



Occupational
Cancer
Research
Centre

Occupational Cancer and the Research Program of the OCRC and CAREX Canada

Paul A. Demers, PhD

CHSI Research Exchange Series

October 18th, 2011

Outline



- An Overview of the Major Occupational Carcinogens
- The Occupational Cancer Research Centre and its Research Program
- CAREX Canada

Scrotal Cancer among Chimney Sweeps

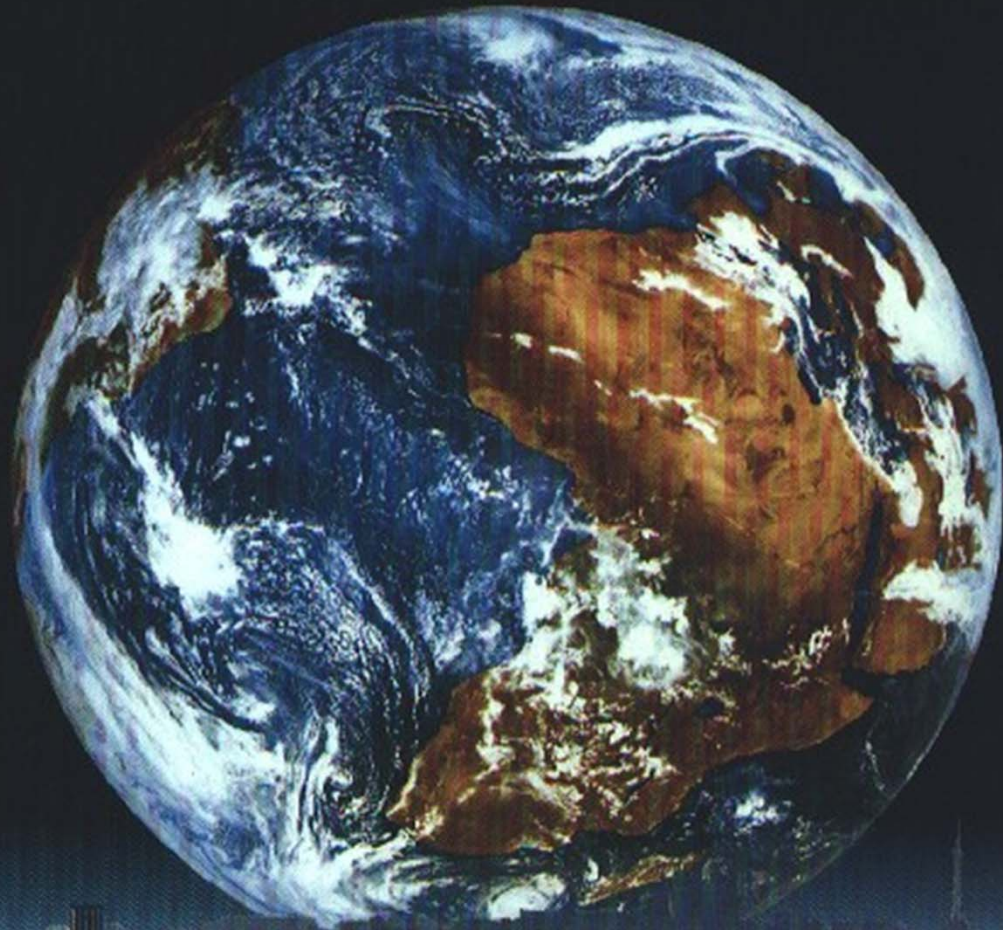


- Percival Pott (1775) linked scrotal cancer in chimney sweeps to the nature of their work and their exposure to cancer causing agents in soot
- He was the first to identify an occupational carcinogen
- Finally in 1840's laws were passed prohibiting young boys from performing the work

**INTERNATIONAL
AGENCY FOR
RESEARCH ON
CANCER**



WORLD
HEALTH
ORGANIZATION



IARC Monograph Evaluations

IARC Classification of Carcinogens

Group	Classification	Agents
1	Carcinogenic to Humans	107
2A	Probably Carcinogenic	59
2B	Possibly Carcinogenic	267
3	Unclassifiable	508
4	Probably Not Carcinogenic	1

What do we Know about Occupational Carcinogens?



- ~ **60** definite or probable workplace carcinogens (IARC 1 and 2A)
- Over **100** additional workplace exposures are possible carcinogens (IARC 2B)
- Many other workplace exposures with a suspicion of human carcinogenicity
- Even greater number of workplace substances with little formal evaluation

CAREX Canada Priority Occupational Carcinogens (IARC Classification, cancers)

Industrial Chemicals

Aromatic amines (1, bladder)

1,3-Butadiene (1, lymphohemaetopoietic)

TCDD (dioxins) (1, all cancers)

Benzene (1, leukemia, *multiple myeloma?*
non-Hodgkin's lymphoma?)

Formaldehyde (1, nasopharynx, leukemia,
sinonasal?)

Vinyl chloride monomer (1, liver)

Ethylene oxide (1, lymphoid?, breast?)

Polychlorinated Biphenyls (PCBs)(1/2A, ?)

| Acrylamide (2A), Epichlorohydrin (2A), many



CAREX Canada Priority Occupational Carcinogens (IARC Classification, Cancers)

Metals

Arsenic & compounds (1, lung, bladder, *kidney?, liver?, prostate?*)

Beryllium and compounds (1, lung)

Cadmium & compounds (1, lung, *prostate?, kidney?*)

Chromium, hexavalent (1, lung, *sinonasal?*)

Nickel & compounds (1, lung, *sinonasal*)

Lead & compounds (2A/2B), Antimony trioxide (2B), Cobalt (2A/2B)



CAREX Canada Priority Occupational Carcinogens (IARC Classification, Cancers)

Dust and Fibres

Asbestos (1, lung, mesothelioma, larynx, ovary, pharynx?, *colorectal?*, *stomach?*)

Erionite (1, mesothelioma)

Silica (1, lung)

Wood Dust (1, sinonasal, nasopharynx)

Leather Dust (1, sinonasal)



CAREX Canada Priority Occupational Carcinogens (IARC Classification, cancers)

Radiation

X-radiation, gamma-radiation (1, lung, breast, leukemia, many others)

Radon decay products (1, lung)

Plutonium (1, lung liver, bone)

Solar radiation (1, skin)

UV Tanning Devices (1, skin & eye melanoma)

Magnetic fields (ELF)(2B)



CAREX Canada Priority Occupational Carcinogens (IARC Classification, cancers)

Combustion Products and Others

Polycyclic aromatic hydrocarbon related exposures (mix of 1/2A/2B, lung, skin, bladder)

Mineral oils (1, skin)

Diesel Exhaust (2A, lung?)

Environmental Tobacco Smoke (1, lung)

Antineoplastic Agents (1/2A, leukemia, bladder)

Shiftwork at Night (2A, breast?)



CAREX Canada Priority Occupational Carcinogens (IARC Classification)

Chlorinated Solvents

Tetrachloroethylene (2A)

Trichloroethylene (2A)

1,2 – Dichloroethane (2B)

Dichloromethane (2B)

Chloroform (2B)



CAREX Canada Priority Occupational Carcinogens (IARC Classification)

Pesticides

Chlorophenoxy Herbicides
(2,4-D, MCPA, MCPP)(2B)

Chlorothalonil (2B)

Dichlorvos (2B)

