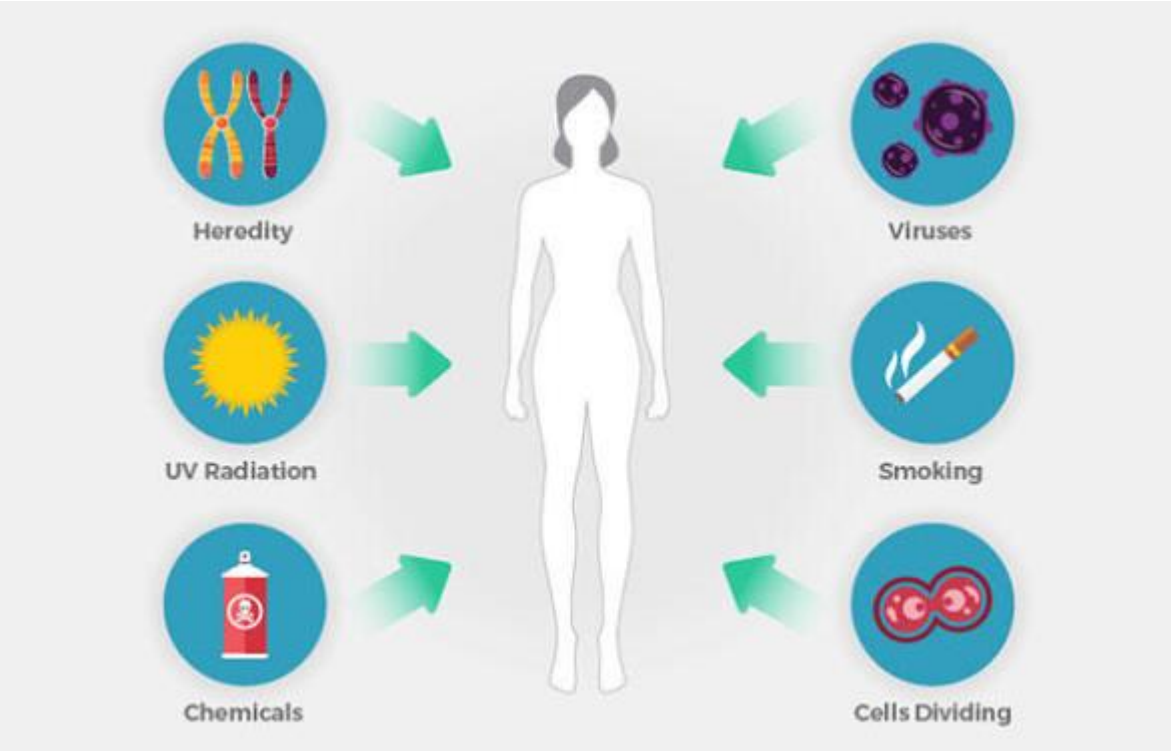
Cancer is a big issue

- Canada: Leading cause of death
- 2 in 5 Canadians
- Global: Over 19 million new cases/year (up from 14 million in 2012)



Source: IARC Global Cancer Observatory: http://gco.iarc.fr/

Risk Factors



Source: US National Cancer Institute

Occupational Cancer

Global Estimates, 2016:

- 349,000 deaths
- 7.2 million Disability Adjusted Life Years

*"**Occupational cancer**…tends to be concentrated among relatively small groups of people among whom the risk of developing the disease may be quite large, and such risks can usually be reduced or even eliminated, once they have been identified.*

The detection of occupational hazards should therefore have a higher priority in any program of cancer prevention than their proportional importance might suggest."

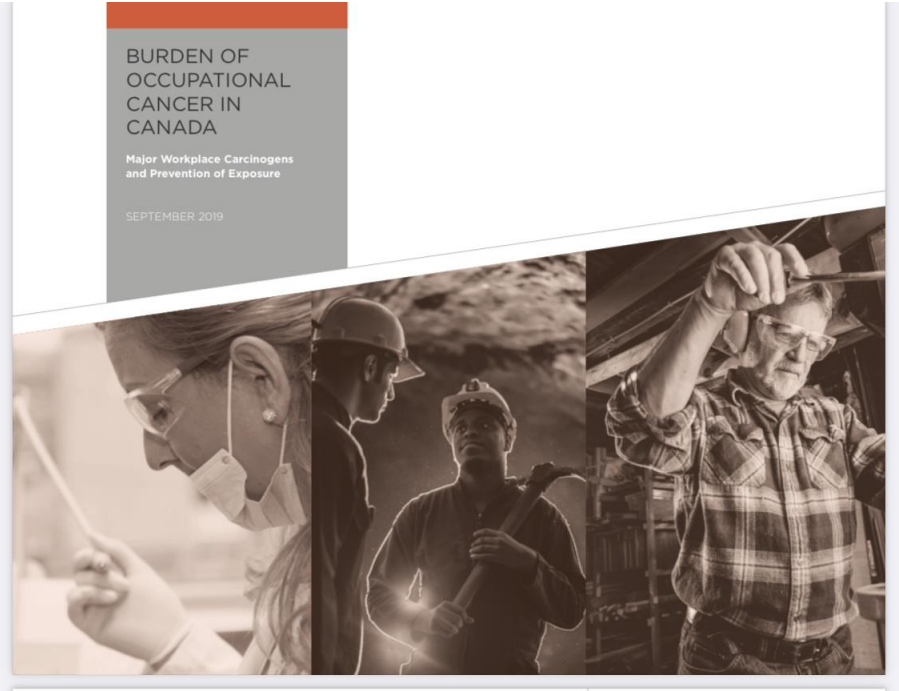
Doll & Peto, 1981

Source: https://oem.bmj.com/content/77/3/151.abstract

Burden of Occupational Cancer in Canada

2019 Report:

- Occupational exposures account for about 4% of new cancer cases (9,700-10,400)
- Majority attributed to **solar radiation**, asbestos, diesel engine exhaust, **crystalline silica**, and **shiftwork**
- Other important exposures: **welding fumes**, radon, second-hand smoke, polycyclic aromatic hydrocarbons, arsenic, benzene

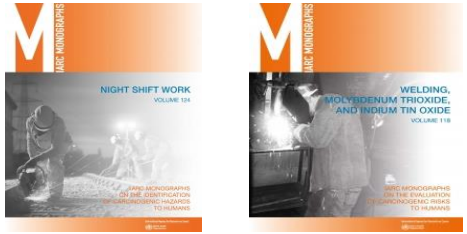


https://www.occupationalcancer.ca/burden/current-burden/

Occupational Cancer Burden Estimates

1. What causes cancer in humans
(what is the hazard?)

IARC MONOGRAPHS ON THE IDENTIFICATION OF CARCINOGENIC HAZARDS TO HUMANS



International Agency for Research on Cancer

World Health Organization

2. How many people are exposed to the hazard?

CAREX CANADA

3. What are the risks associated with exposure to the hazard?

Occupational Cancer Burden Estimates

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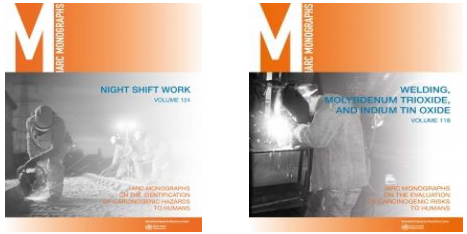

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2. How many people are exposed to the hazard?

CAREX CANADA

3. What are the risks associated with exposure to the hazard?

IARC Monographs: “The encyclopaedia of carcinogens”

- Chemicals
- Complex mixtures
- Occupational exposures
- Physical and biological agents
- Personal habits

International Agency for Research on Cancer

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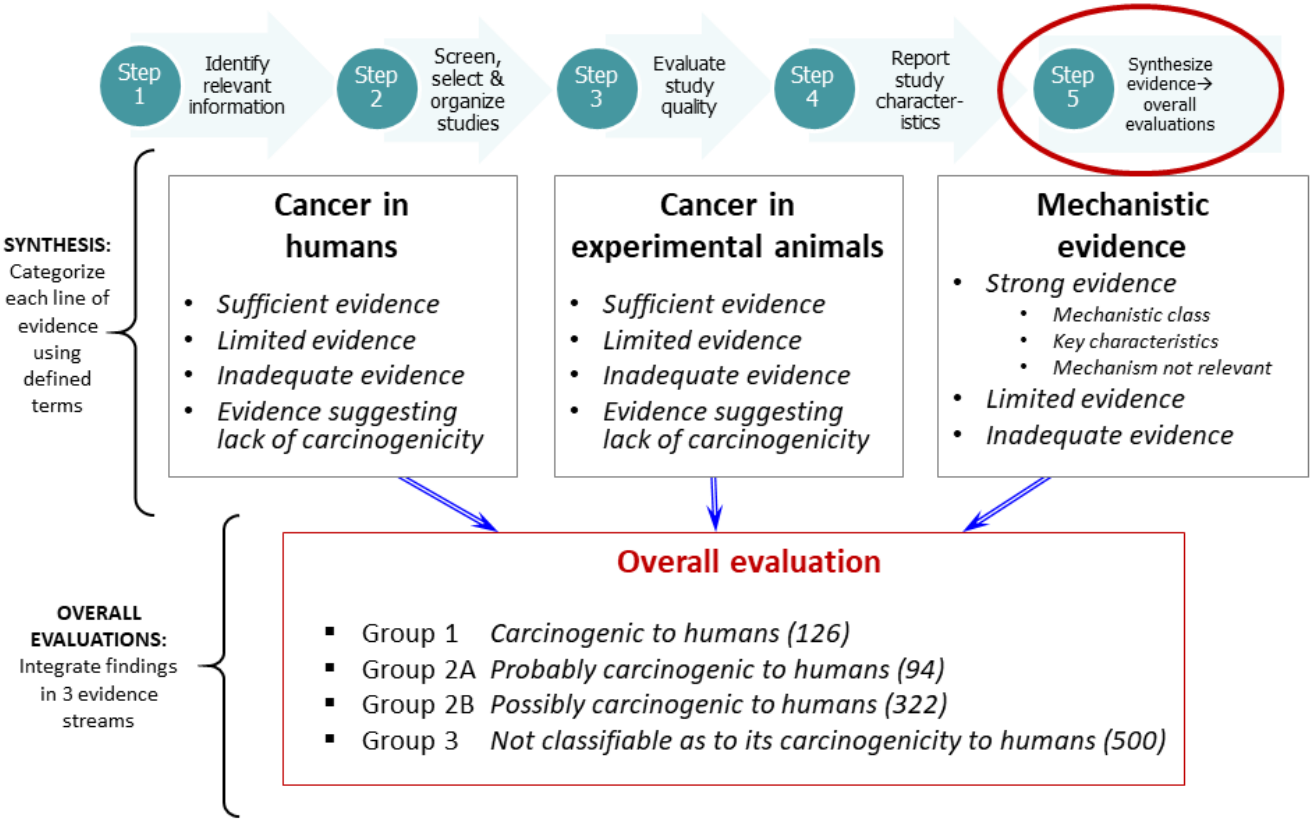
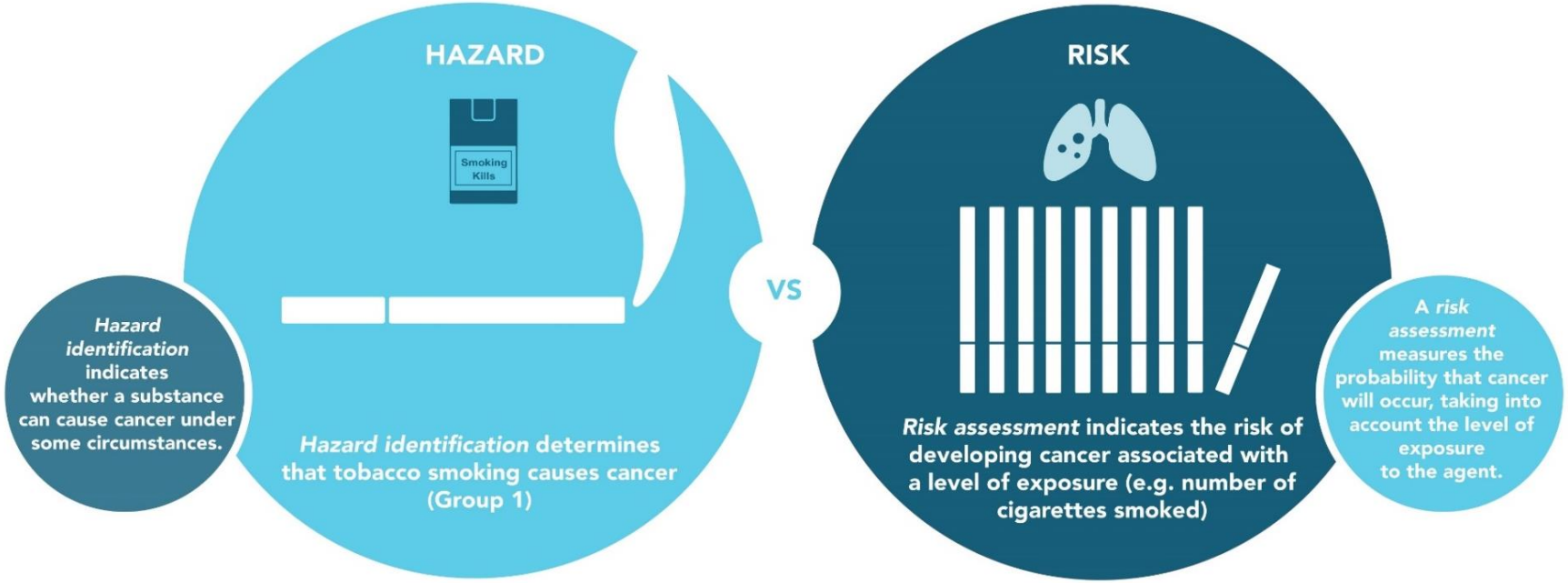
Evidence Synthesis and Classification