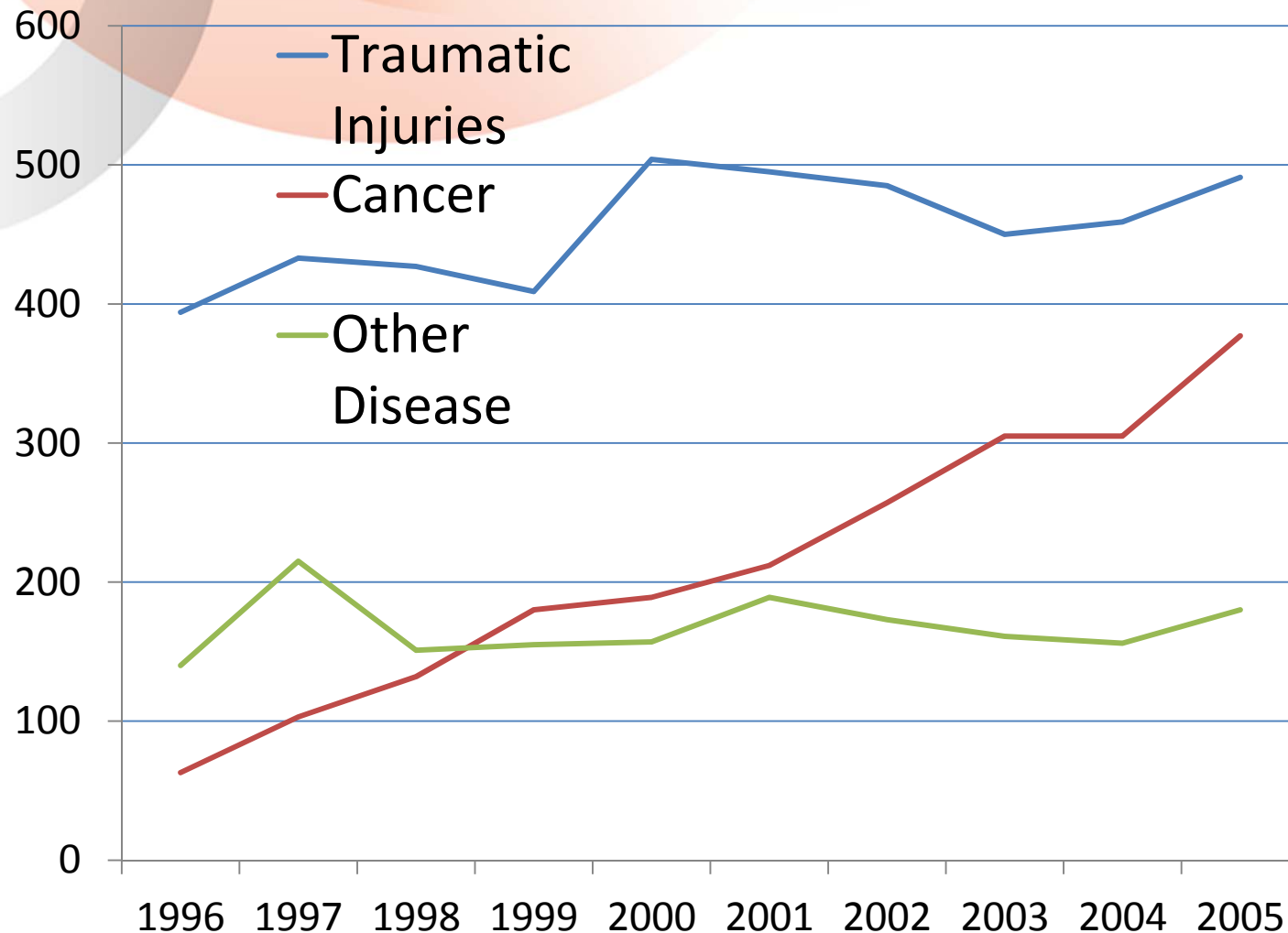
Lindane (2B)

Pentachlorophenol (2B)

Atrazine (3)

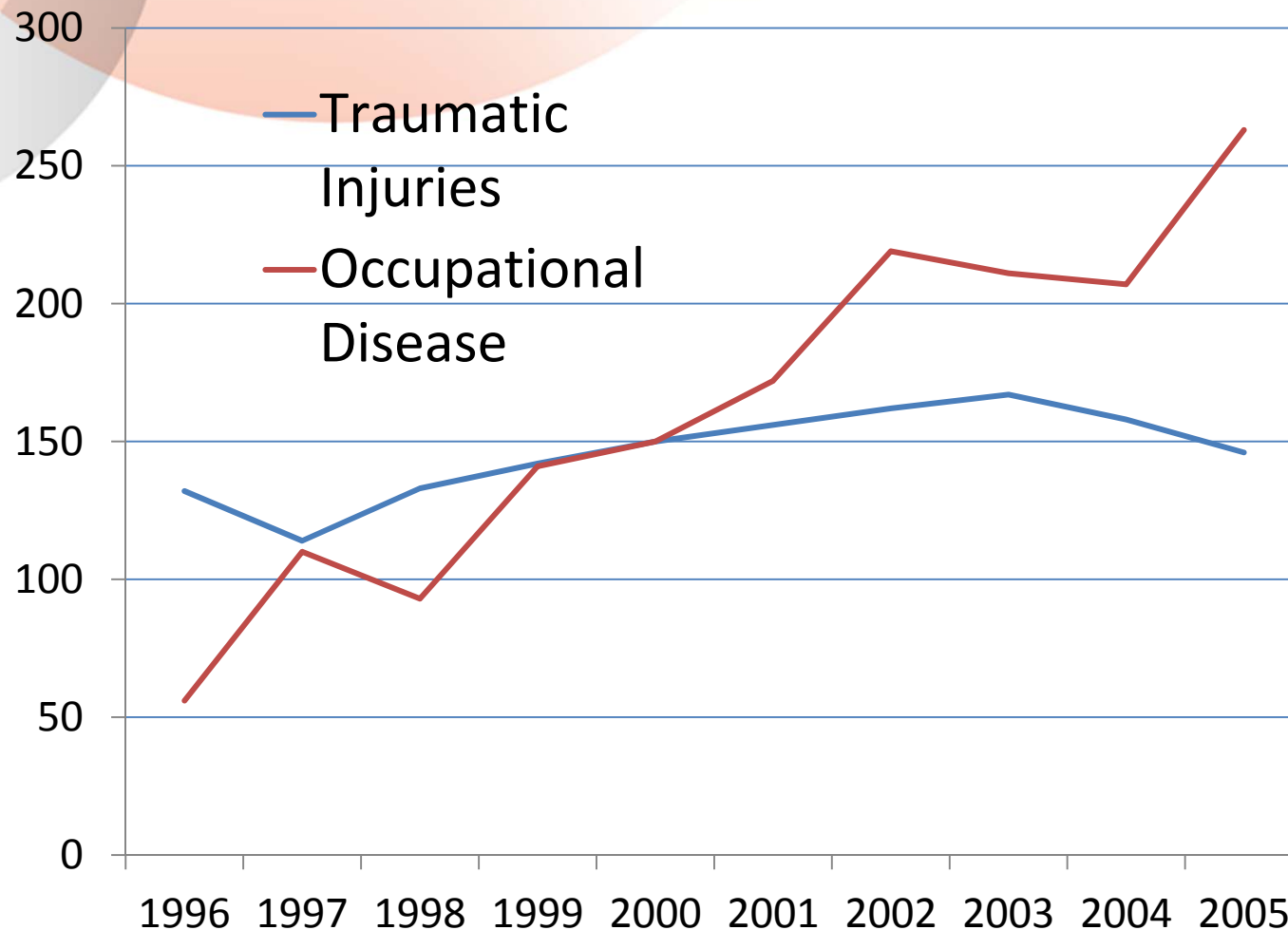


Accepted Claims for Workplace Fatalities: Canada



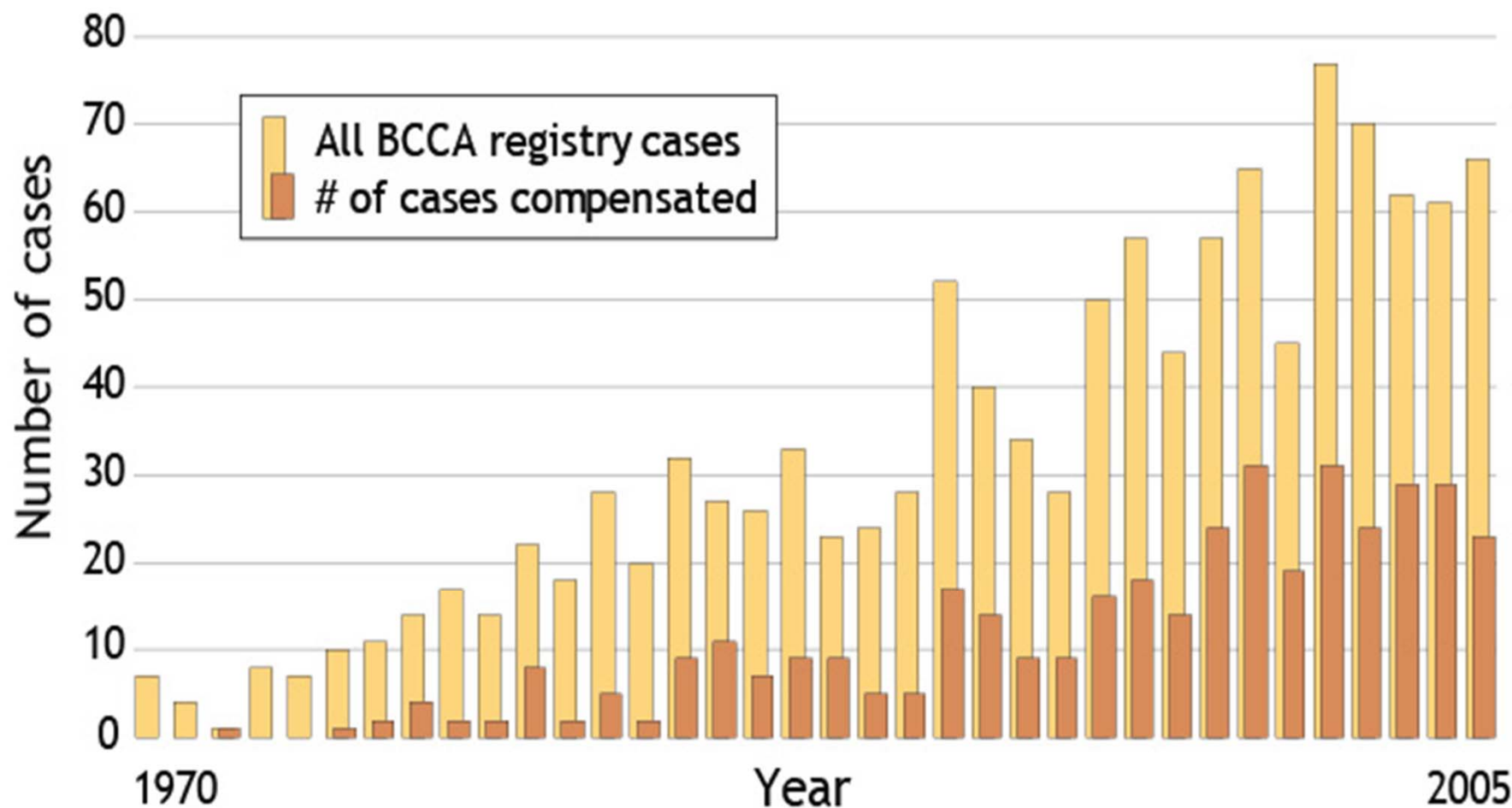
Centre for the Study of Living Standards. Five Deaths a day: Workplace fatalities in Canada 1993-2005. CSLS Paper 2006-04 Ottawa, 2006. [Towards a cancer-free workplace](#)

Accepted Claims for Workplace Fatalities: Ontario



Centre for the Study of Living Standards. Five Deaths a day: Workplace fatalities in Canada 1993-2005. CSLS Paper 2006-04 Ottawa, 2006. [Towards a cancer-free workplace](#)

Mesothelioma Cases, 1970-2005



Estimated Burden of Occupational Cancer from Various Studies



Author and Location		Attributable Fraction (%) By Cancer Site and Gender					
		Lung	Leukemia	Bladder	Skin (NMSC)	Nasal	Total
Nurminen et al (2001) Finland	Male	29	19	14	13.1	24	14
	Female	5	2.5	0.7	3.8	6.7	2
Steenland et al (2003) United States	Male	8-19	0.8-3	6-19	1.2-6	31-43	3-7
	Female	2	0.8-3	6-19	-	-	0.8-1
Rushton et al (2010) United Kingdom	Male	21	0.9	7.1	7.1	46.0	8.2
	Female	5	0.5	1.9	1.1	20.1	2.3
Alberta Health Services, AHS (2010), Alberta	Male	6-33	1.8-19	1.2-27	1.2-13.1	24-64.3	3-14
	Female	1-6	0.5-3	0.4-19	3-3.8	2-18.4	0.1-2

Funding for Cancer Research in Canada: 2005-2007*



- Funding from 37 federal, provincial, and voluntary programs (does not include WCB's) for cancer research
 - Funding for all cancer research: \$1,143 million
 - Risk and prevention research: \$122.3 million (10.7%)
 - Occupational cancer \$1.3 million (0.11%)
- 2008: CAREX Canada funded by CPAC: \$4.2 million
- 2009: Occupational Cancer Research Centre funded by WSIB, Canadian Cancer Society, Cancer Care Ontario: \$4.6 million

* Investment in Cancer Risk and Prevention Research, 2005-2007.
Canadian Cancer Research Alliance. May, 2010



Occupational
Cancer
Research
Centre

Occupational Cancer Research Centre

A partnership for the prevention of occupational cancer

Funded in 2009 to:

1. Build an occupational cancer research program
2. Build research capacity in Ontario
3. Deliver and exchange knowledge
4. Build a sustainable centre



OCRC Vision, Mandate & Scope



Occupational
Cancer
Research
Centre

VISION

The prevention of occupational cancer through the identification and elimination of exposures to carcinogens in the workplace

MANDATE

- Conduct research on occupational cancer and carcinogens
- Bridge occupational, environmental, and public health
- Build research capacity

SCOPE

- Ontario-wide focus
- Nationally/internationally networked
- Multi-disciplinary approach
- Applied research

Occupational Cancer Research Centre

- Based at Cancer Care Ontario
- Current staff:
 - Director
 - Associate Director
 - 5 other affiliated scientists (working on one or more OCRC projects)
 - 5 research associates (2 additional being recruited)
 - Administrative Assistant (being recruited)
- Current trainees:
 - 5 student research assistants
 - 1 post-doctoral fellow

The OCRC's Research Program



Three focus areas:

1. Identification of causes of cancer in the workplace
2. Surveillance of occupational cancers & workplace exposures
3. Intervention research to develop & evaluate prevention & exposure reduction strategies

OCRC Stakeholder Needs Assessment Survey

Most frequently identified exposures



Exposure category	Examples of commonly listed exposures	Frequency
Chemicals	Formaldehyde, amines, PCB, sulphuric acid mists...	30
Dusts and fibres	Asbestos, fibreglass, silica, wood dust, carbon black	27
Radiation	Electromagnetic fields, nuclear, cell phone, solar, ionizing radiation, radiofrequency radiation, WIFI...	24
Lifestyle factors	Smoking, physical activity, stress, diet, alcohol	18
Shiftwork	--	16
Pesticides	--	15
Nanomaterials	--	14
Exhaust	Diesel, gasoline	14
Metals	Uranium, chromium, cobalt, gold, nickel, smelter fumes, tungsten, welding fumes, lead	13
Work environment	Indoor air, environmental tobacco smoke, mould	12
Solvents	Solvents (general), benzene, trichloroethylene...	9
Fossil fuels & oils	Metal working fluid, oil mists, coal tar, fuel, asphalt	7
Pharmaceuticals	Antineoplastic drugs, cytotoxic drugs	4

Hohenadel et al. Priority issues in occupational cancer research: Ontario stakeholder perspectives. *Chron Dis Can* 2011;31(4):147-51.

ACS/NIOSH/IARC Top 20 Priorities



Ultrafine particles

Titanium dioxide
Carbon black
Diesel Engine Exhaust
Welding fumes

Metals

Lead & lead compounds
Indium phosphide
Metallic cobalt

Pesticides

Atrazine

Shiftwork

Chlorinated solvents

Trichloroethylene
Perchloroethylene
Methylene chloride
Chloroform

Other Chemicals

Formaldehyde
Styrene & Styrene-7,8-Oxide
Acetaldehyde
Propylene Oxide
Polychlorinated Biphenyls (PCBs)
Di (2-ethylhexyl) phthalate (DEHP)

Ward EM, Schulte PA, Straif K, et al. Research Recommendations for Selected IARC-Classified Agents. Environmental Health Perspectives 2010;119(10):1355-1362.