Hazard versus Risk



International Agency for Research on Cancer
World Health Organization

IARC MONOGRAPHS ON THE IDENTIFICATION OF CARCINOGENIC HAZARDS TO HUMANS

FR

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HOME

The *IARC Monographs* identify environmental factors that are carcinogenic hazards to humans. These include chemicals, complex mixtures, occupational exposures, physical agents, biological agents, and lifestyle factors. National health agencies can use this information as scientific support for their actions to prevent exposure to potential carcinogens.

READ MORE

NEWS

Volume 123: Some Nitrobenzenes and Other Industrial Chemicals

SOME NITROBENZENES AND OTHER INDUSTRIAL CHEMICALS

MORE

18.02.2020

NEWS

Advisory Group recommendations on updates to the Preamble

MORE

HUMAN CANCER: KNOWN CAUSES AND PREVENTION BY ORGAN SITE

PDF

IARC HANDBOOKS OF CANCER PREVENTION

VISIT WEBSITE

FEATURED VOLUMES

ISOBUTYL NITRITE, β-PICOLINE, AND SOME ACRYLATES

IARC MONOGRAPHS, VOLUME 122

VOLUME 122

UPCOMING MEETINGS

SEE UPCOMING MEETINGS

SEE ALL NEWS

SEE ALL MEETINGS

MONOGRAPHS AVAILABLE

OUTDOOR AIR POLLUTION

VIEW LIST OF MONOGRAPHS

https://monographs.iarc.who.int/

Occupational Cancer Burden Estimates Based On:

1. What causes cancer in humans
(what is the hazard?)

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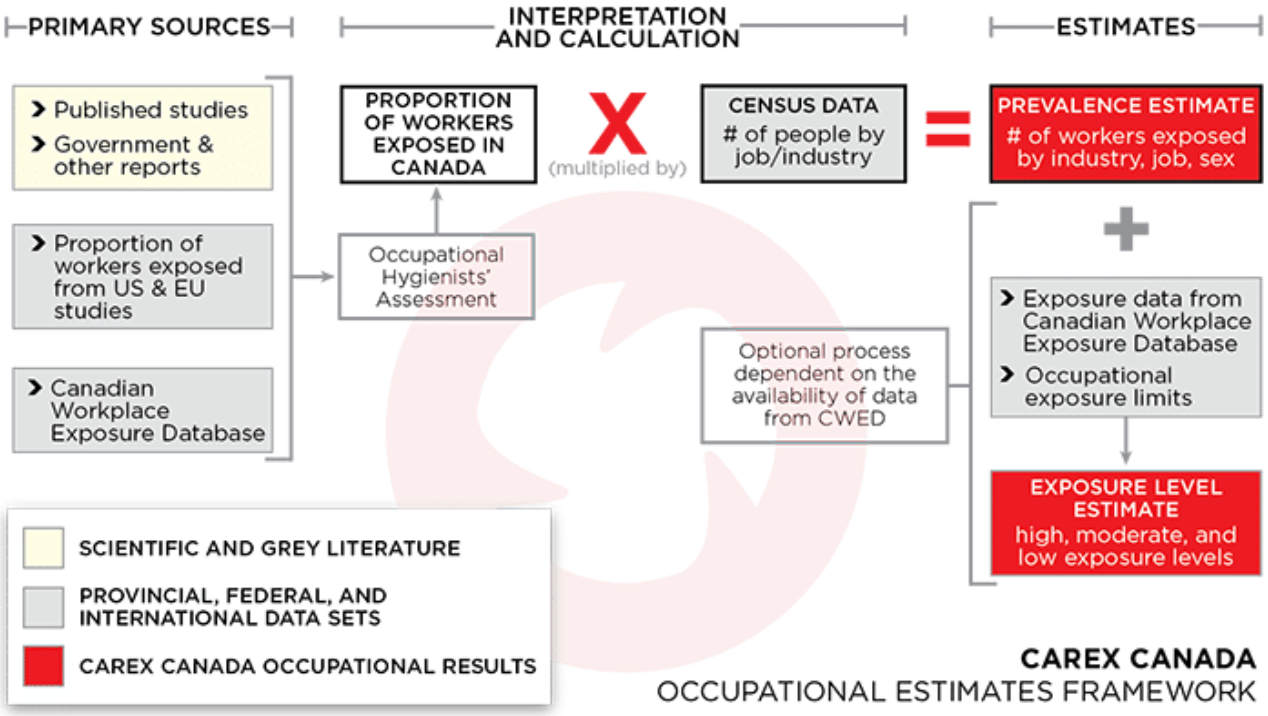
Canadian Workplace Exposures



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https://www.carexcanada.ca/

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MORE RESOURCES

- Classifying Carcinogens
- Prioritizing Canadians' Exposures
- Environmental Approach
- Occupational Approach
- Canadian Workplace Exposure Database

Profiles & Estimates

CAREX Canada has developed profiles and estimates of occupational and environmental exposure for a number of known, probable, and possible carcinogenic agents. The profiles detail carcinogenic evidence, main uses, regulatory information, and the potential for exposure to the Canadian population. The environmental exposure estimates have detailed information on where people in Canada are exposed, at the national and provincial levels. The occupational exposure estimates calculate the numbers of workers exposed by industry and occupation, and where data exist, levels of exposure are estimated. Detailed information about data sources and methods are available for all estimates and profiles.

Looking for information about a substance that's not listed here? It might be profiled on our Emerging Issues page.

ALL | PRIORITY CARCINOGENS | FIBERS AND DUSTS | INDUSTRIAL CHEMICALS | METALS | PESTICIDES | RADIATION | OTHERS

ENVIRONMENTAL ESTIMATES | OCCUPATIONAL ESTIMATES


1,2-Dichloroethane


1,3-Butadiene


1,4-Dioxane


2,4-D


Acetaldehyde


Acrylamide


Acrylonitrile


Antimony Trioxide


Antineoplastic Agents


Arsenic


Asbestos


Benzene

https://www.carexcanada.ca/carcinogen-profiles/#

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eWORK

- Home
- Industry
- Occupation
- Province

eWORK Online

eWORK Online is an interactive tool for exploring CAREX Canada's occupational exposure estimates to known and suspected carcinogens. Results show the number of workers exposed to these carcinogens nationally, by province, by industry, and by occupation for 2016. Visit our occupational approach page to learn more about the methods and data sources used to produce these estimates. For an overview of how to use eWORK Online, refer to our videos page.

All carcinogens nationwide

The table below summarizes the total number of Canadian workers exposed to known or suspected carcinogens in 2016, as well as the sex* of exposed workers and estimated levels of exposure (where available). Click the carcinogen name to visit the substance's profile and learn more about its evidence of carcinogenicity, main uses, regulation, trade and production, and exposures. Workplace exposure visuals, additional estimates, exposure level definitions, and more are available via the profile's occupational exposures tab.

Download this table

Workers Exposed | Exposure Level

Carcinogen ▲	Total ▼	Male ▲	Female ▲
Night shift work ⚠	**1,756,970**	964,665	792,306
Solar radiation	**1,657,636**	1,331,985	320,123
Gasoline engine exhaust	**1,493,451**	1,229,229	261,283
Diesel engine exhaust	**966,422**	879,274	84,976
Polycyclic aromatic hydrocarbons (excl. environmental tobacco smoke)	**467,023**	350,235	115,950
Silica, crystalline	**428,981**	402,238	26,671
Second-hand smoke ⚠	**417,973**	-	-
Benzene	**360,099**	321,604	38,310
Welding Fumes	**332,848**	309,860	22,299
Wood dust	**304,352**	285,703	18,405
Lead and lead compounds	**273,464**	245,563	27,788

*The total number of workers exposed may not always equal the sum of exposed men and women because Statistics Canada randomly rounds labour force values, which form the basis of our estimates, to multiples of 5 for confidentiality purposes.

Note: Some of our estimates use a modified approach to assess occupational exposure, including unique data sources which are not directly comparable to estimates that are calculated using the Census of Population. Click the ⚠ to learn more about these modifications to the approach.

Detailed breakdowns

To view our estimates of workplace exposure by industry, occupation, or province in the tabs below. The industry and occupation tabs allow you to view the number of workers exposed to a particular carcinogen in each industry or occupation (when sorted "by carcinogen"), or the number of workers exposed to each carcinogen in a particular industry/occupation (when sorted "by industry/occupation"). The province tab allows you to explore the total number of workers exposed to each carcinogen by province, as well as a regional breakdown by industry and occupation.

Industry | Occupation | Province

Get the complete dataset

Can't find what you're looking for using eWORK Online? Download the Excel version of our eWORK tool for our complete dataset, which features more complex filters and allows for more in-depth queries.