Towards a cancer-free workplace

IARC Evaluation Priorities 2010-2014



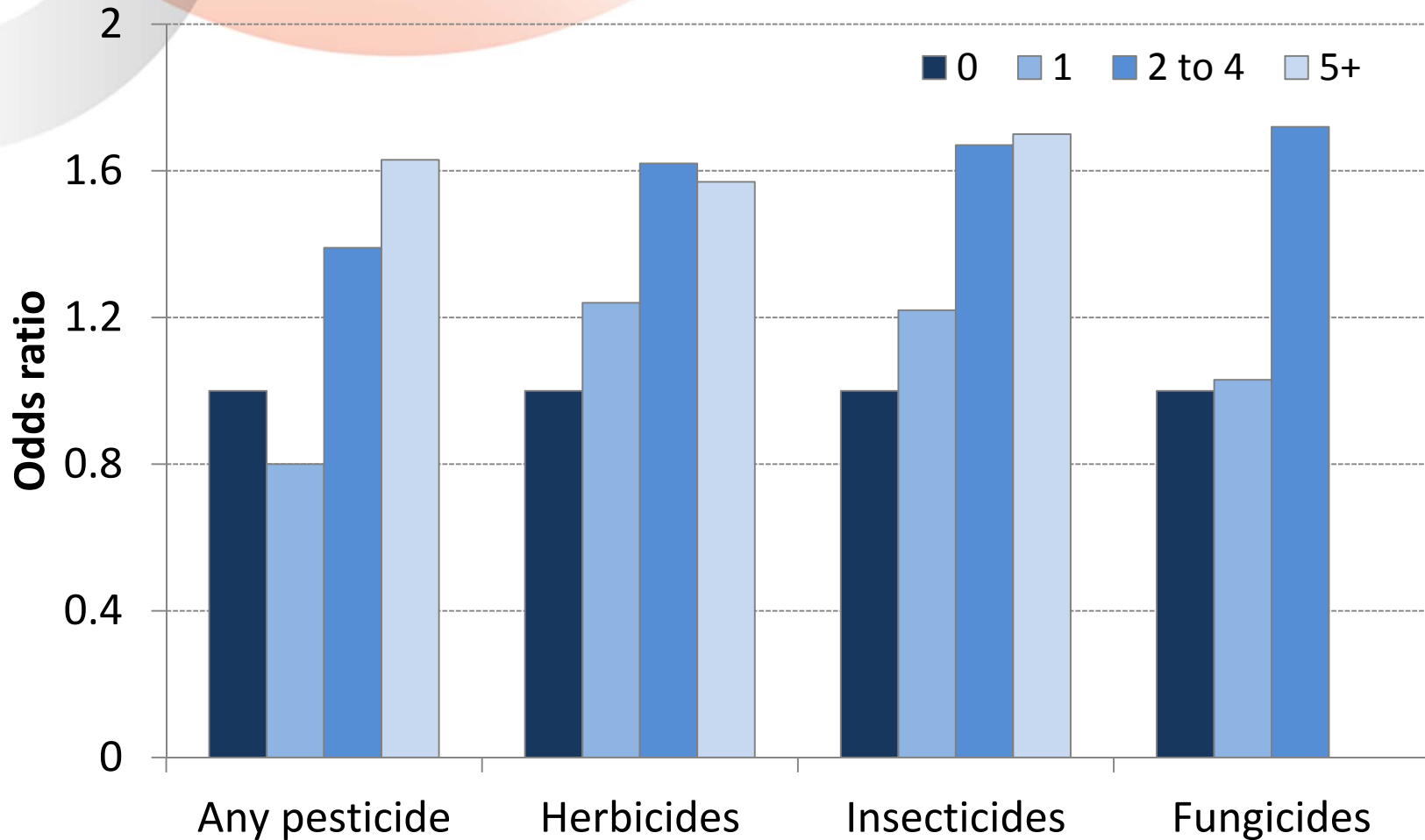
High Priorities (occupational)	Medium priorities (occupational)
Asphalt & bitumen	Atrazine
Carbon-based nanoparticles	Metalworking fluids & lubricants
Crystalline fibres other than asbestos	N-Nitrosamines
Ultrafine particles	Polybrominated biphenyls (PBB)
Motor vehicle exhaust emissions	Polybrominated diphenyl ethers (PBDE)
Perfluorinated compounds (e.g. PFOA)	Polychlorinated biphenyls (PCB)
Radiofrequency electromagnetic fields	DEHP and other phthalates
Sedentary work	Styrene
Stress	Trichloroethylene & other chlorinated solvents
Iron & iron oxides	
Welding	

Report of the Advisory Group to Recommend Priorities for *IARC Monographs* during 2010–2014. IARC, Internal Report 08/001. Lyon, France, 2008

Epidemiologic Studies the Causes of Cancer

- Cross-Canada study of pesticides
 - Analyses of the risk of Non-Hodgkin's and Hodgkin's lymphoma as well as multiple myeloma in collaboration with the U.S. NCI
- Ontario uranium miner cohort
 - Reanalysis after linkage with national mortality and cancer incidence files in collaboration with CNSC
- Toronto lung cancer case-control study
 - New analyses and collaboration with the international Synergy project coordinated by IARC
- Occupational exposure to diesel and gasoline engine emissions and the incidence of colorectal and bladder cancer in Canadian men
 - New analyses using data from the National Enhanced Cancer Surveillance System

Effect of exposure to multiple pesticides overall and by pesticide type on NHL



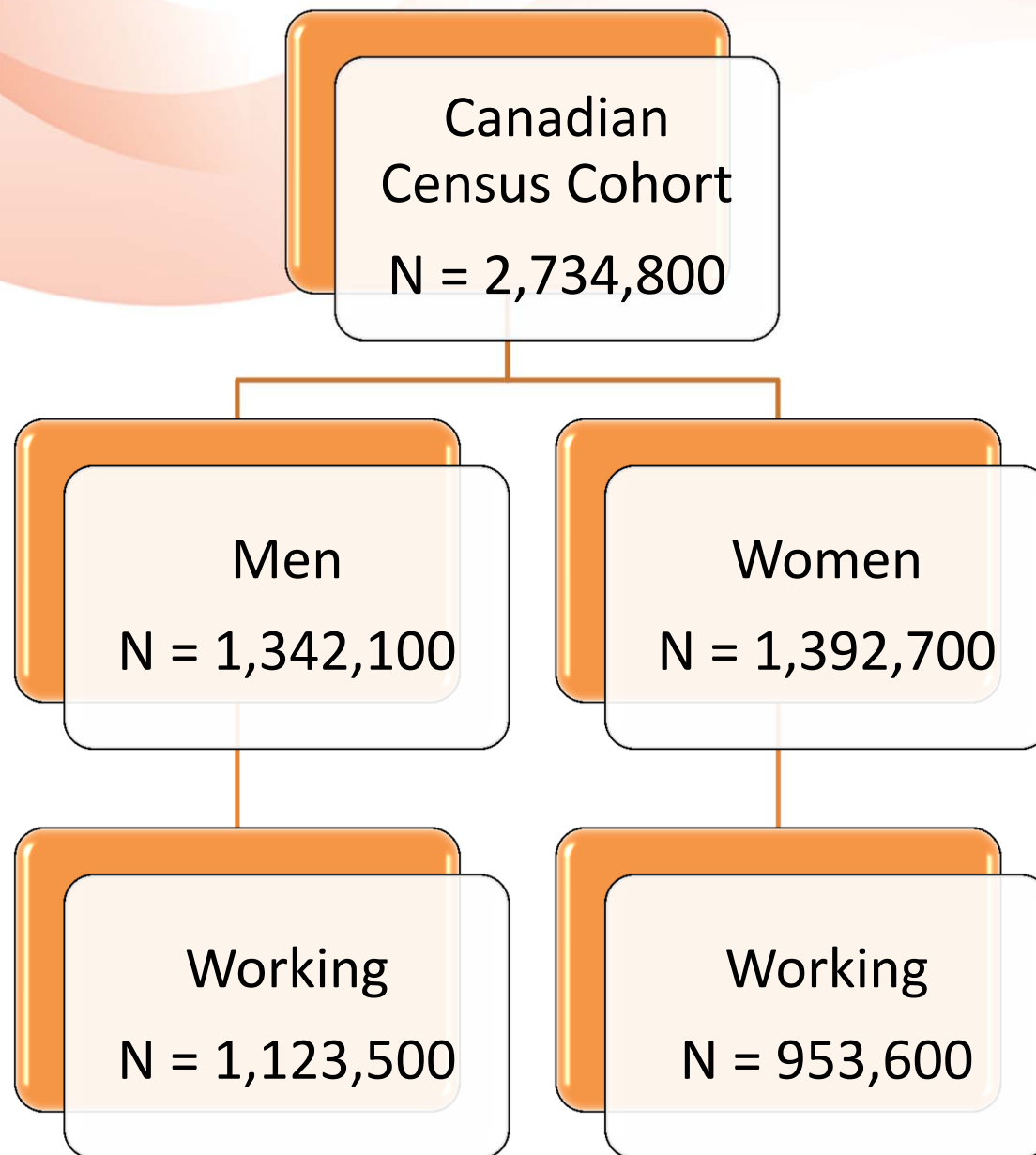
Surveillance of Occupational Cancer & Carcinogens

- Linkage of 1991 Census (20% sample) with tumour registry data in collaboration with Statistics Canada
- Development of an Occupational Cancer surveillance Program for Ontario
- Mesothelioma patterns and projections in Ontario and Canada
- Sinonasal cancer surveillance and exposure to sinonasal carcinogens in Ontario
- Cancer Among Nordic Firefighters in collaboration with the Nordic Occupational Cancer Group (NOCCA)
- Analyses of the Ontario MoL exposure database (MESU) in collaboration with CAREX Canada

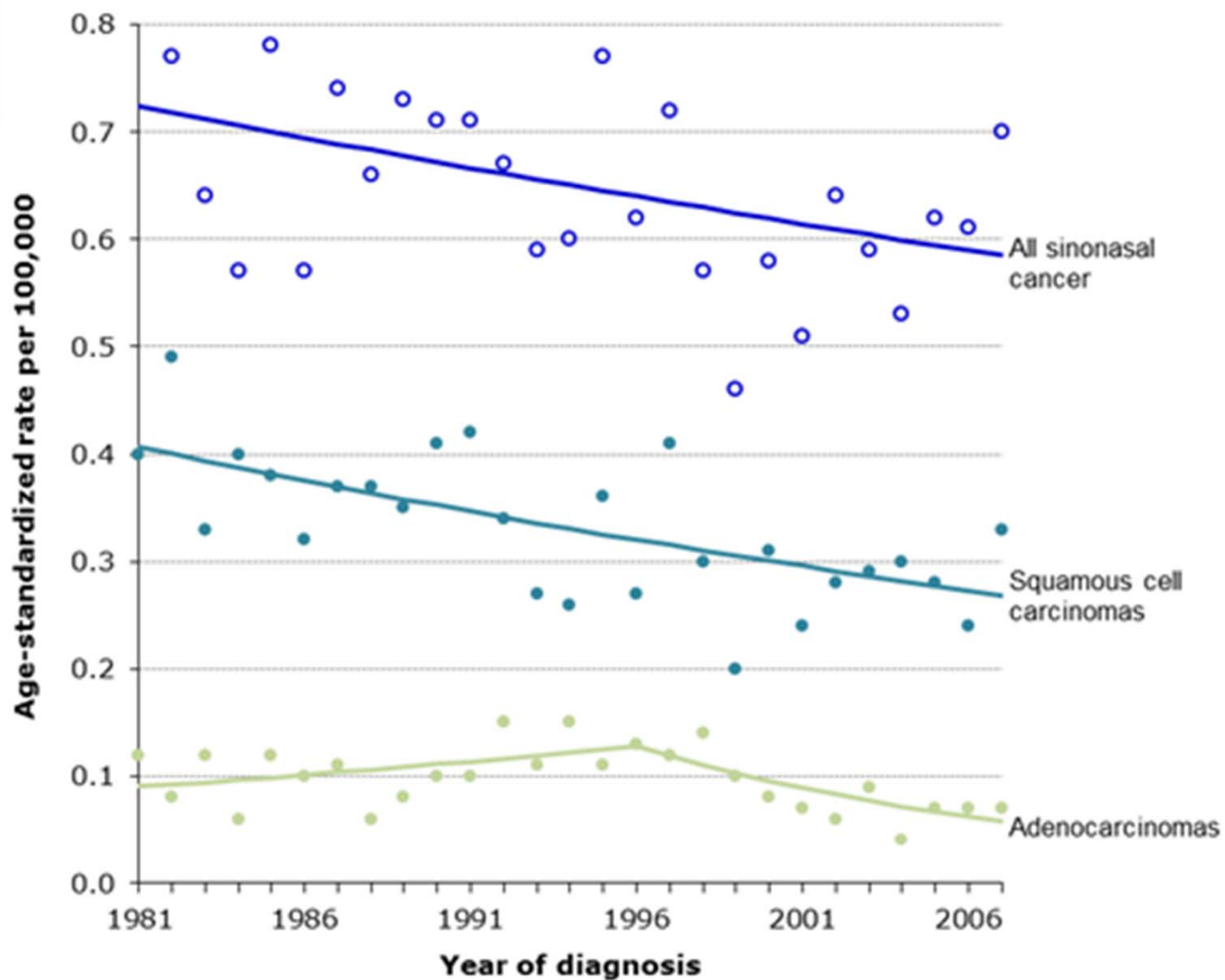
Creation of National Occupational Cancer Surveillance Cohort



- 1991 Long-Form Census
 - Representative 20% sample of population
- Linked to:
 - Canadian Mortality Database
 - Vital statistics
 - Canadian Cancer Database
 - Cancer incidence registry
 - Tax Summary Files
 - Derived from personal tax returns
- Follow-up: 1991 – 2003 (to be extended to 2005)



Sinonasal cancer incidence rates, Ontario, 1981–2007, both sexes combined



Source: Cancer Care Ontario (Ontario Cancer Registry, 2011)
Rates are adjusted to the age distribution of the 1991 Canadian population

Other OCRC Research Projects



- Determining human and economic burden of occupational cancers for Ontario/Canada
- Identifying optimal methods of occupational history taking and referral for workers compensation
- A comparison of Ontario Occupational Exposure Limits for Carcinogens to other jurisdictions in Canada and elsewhere
- An examination of trends in occupational cancer epidemiology research in Canada and internationally
- Systematic review of selected occupational cancer prevention efforts
- Historical review on occupation cancer research in Ontario



www.carexcanada.ca

Surveillance of environmental & occupational exposures for cancer prevention

Surveillance de l'exposition aux agents cancérigènes en milieu de travail et dans l'environnement pour la prévention du cancer

CANADIAN **PARTNERSHIP**
AGAINST **CANCER**



PARTENARIAT CANADIEN
CONTRE LE **CANCER**



CAREX Canada - OVERVIEW

- The objectives of CAREX Canada are to:
 - develop estimates of the **number** of Canadians exposed to IARC carcinogens in their workplace & community environments,
 - identify **how** & **where** people are exposed, and
 - when possible, determine their **level** of exposure.
- Estimates are generated using existing Canadian exposure data, census population data & the best exposure estimation procedures available.

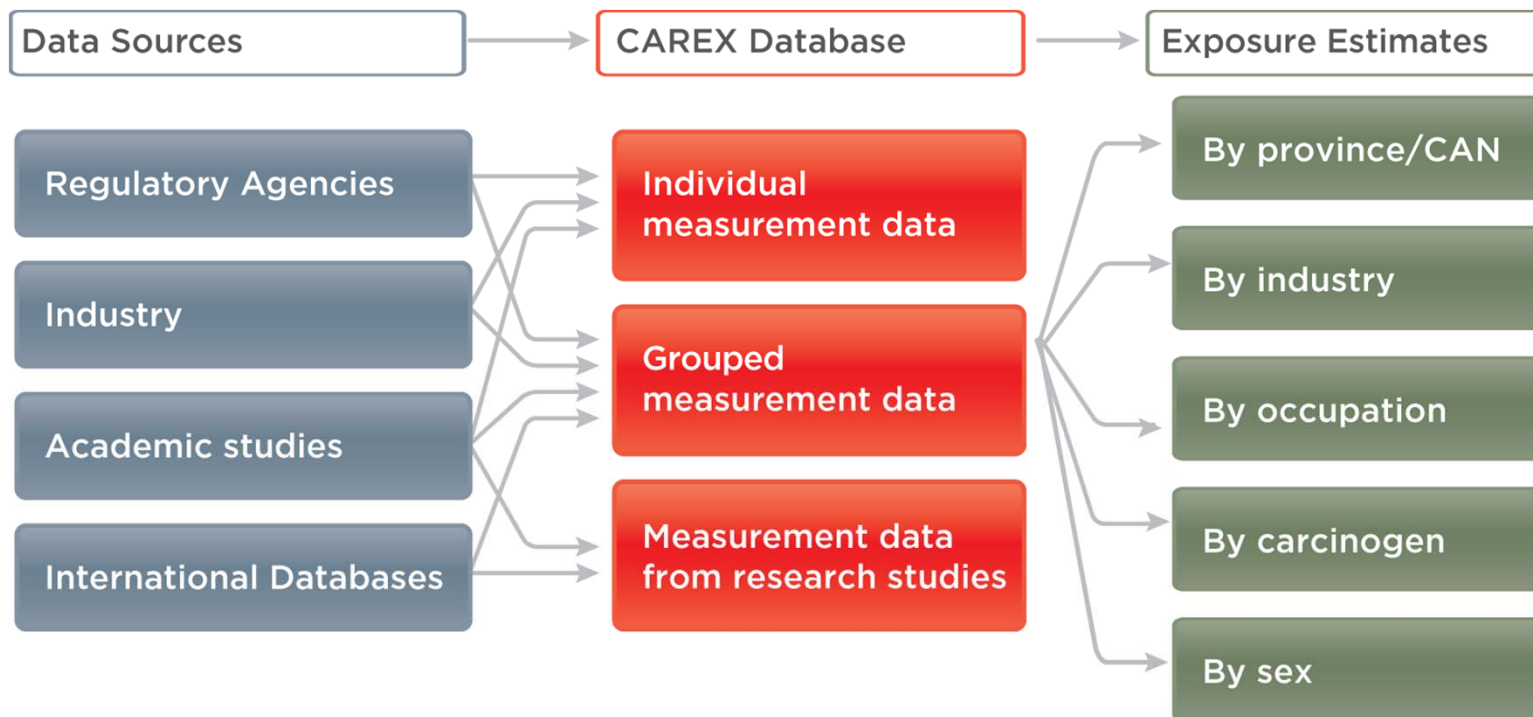
Potentially Exposed Workers: Initial Estimates