Download the complete dataset

https://www.carexcanada.ca/ework/

Exposure Reduction Resources

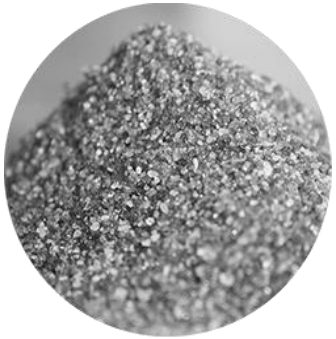
This is a compilation of key publications and resources from a detailed scan of exposure control resources. Please note that it is not an exhaustive list. *Reference to certain organizations does not represent a recommendation or endorsement by CAREX Canada.*

- BOTH OCCUPATIONAL AND ENVIRONMENTAL EXPOSURES - GENERAL
- BOTH OCCUPATIONAL AND ENVIRONMENTAL EXPOSURES - SPECIFIC CARCINOGENS - SOLAR UV RADIATION
- ENVIRONMENTAL EXPOSURES - GENERAL
- ENVIRONMENTAL EXPOSURES - SPECIFIC CARCINOGENS - ACRYLAMIDE
- ENVIRONMENTAL EXPOSURES - SPECIFIC CARCINOGENS - ARSENIC
- ENVIRONMENTAL EXPOSURES - SPECIFIC CARCINOGENS - ASBESTOS
- ENVIRONMENTAL EXPOSURES - SPECIFIC CARCINOGENS - DIOXINS
- ENVIRONMENTAL EXPOSURES - SPECIFIC CARCINOGENS - FORMALDEHYDE
- ENVIRONMENTAL EXPOSURES - SPECIFIC CARCINOGENS - PESTICIDES
- ENVIRONMENTAL EXPOSURES - SPECIFIC CARCINOGENS - RADON
- ENVIRONMENTAL EXPOSURES - SPECIFIC CARCINOGENS - SECOND-HAND SMOKE