Known or suspected carcinogen (IARC)	Exposed
Shift work with circadian disruption (2A)	2,800,000
Solar radiation (1)	1,500,000
Diesel engine exhaust (2A)	804,000
Silica (crystalline) (1)	349,000
Other PAHs (2A/2B)	307,000
Benzene (1)	297,000
Wood dust (1)	293,000
Lead (2A)	202,000
Ionizing radiation (1)	153,000
Asbestos (1)	152,000
UV radiation (artificial sources)(1)	150,000
Chromium (VI) compounds (1)	83,000
Nickel compounds (1)	53,000
Formaldehyde (1)	41,600

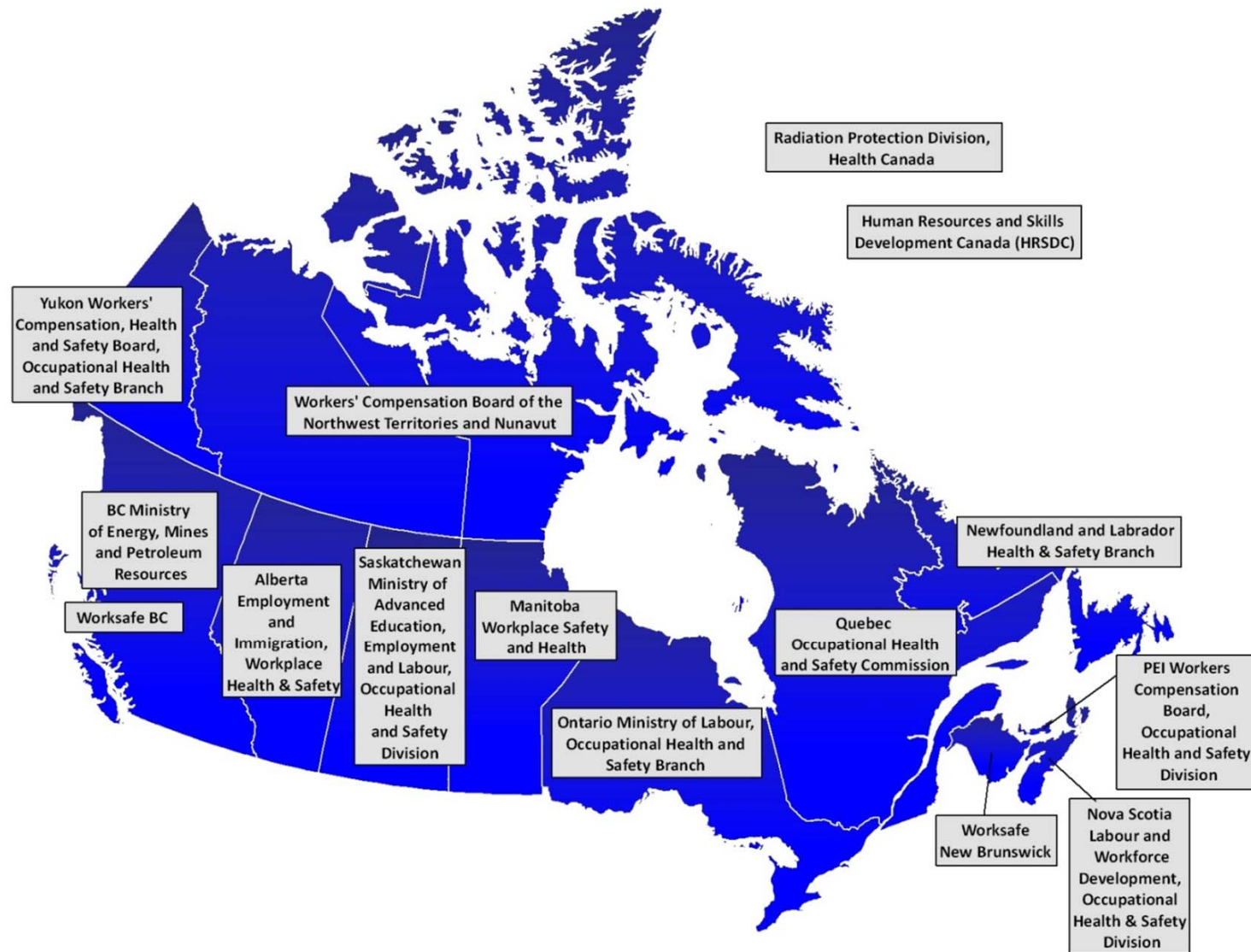


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Canadian Workplace Exposure Database (CWED)



Workplace Regulatory Agencies in Canada



Provincial Workplace Measurements

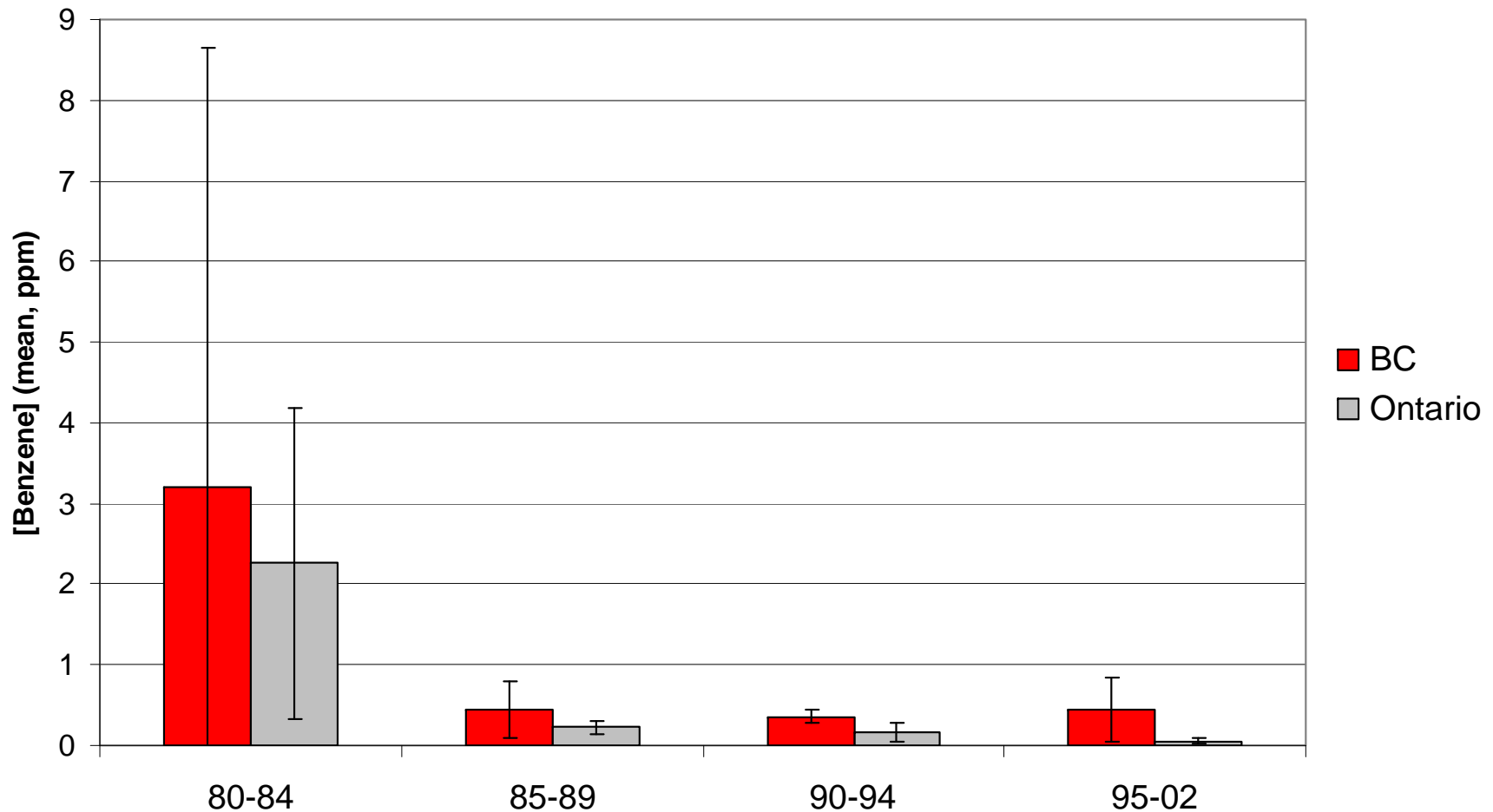
	Ontario (81-96)	BC (81-04)	Quebec (01-05)
Wood dust	3,848	7,194	4,588
Formaldehyde	7,936	2,788	4,629
Lead	7,806	3,060*	3,459
Silica	4,666	1,640	3,373
Perchloroethylene	2,764	2,148	882
Benzene	1,441	658	1,240
Cadmium	1,358	851	662
Asbestos	1,787	4,718	1,385
Beryllium	292	128	17,864