https://www.carexcanada.ca/resources/exposure-reduction/

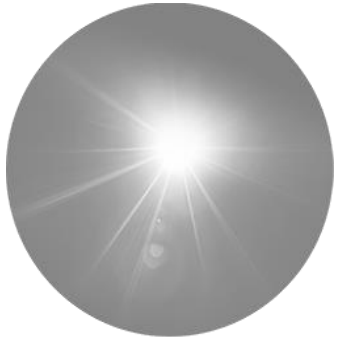
Cancer causing agents we will cover

Night Shift Work



Crystalline Silica

Welding

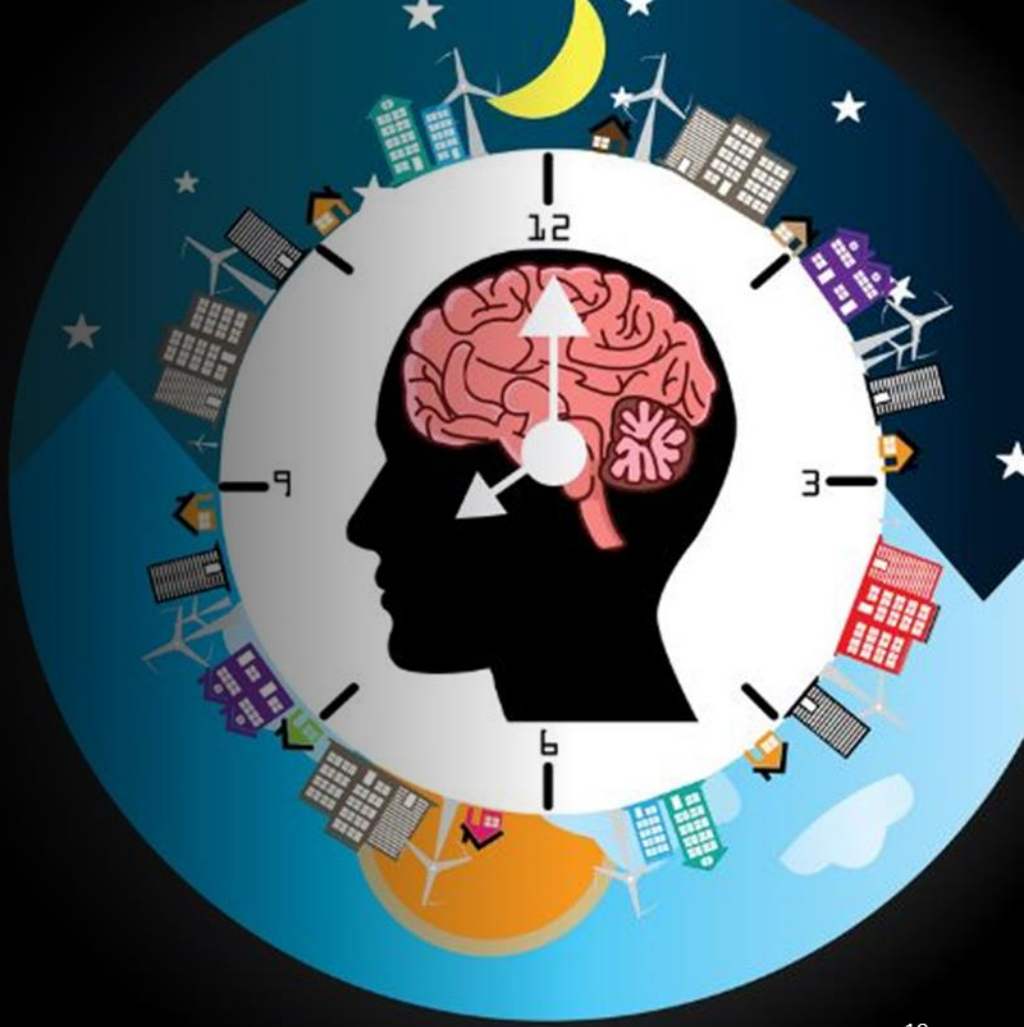


Ultraviolet Radiation

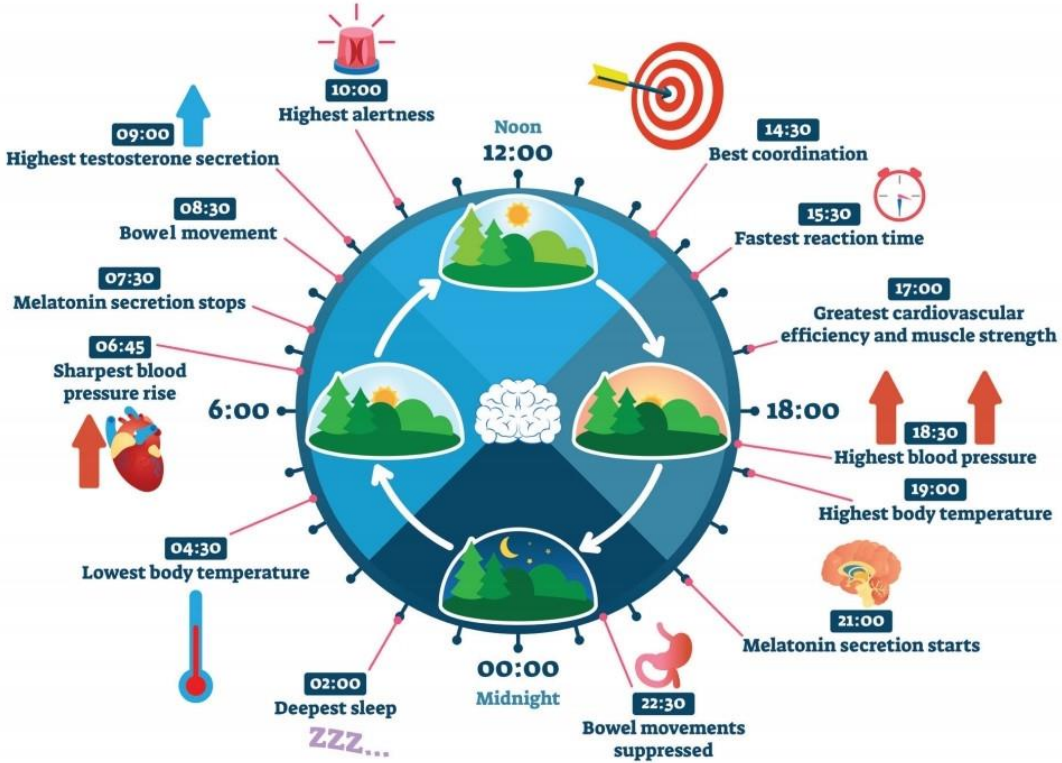
Night Shift Work

Night Shift Work

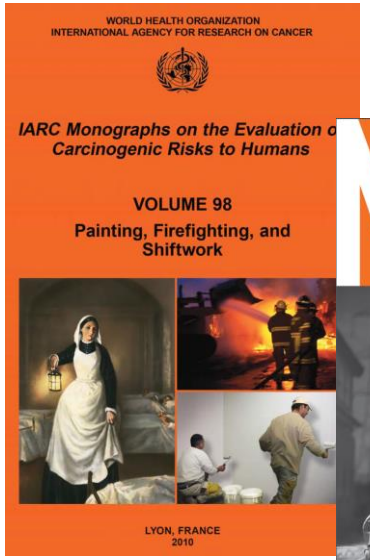
typically conducted between 12-5am



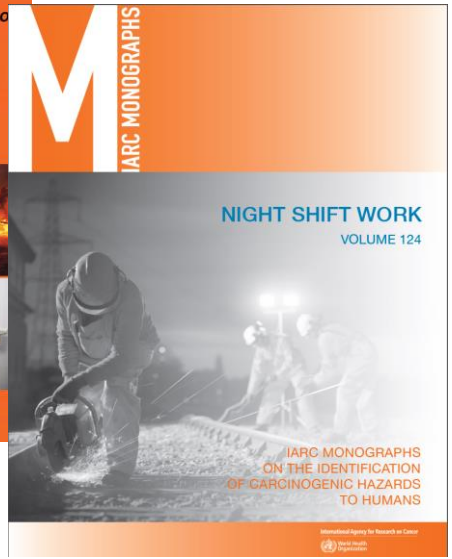
Impacts on Health



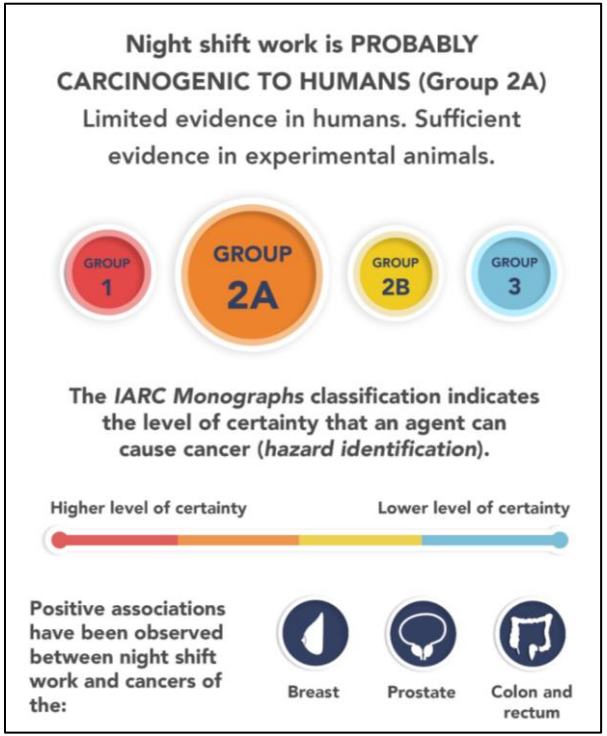
Night Shift Work and Cancer



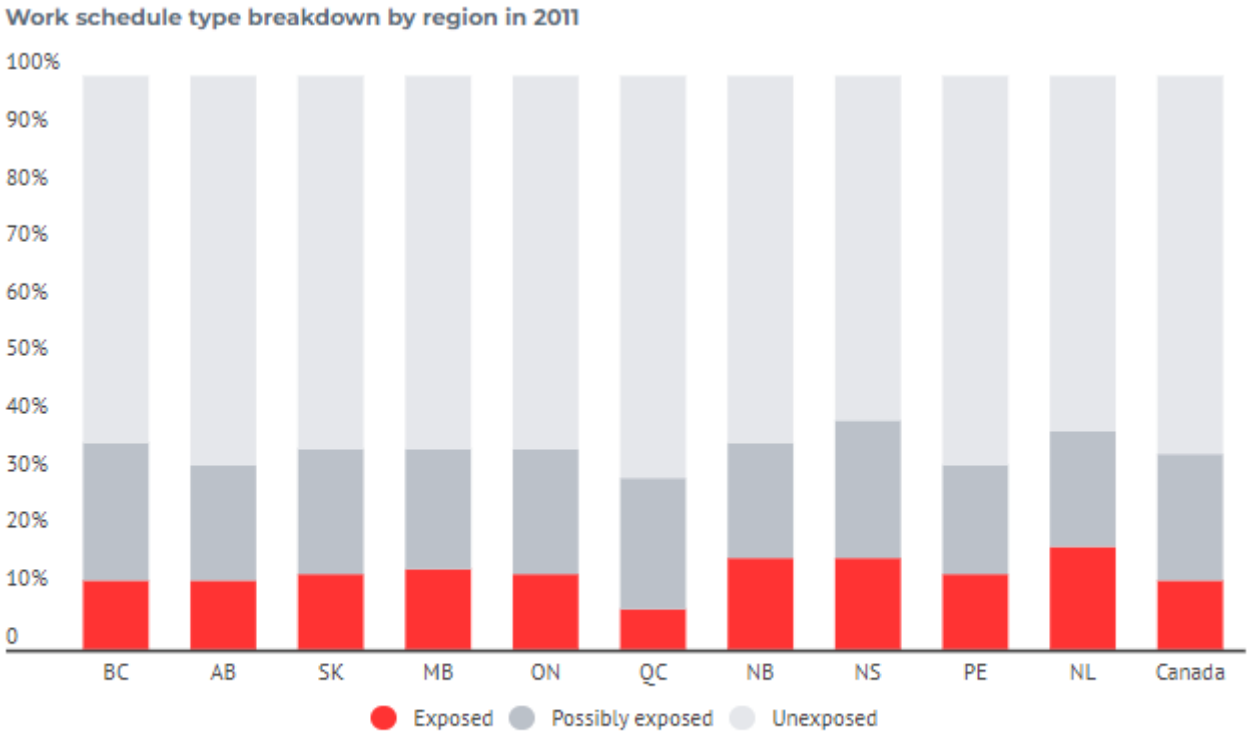
Group 2A



Group 2A

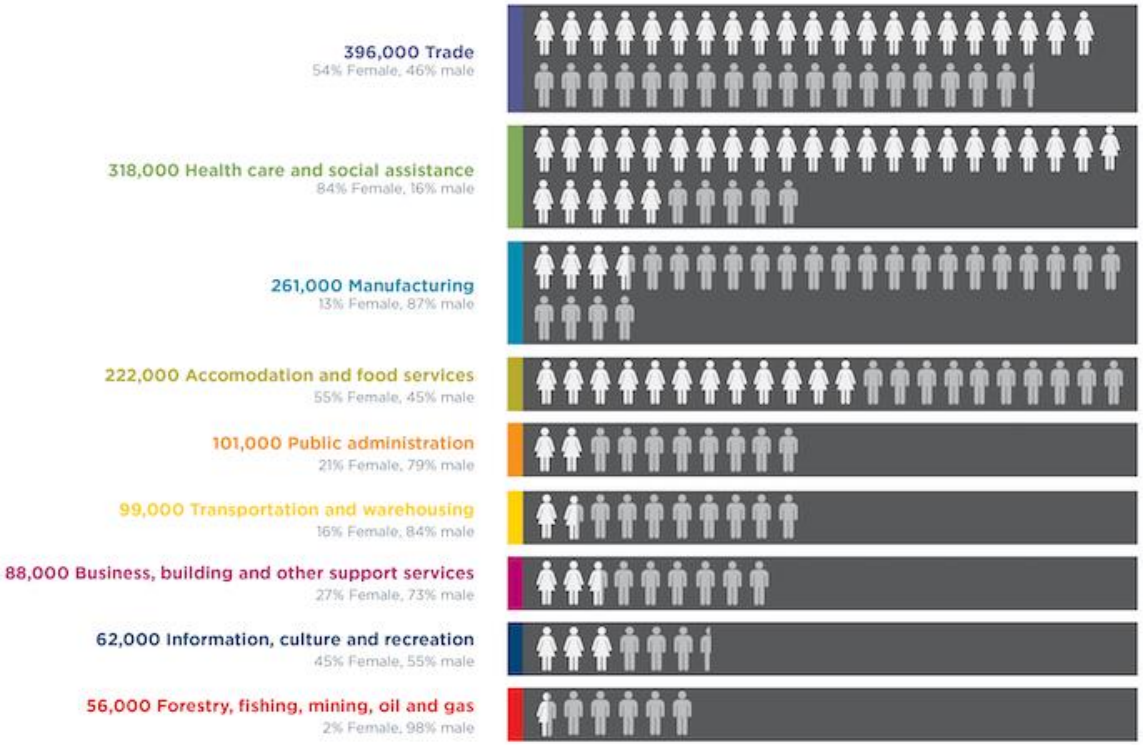


Night Shift Work Across Provinces



Exposed = regular night or rotating shift
Possibly exposed = regular evening, split shift, on call, irregular schedule, or other
Unexposed = regular day

Night Shift Work by Industry & Gender



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Burden of Occupational Cancer in Canada

Night shift work leads to approximately 470 to 1,200 breast cancers in women each year

- This amounts to 2-5% of all female breast cancers diagnosed annually
- Most occur among workers in the health care sector (also accommodation and food services, trade, manufacturing)

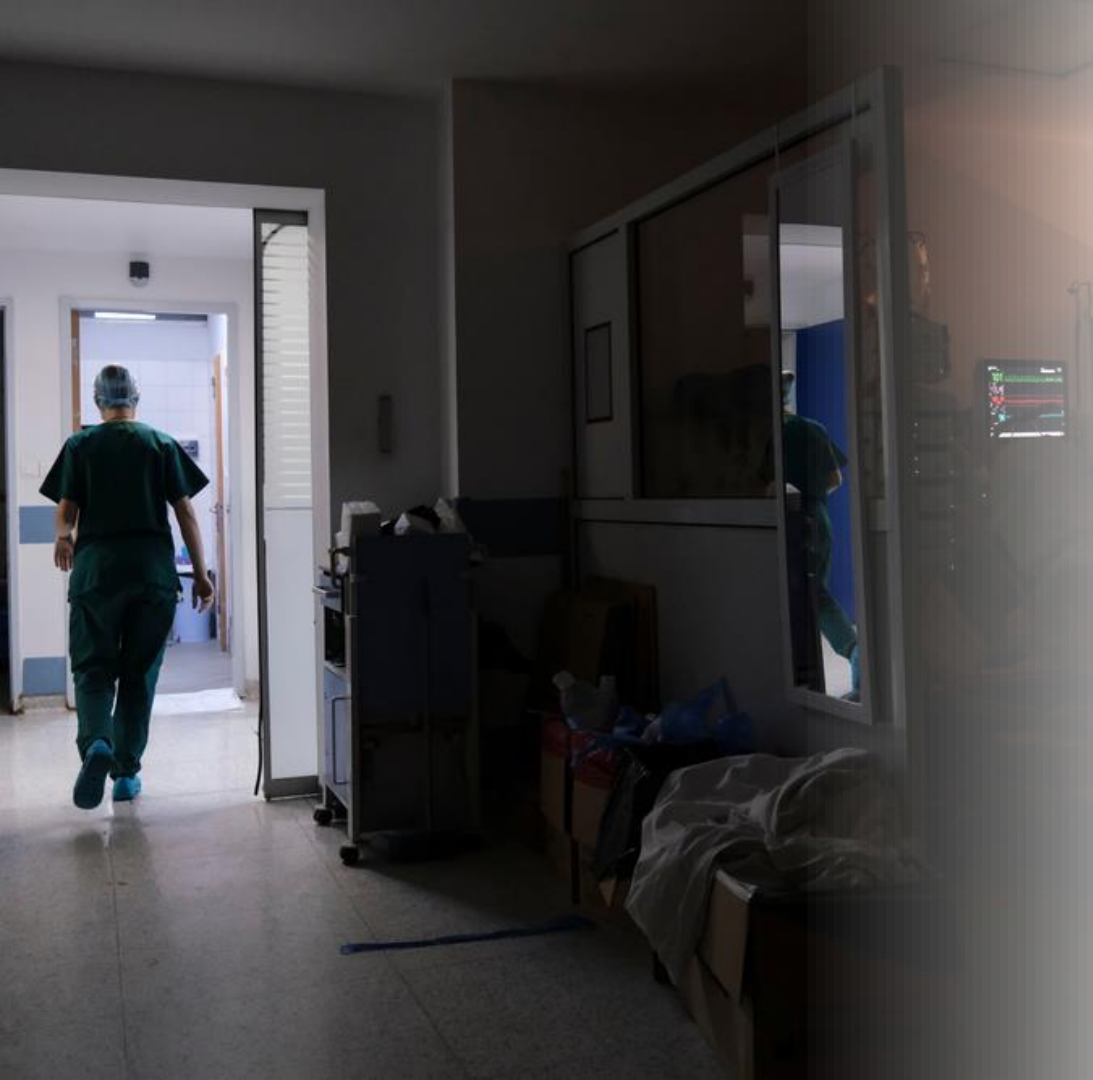
Pahwa M, Labrèche F, Kim J, Harris MA, Song C, Peters CE, Arrandale VH, Davies H, McLeod CB, Demers PA. "The impact of night shift work on breast cancer: Results from the Burden of Occupational Cancer in Canada Study." *Am J Ind Med* 2019;62(8):635-642.