* plus 5,200 blood-lead & 17,400 urine-lead biological measurements

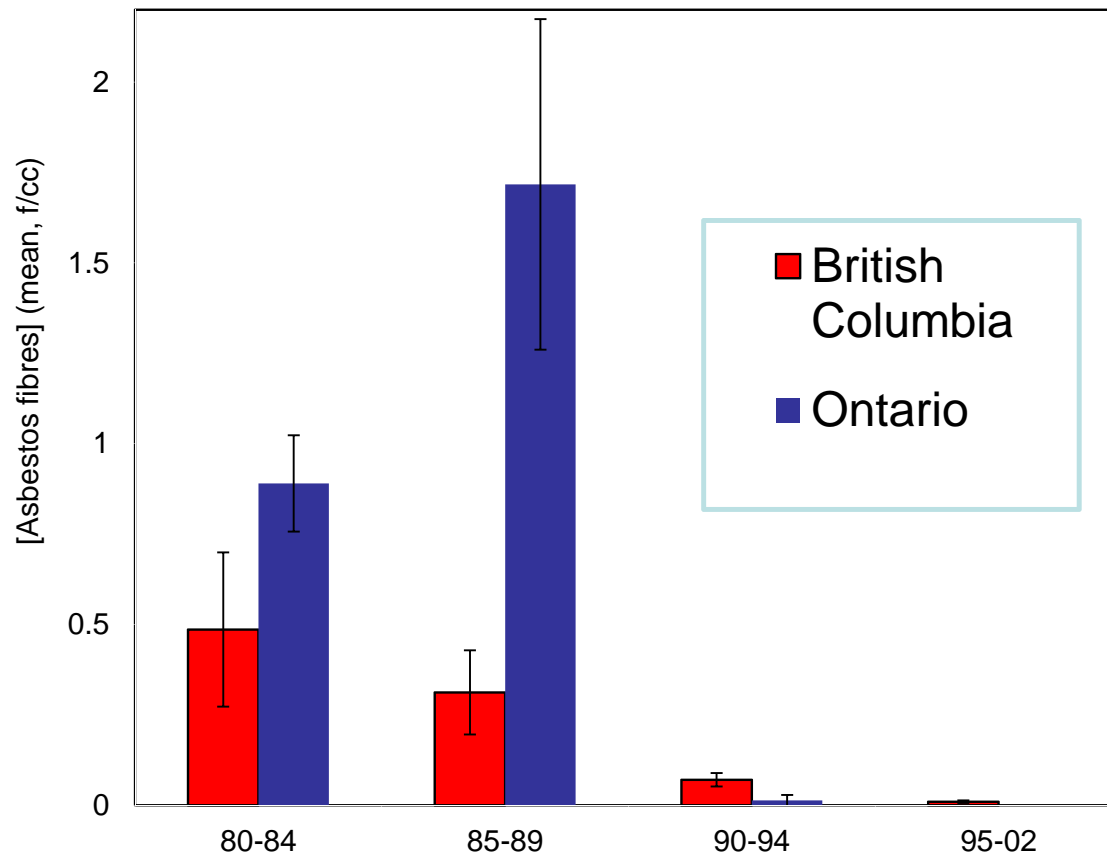
www.carexcanada.ca

Mean benzene exposure over time in BC and Ontario workplaces

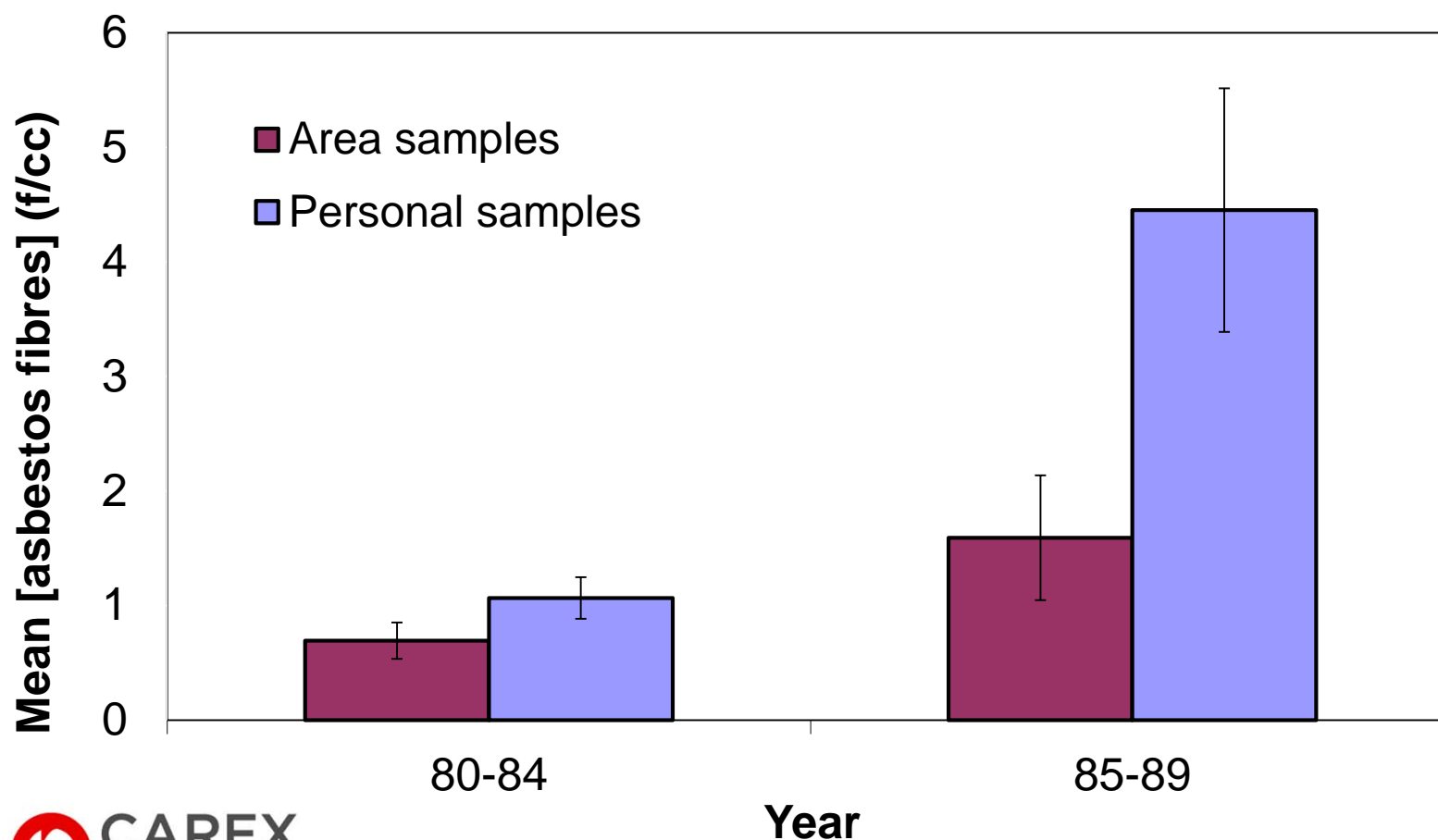


* current ACGIH TLV is 0.5 ppm, NIOSH PEL is 0.1 ppm www.carexcanada.ca

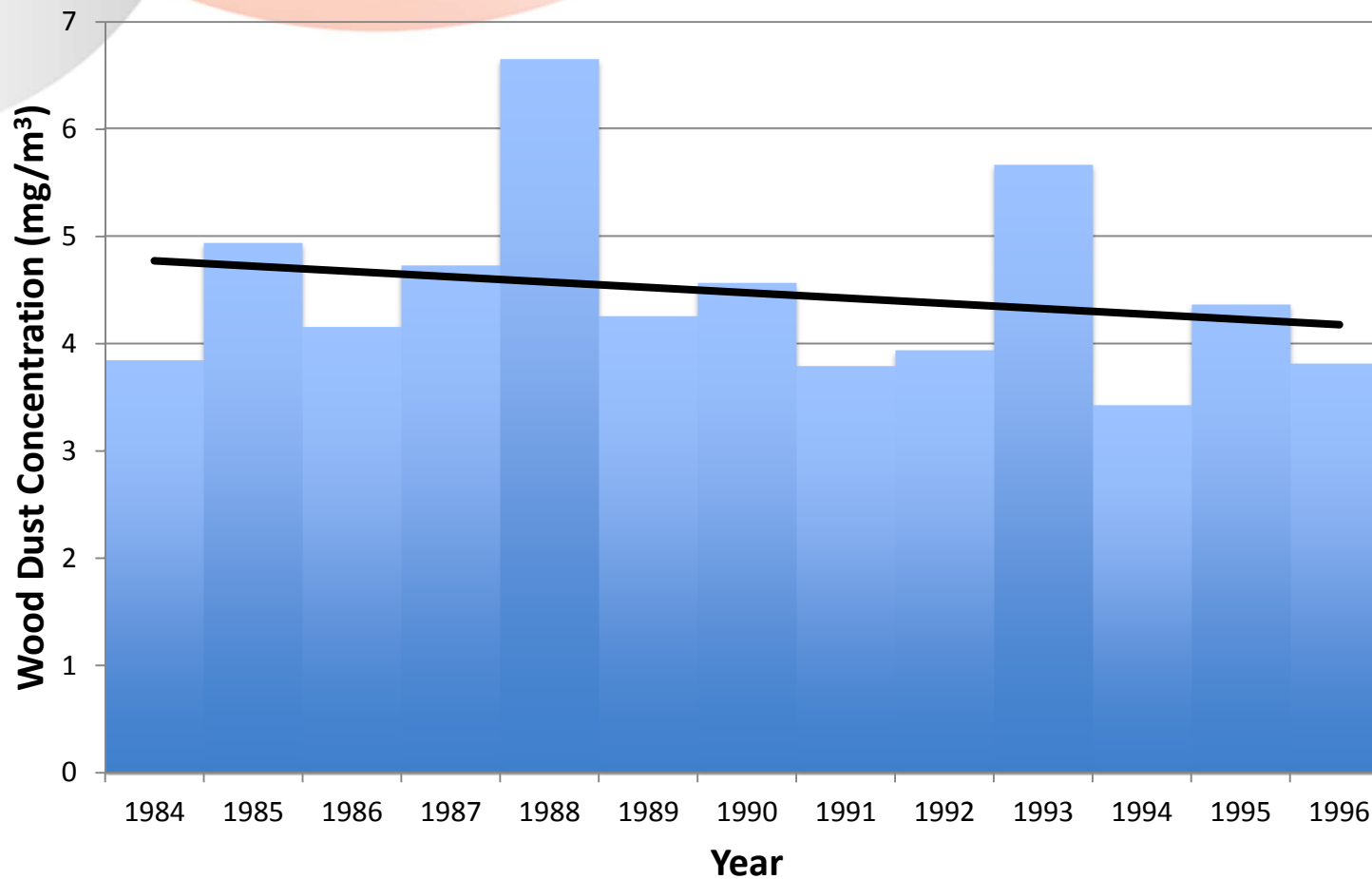
Mean Concentration of Asbestos Fibres by Province and Year



Mean Asbestos Levels in Ontario Motor Vehicle Parts Manufacturing (n=491)



Mean Concentration by Sampling Year



Levels of Exposure to Benzene by Industry Sector, Ontario 1981-1996

<u>Industry Sector (measurements)</u>	<u>Mean ppm (range)</u>
Gasoline stations (12)	13.0 (0.01-55.8)