Canadian Regulations

- Working time mostly governed by general duty clauses
- PEI Employment Standards Act: sections on “Hours of Work” and “Rest Periods” (no specific mention of night shift work)
- Varying degrees of protection for new or expectant mothers
- Exemptions to standard work week provisions (e.g., maritime duty time limits, other sector specific)

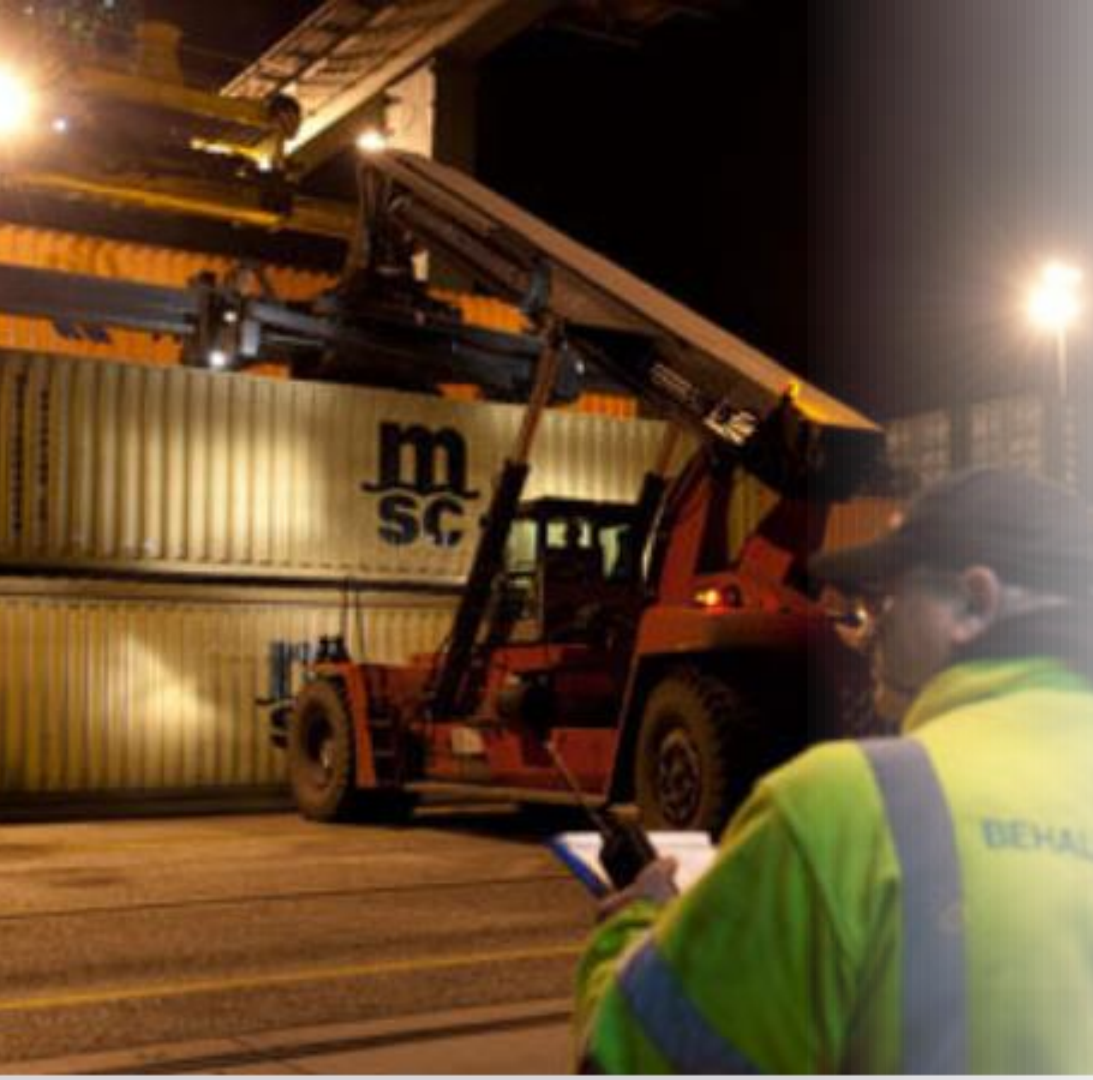
Global Regulations

- International Labour Standards on Working time, European Commission EU Working Time Directive
- Often protected: youth, new/expectant mothers
- Exemptions & special rules for various worker categories
- Return to night shift work after cancer treatment?



Risk Reduction

- Completing work during standard daylight hours is best
- Interventions that may help reduce negative impacts:
  - Optimizing shift schedule design (e.g., fast forward rotating schedules)
  - Flexible work schedules that allow for worker input



Summary

- Night shift work prevalent across a range of industries
- Linked to increased risk of breast, prostate, colorectal cancers
- Limited regulation
- None is best, but best practices may help reduce cancer risk

Solar Radiation

Ultraviolet radiation(UVR)

International Agency on Research for Cancer (IARC) classification is

Group 1-Carcinogen

Ultraviolet radiation(UVR)

- Ultraviolet light in the workplace
  - Sun
  - Tanning beds
  - Water treatment
  - Disinfection systems
  - Research equipment
  - Teeth whitening
  - Nail salons

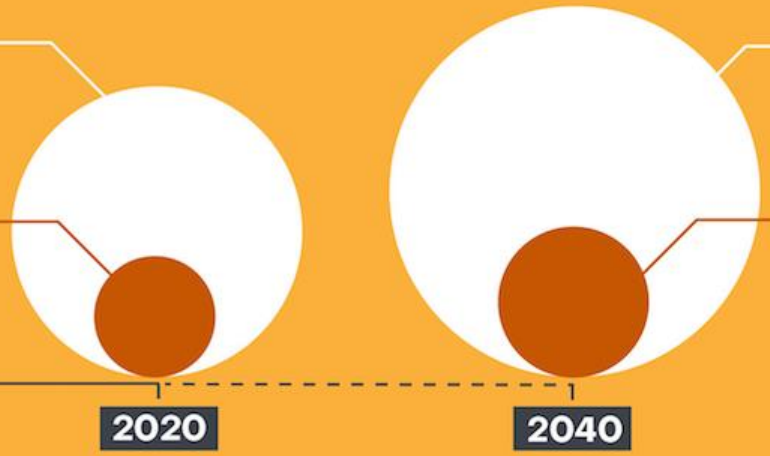
Other exposures to Radiation

- X-rays and radioactive substances
- As Low As Reasonable Achievable (ALARA)
- Outrage if strong protections are not in-place
- Statistics suggest there is not enough protection for UVR

MELANOMA WORLDWIDE

325 000
new cases of melanoma were diagnosed worldwide

57 000
people died from the disease



510 000
new cases

96 000
deaths should be expected by 2040

Skin cancers are the most common groups of cancers diagnosed worldwide, with more than 1.5 million new cases estimated in 2020

International Agency for Research on Cancer

World Health Organization

Two classifications of Skin Cancer

- Melanoma
- Non-melanoma
- Solar UVR exposure is the principal cause *…and a preventable risk factor.*

William McElligott: the left-hand side of the truck driver's face was exposed to the sun, the other shaded in the cab. Photograph: The New England Journal of Medicine

Don't Be This Guy

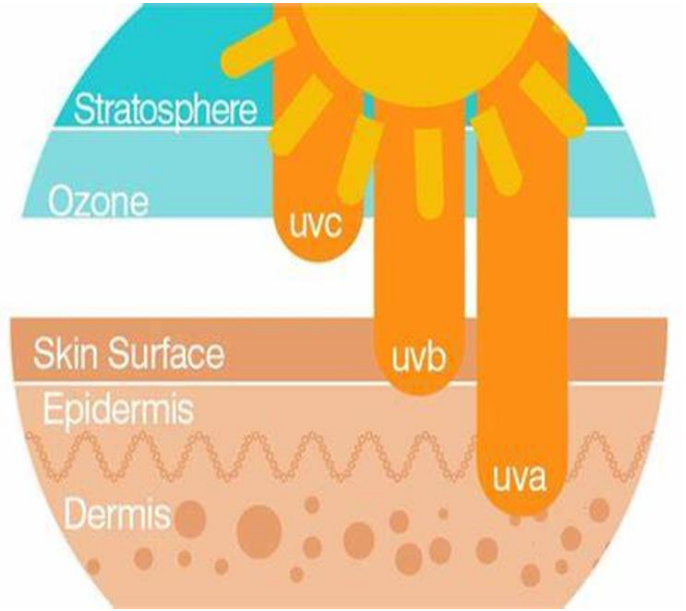
Skin Cancer in Outdoor Workplaces

- Outdoor workers experience a substantial amount of sun exposure.
- Any workers in an industry who are exposed to solar UV for at least **two hours of each working day** are considered at-risk.

Skin Cancer is Most Common Cancer!

- Skin cancer is the most common type of cancer diagnosed in Canada.
- …one-third of all new cases of cancer in the country are skin cancer. (Doctor’s Nova Scotia, May 27, 2022)

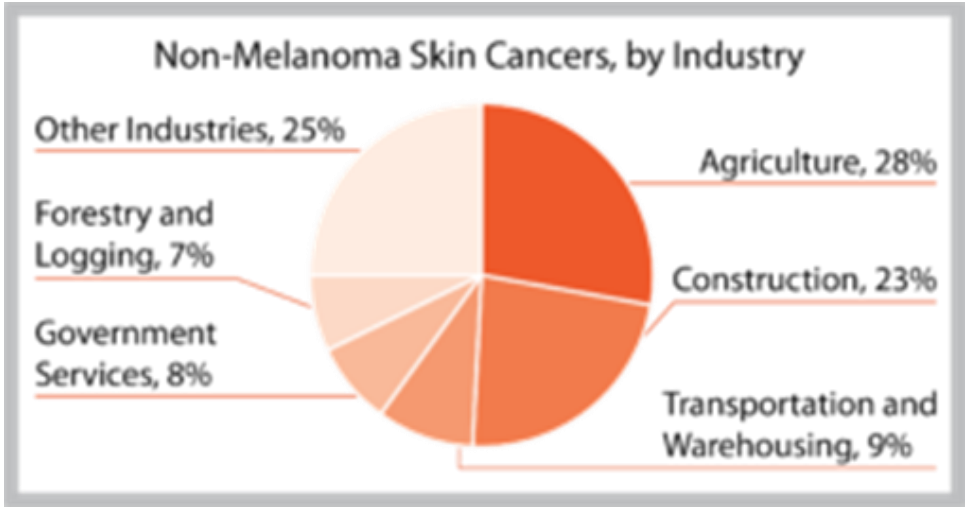
Skin Cancer Risk on PEI

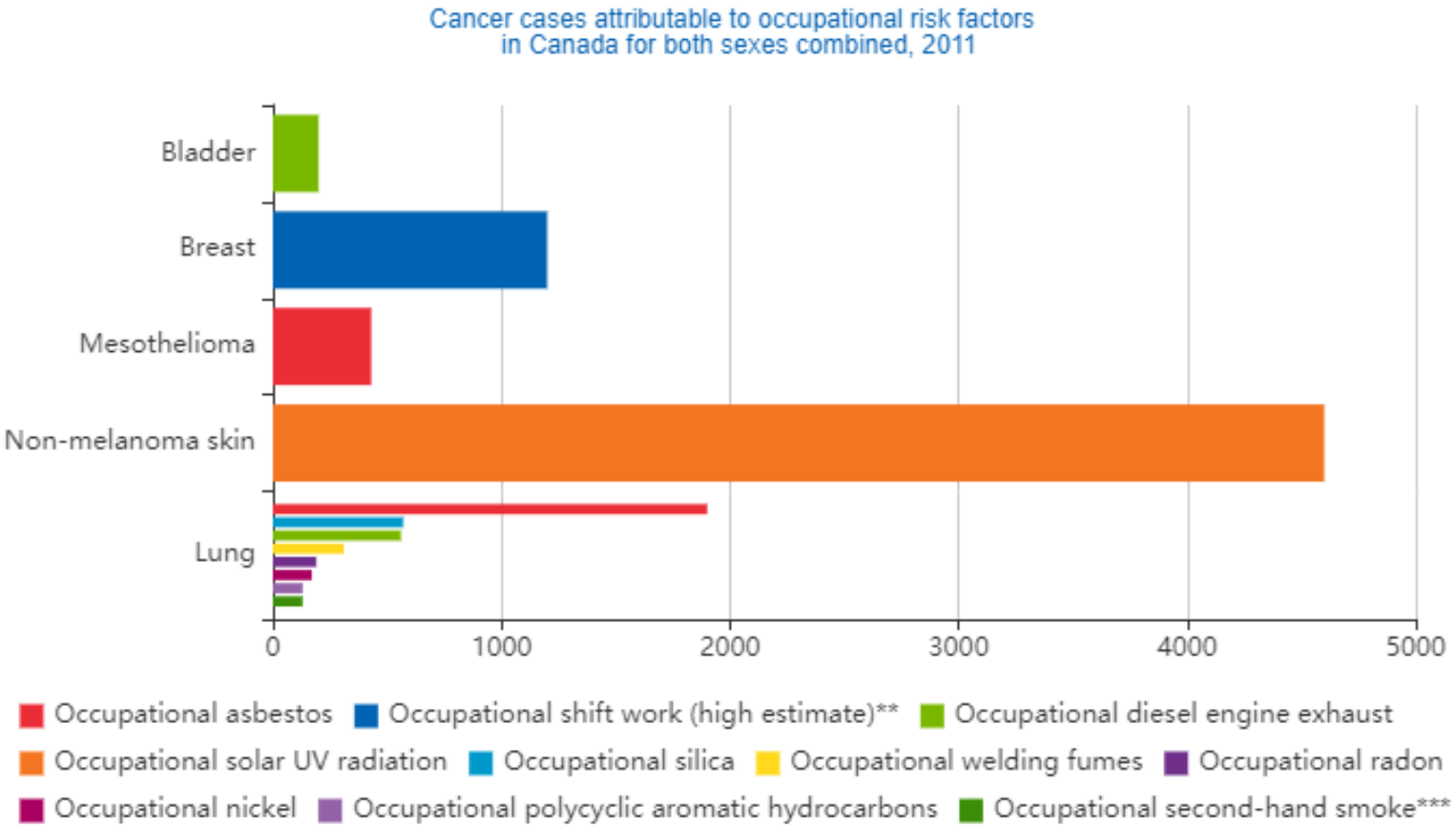


- P.E.I. has the highest rates of melanoma in Canada.
- Males on PEI are at higher risk — twice as many males get melanoma, in comparison to the national average.
- Melanoma is diagnosed less common than other types, but it is the most dangerous (Cdn Dermatology Assoc.)
- It was estimated that 9,000 Canadians would be diagnosed with melanoma skin cancer in 2022.

Outdoor workplace exposures

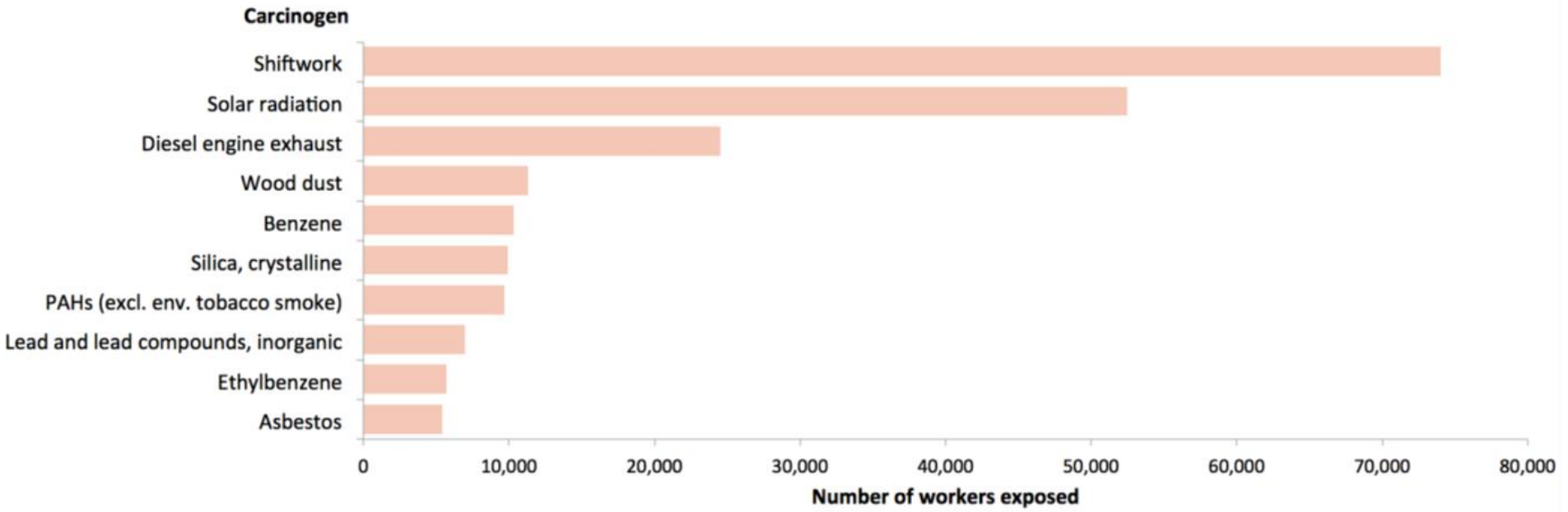
- Occupations with the largest number of exposed workers include:
- Farmers and farm managers
- Construction trades helpers and labourers
- Landscaping and ground maintenance labourers
- Fishing and aquaculture





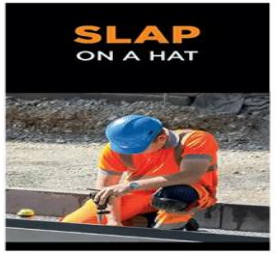
*All results are based on 2011 cancer statistics.
**The results for shiftwork were estimated as a range because research studies are not in agreement on the impact of shiftwork on breast cancer risk.
**Low estimate available in download.
***Second-hand-smoke data only for non-smokers.

Number of Workers Exposed to Cancer causing agents



New Recommendations for Protection

- In 2016, “dermatologists and cancer groups…agreed to a single set of rules.”
- Recommended SPF increased from 15 to 30 or more
- Clothing is better — reach for a shirt before the sunscreen.
- Peak hours are now 11 a.m. to 3 p.m.



Control Measures are needed

- Work in the shade whenever possible
- Avoid working outside in the peak exposure hours when possible
- Cover your skin with clothing
- Wear a hat with a brim and neck flap
- Wear sunscreen with SPF 30 or more
- Wear lip balm with SPF
- Wear eye protection (sunglasses)
- Stay hydrated

Control Measures are needed

- Create safe work procedures and policies
- Make sun safety part of your Occupational Health and Safety program

Sun Safety Resources

Sun Safety at Work website https://sunsafetyatwork.ca/

CAREX https://www.carexcanada.ca/special-topics/sun-safety/

Canadian Dermatology Association

https://dermatology.ca/public-patients/sun-protection/

Health Canada

https://www.canada.ca/en/health-canada/services/sun-safety/sun-safety-basics.html

Sun Safety in Canada

Did you know? over **1.5 million** outdoor workers in Canada are substantially exposed to the sun on the job.*

The largest industrial groups exposed are:*

- construction
- farming
- building care and maintenance

Exposure to ultraviolet radiation (UV) can cause sunburn, premature skin aging, eye damage and skin cancer. Tans and sunburns are signs that UV rays have damaged the skin. This damage can occur quickly and stay with you for life.

Exposure Category	Low	Moderate			High		Very High			Extreme
UV Index	0	2	3	4	5	6	7	8	9	10	11+

The UV index measures the strength of the sun's rays. The higher the number, the greater the need to take precautions. Employers should:

- **Avoid unnecessary exposure of workers to the sun,** especially from **11 am - 3 pm** Use protection when the UV index is **3 or higher.**
- **Use shaded areas,** set up shade structures, or use umbrellas, buildings, trees, or canopies to shield against the sun's rays.
- **Provide access to water.**
- **Encourage breaks in areas where workers can cool down.**

If you employ outdoor workers, sun safety should be part of your health and safety program *

- Develop a sun safety policy
- Involve workers in the design and implementation of the program
- Review current processes for managing sun exposure, and assess the risks
- Implement control measures
- Monitor, review, and take corrective action as necessary

* Resources on developing a sun safety program: sunsafetyatwork.ca

Reduce the risk

Use sunscreen on exposed skin. Apply waterproof sunscreen with a Sun Protection Factor (SPF) of at least 30 that has both UVA and UVB protection to all exposed areas. Re-apply every two hours and after sweating.

Protect your skin on cloudy days and in the winter too, especially in snow or at high altitudes.

Cover and protect your skin with a broad brimmed hat, a lightweight long-sleeved shirt, and long pants. Wear UV-blocking sunglasses to protect your eyes.

Examine the skin regularly for suspicious spots. Check your skin for irregularities such as moles. See a doctor if you have unusual skin conditions that don't heal in four weeks, sore ulcers or a scaly patch on the skin, a white patch on the lips that doesn't heal, or moles that grow quickly, change shape or colour, or bleed repeatedly.

*CAREX Canada, https://www.carexcanada.ca/

CCOHS.ca
Canadian Centre for Occupational Health and Safety

May is Sun Awareness Month

- Check the Canadian Dermatology Association website for promotional materials to help promote sun safety at your workplace beginning May 1, 2023

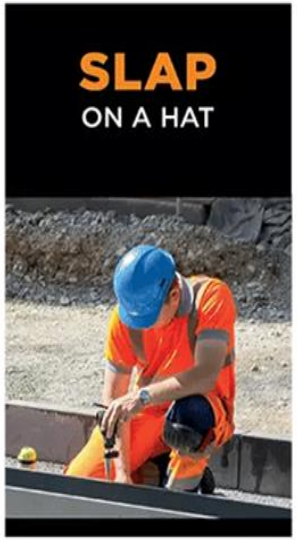
May is Sun Awareness Month

- It is true that some skin types are at higher risk but no skin type is totally immune
- UVA does not cause skin burns but still damages skin as shown in image of truck driver

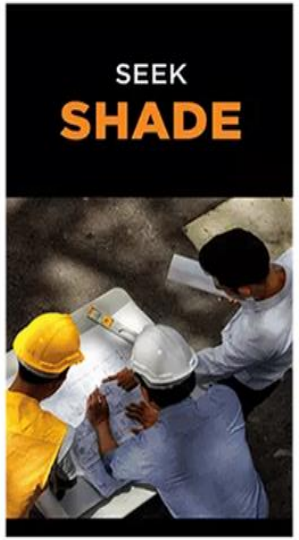
Thank You!


SLIP ON
SUN PROTECTIVE
CLOTHING

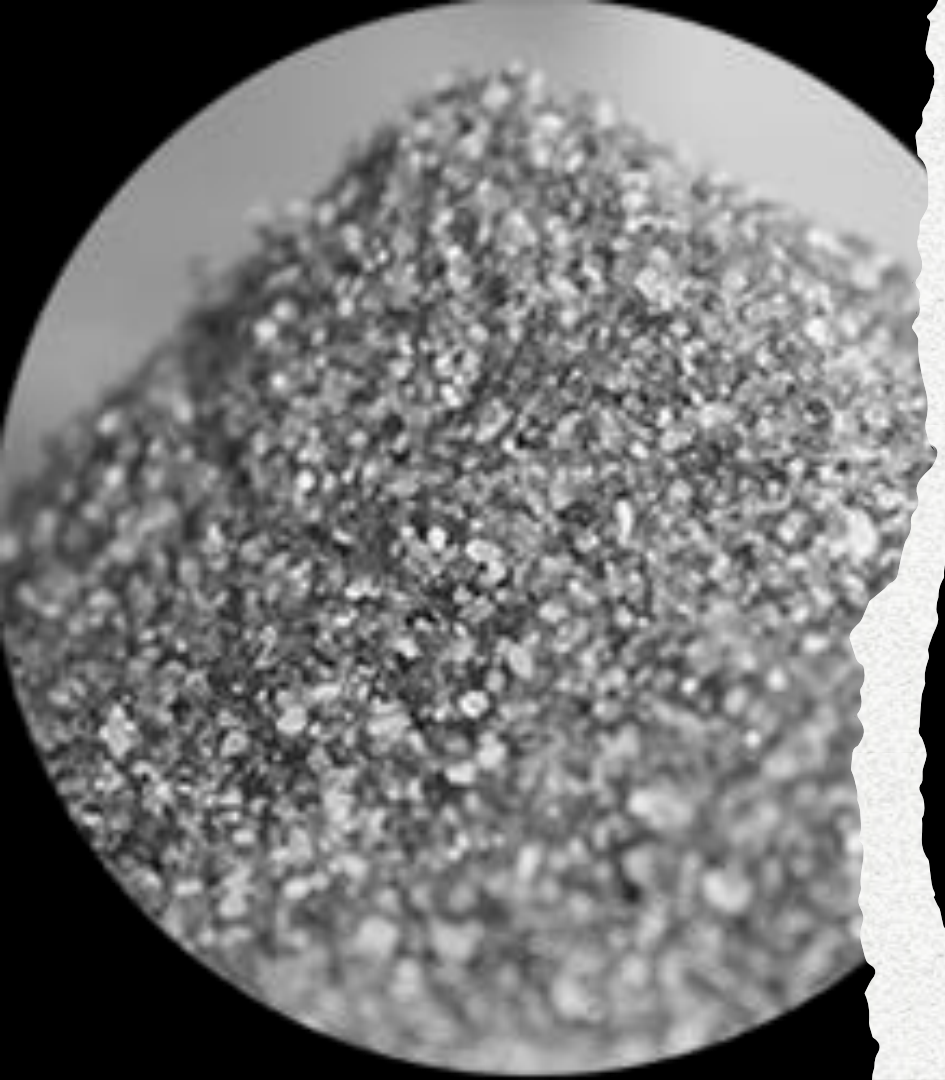

SLOP ON
SPF30 OR HIGHER
SUNSCREEN


SLAP
ON A HAT


SLIDE
ON SOME
SUNGLASSES


SEEK
SHADE


OK 防晒相机



Crystalline Silica

As shown in Table 1, approximately 3,000 cancers diagnosed each year in Ontario are due to occupational exposure to 16 carcinogens commonly found in the workplace (10).

Table 1: Burden of occupational cancer in Ontario

Carcinogen	Annual cancers in Ontario (Note 1)	Currently exposed (Note 2)
Solar UV at work	1400 non-melanoma skin	449,000
Asbestos	630 lung, 140 mesothelioma, 15 laryngeal, <5 ovarian, *additional colorectal and stomach*	52,000
Diesel exhaust	170 lung, *45 bladder*	301,000
Crystalline silica	200 lung	142,000
Welding fumes	100 lung	169,000
Arsenic	20 lung	8,000
Benzene	10 leukemia, <5 multiple myeloma	147,000
PAHs	*60 lung, 15 skin, 30 bladder*	134,000
Shiftwork	*180-460 breast*	833,000
Artificial UV Radiation	5 ocular	48,000
Wood dust	<5 sinonasal, <5 nasopharyngeal	92,000
Formaldehyde	<5 leukemia, <5 sinonasal, <5 nasopharyngeal	63,000

Crystalline silica	200 lung	142,000
Welding fumes	100 lung	169,000

Many respiratory hazards cannot be seen by the naked eye

And many ill health effects don't appear until many years later

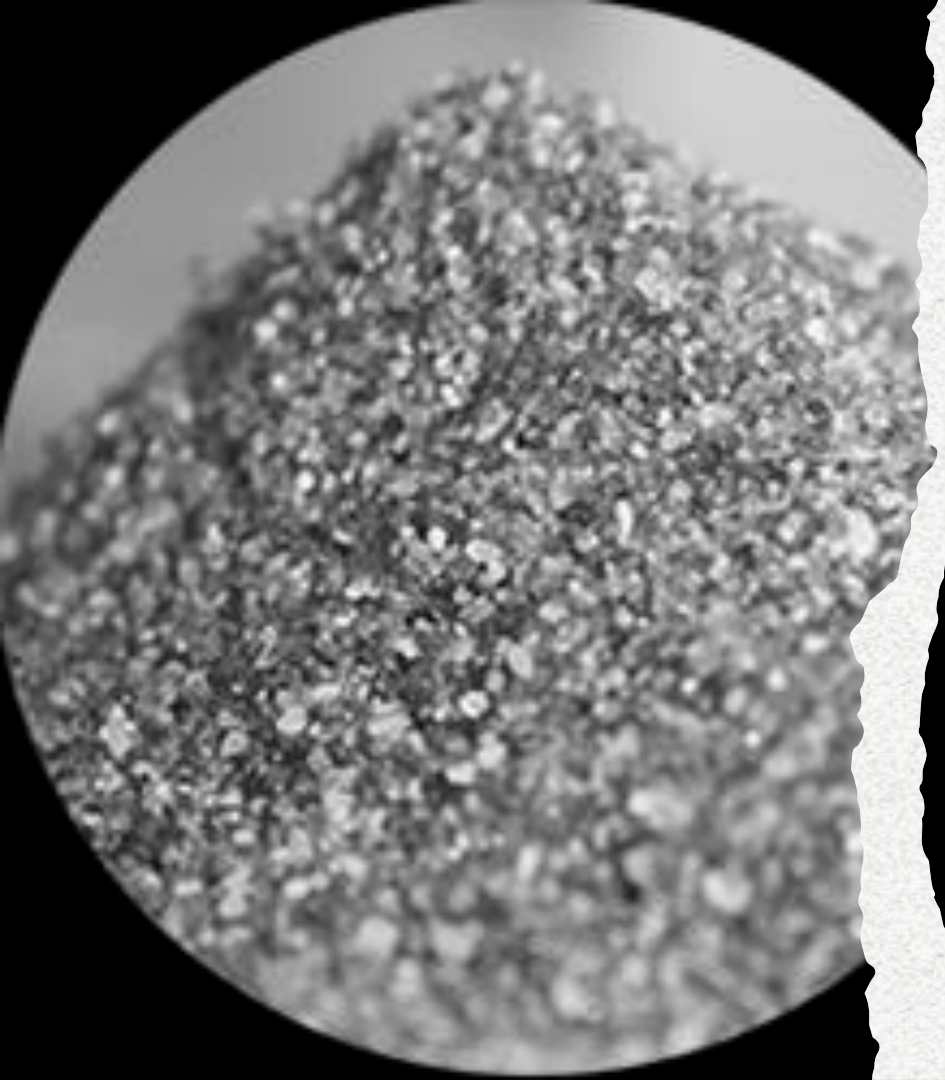
19,976#

LOST TIME CLAIMS IN 2021

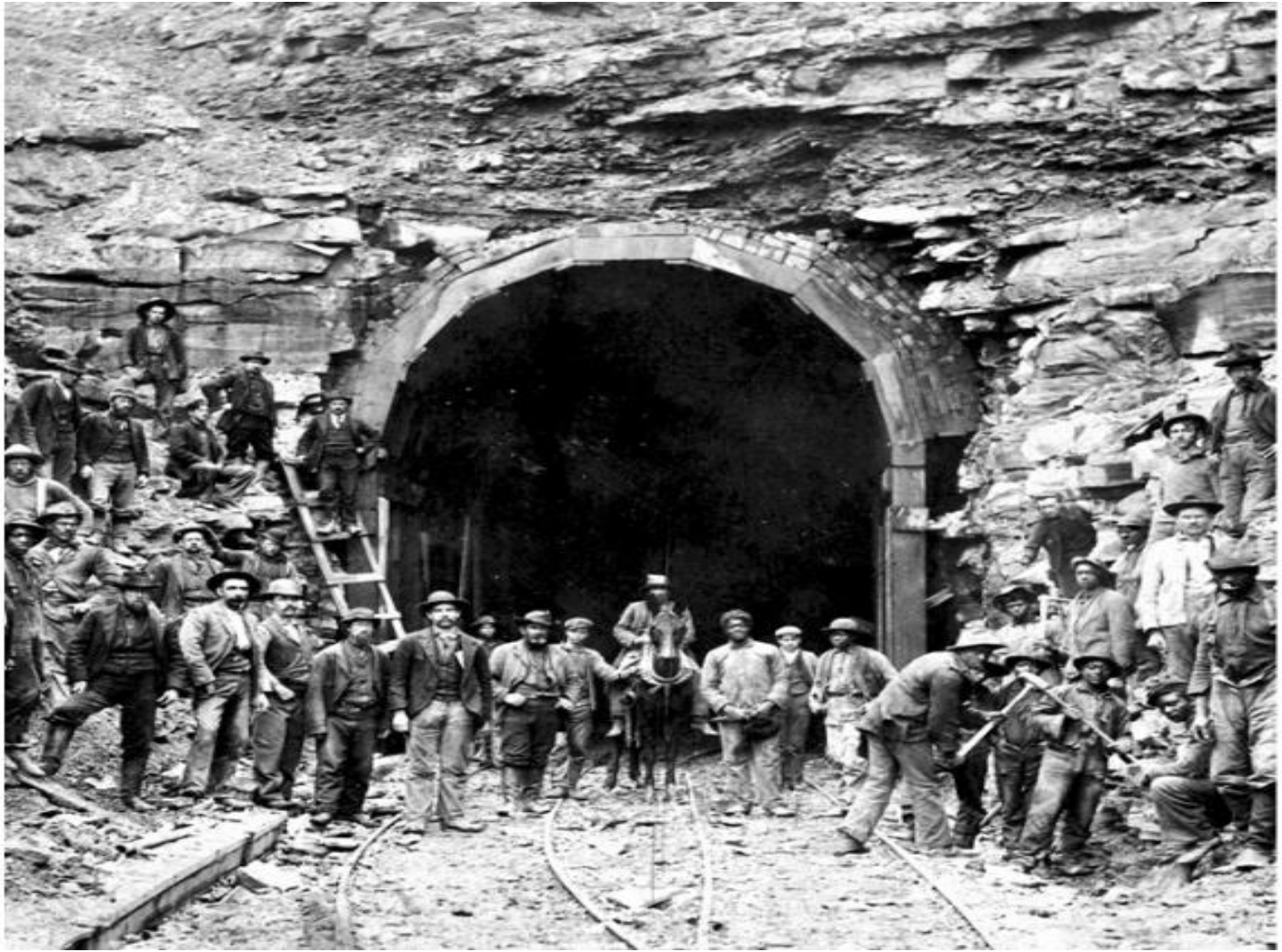
Source: Association of Workers' Compensation Boards of Canada, National Work Injury/Disease Statistics Program (NWISP)

50%

HIGHER LUNG CANCER MORTALITIES AMONG CONSTRUCTION WORKERS THAN AMONG THE GENERAL POPULATION



Crystalline Silica



What are the signs & symptoms?

Type	Timing	Symptoms
Acute silicosis	Within a few weeks or years of silica exposure	Cough, Weight loss Tiredness, Sharp chest pain, Breathlessness
Chronic silicosis	10 to 30 years after silica exposure	Inflamed lungs, Fluid build-up Breathlessness, Low blood oxygen
Accelerated silicosis	Within 10 years of frequent silica exposure	Swelling in the lungs, Swelling in the chest lymph nodes, Difficulty breathing

Silicosis

https://www.worksafebc.com/en/resources/health-safety/videos/silica-exposure?lang=en

Silicosis ≠ Lung Cancer

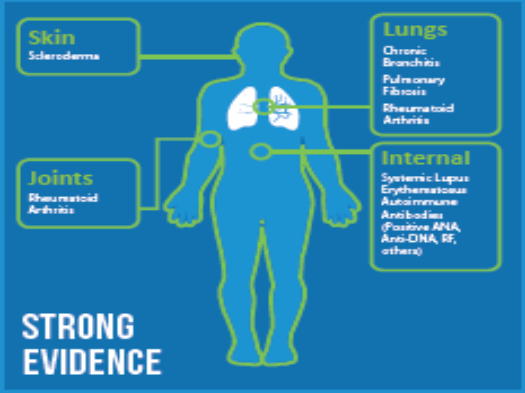
Theories

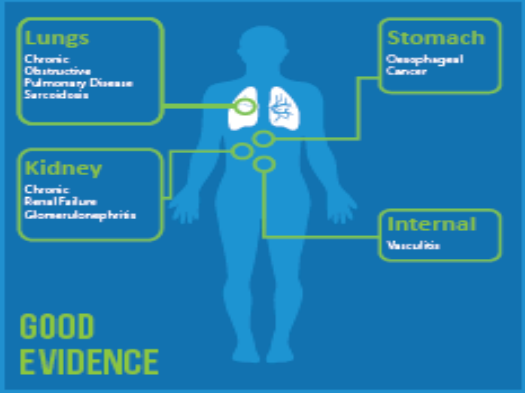
- Reactive oxygen in freshly fractured silica
- Direct DNA binding with silica particles
- Silica induces cellular mutations
- Silicosis undiagnosed

570 PEOPLE GET LUNG CANCER ATTRIBUTED TO SILICA DUST YEARLY IN CANADA

380,000 WORKERS (ESTIMATE) — RESPIRABLE CRYSTALLINE SILICA EXPOSURE **BY CANADIAN INDUSTRY**

Five largest exposure groups	Numbers potentially exposed	
Construction trade contractors (specialists)	141,000	24%
Building construction	65,000	17%
Heavy and civil engineering construction	31,000	27%
Metal ore mining	9,800	32%
Cement and concrete product manufacturing	9,300	30%





AN ESTIMATED 46,000+ DIE WORLDWIDE FROM SILICOSIS & SILICA DUST RELATED DISEASES.

SILICOSIS RESEARCH

www.silicosisresearch.ca

Crystalline Silica (R)

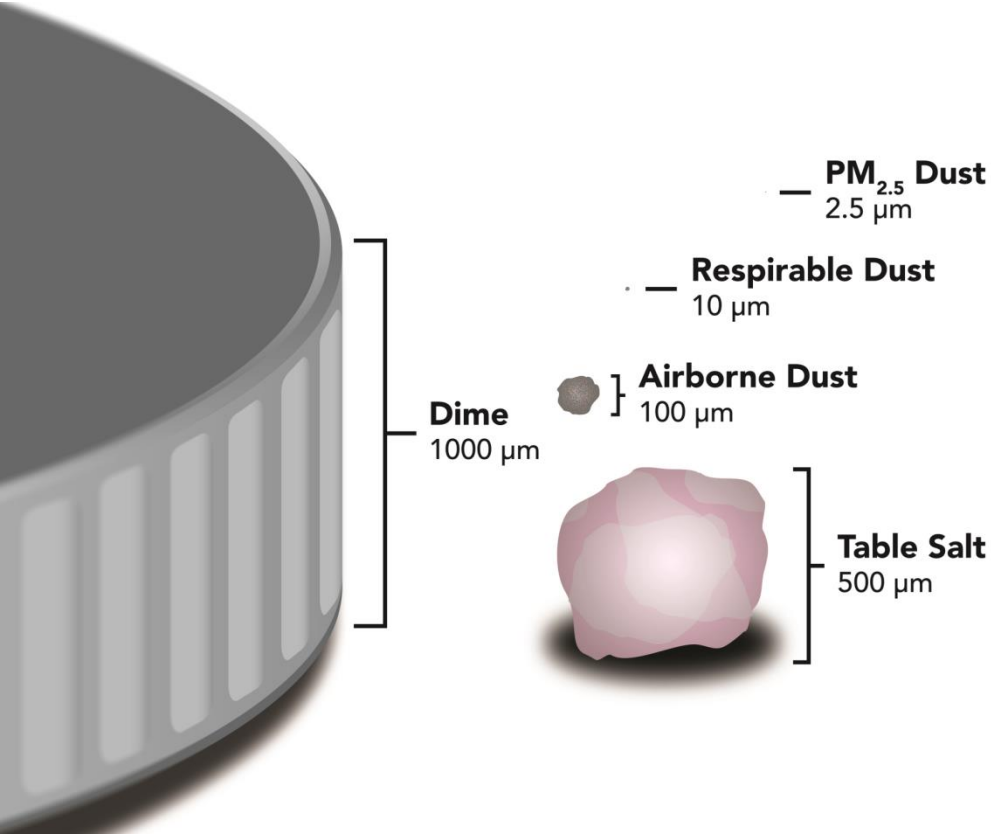
PEI Occupational Health & Safety General Regulations, PART 11.3

…threshold limit values specified by the American Conference of Governmental Industrial Hygienists (ACGIH)…

- Crystalline Silica **(Respirable)**

$$0.025\ mg/m^3$$

Respirable mg/m^3




GilAir3
Personal Air Sampler
Flow
4
3
2
1
WARNING
Possible static hazard. Do not rub with dry cloth. Substitution of components may impair intrinsic safety. Use only specified GilAir-3 battery packs. See Labeling for intrinsic safety approvals.
SENSIDYNE
PG1635

Prevention

- BC Construction Safety Association Silica Tool
- Hazard assessment tool based on **sampling data**
- Exposure Control Plan

Repoint grinding (4 – 8 hrs)

NO Engineering Control	Integrated LEV
1.934 mg/m^3	0.162 mg/m^3
7736%	648%
Full Face PAPR N100/P100 (PF 100)	Half face N100/P100 (PF 10)

Dust Reduction 92%

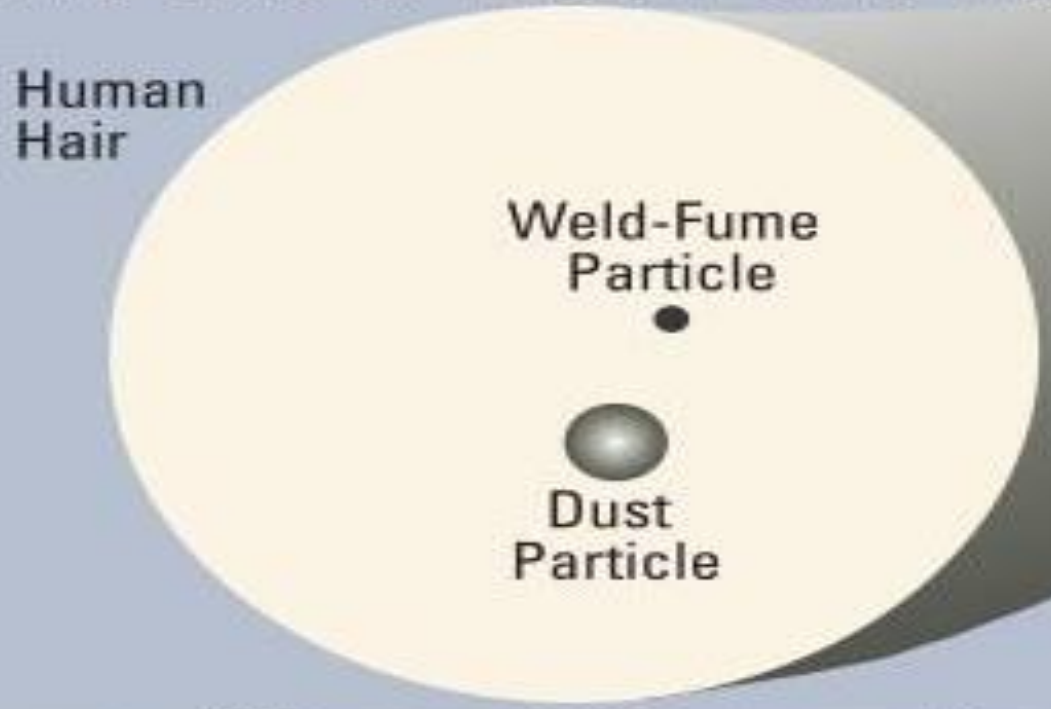
Administrative Controls

- Maintenance of Tools
- Housekeeping
- Decontamination
- Training on silica safety, instruction
- Planning for emergency
- Work shift scheduling
- Barriers
- Enclosures

Welding Fume


2F

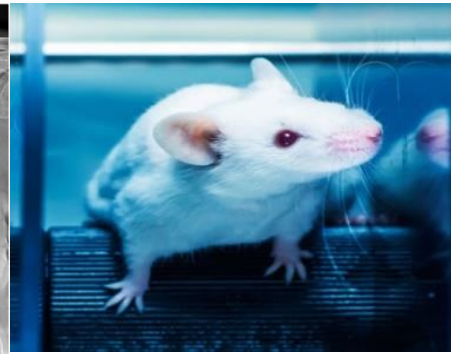
Relative Size of Weld-Fume Particles



Weld-fume particles come from consumable electrodes, molten puddles, shielding gases, base metals, or previously applied paint/surface coatings.

Chemicals - studied by health professionals (e.g. toxicologists, epidemiology)

ACGIH®



What's in Welding Fume?

Irritant	**Aluminum**
Metal Fume Fever	**Beryllium**
Kidney Damage	**Cadmium Ox**
Risk of Lung Cancer	**Chromium**
Metal Fume Fever	**Copper**
Irritant	**Fluorides**
Siderosis	**Iron Oxides**
Poison	**Lead**
Metal Fume Fever / CNS	**Manganese**
Irritant	**Molybdenum**
Irritant / Dermatitis	**Nickel**
Bronchitis	**Vanadium**
Metal Fume Fever	**Zinc**
Various – depends on gas	**Gases**

Welding & Cancer

- Monograph 118: **Welding**, Molybdenum Trioxide, and Indium Tin Oxide (IARC/18)
- Group 1 Carcinogen
- **ALL welding fume is classified as a Group 1** carcinogen
  - Hexavalent chromium in aluminum alloys
  - Iron oxide in ferrous alloys as agents of concern

International Agency on Research in Cancer

- 45 studies representing over 16 million workers. Found that welders are **43 per cent more likely to develop lung cancer than workers who have never worked as welders** and not been exposed to welding fumes.
  - Regardless of steel being welded and method of welding being used.
  - Accounted for factors such as tobacco smoking or exposure to asbestos.
  - Risk increased with time as welder.

IARC

Who is Impacted?

More than 300,000 Canadians may be exposed to welding fumes in their workplaces (CAREX Canada)

- Welding happens in all industry sectors:
  - Welding trade contractors
  - Repair and maintenance
  - Construction
  - Oil or gas
  - Manufacturing

Welding Ventilation


3M
Science.
Applied to Life.™

Thank-you!

www.surveymonkey.com/r/ohsconference