Iron and Steel Mills (29)	2.3 (0.01-16.0)
Printing industry (38)	0.9 (0.01-7.8)
Pharm. & Medicine Mfr. (128)	0.7 (0.01-19.5)
Rubber Manufacture (192)	0.1 (0.01-5.2)
Plastics Manufacture (137)	0.05 (0.01-2.5)
Electrical Components Mfr. (21)	0.03 (0.01-0.2)

Benzene exposure to service station attendants: Personal long-term samples

Source	Location	Mean (ppm)	n samples
CPPI-PACE 1996	Canada	0.04	78
CPPI-PACE 1990	Canada	0.38	280
PACE Pilot 1987	Canada	0.03	42
Rappaport 1987	USA	0.2	49
Halder 1986	USA	0.3	21
Kearney 1986	USA	0.1	18
Runion 1985	USA	0.06	1478
Weaver 1983	USA	0.06	14
McDermott 1979	USA	0.09	84



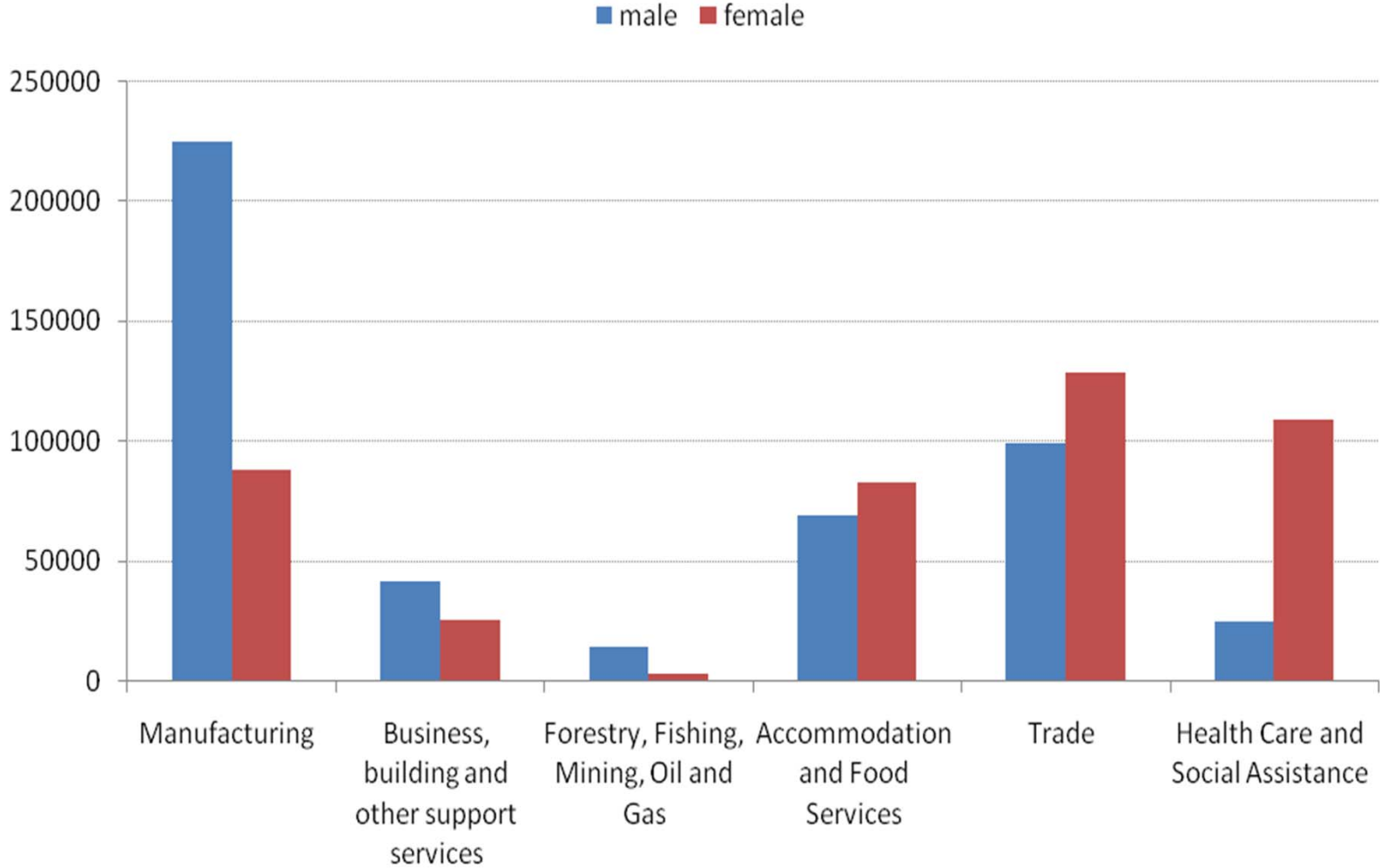
Compiled from Verma et al., 2001. 'Benzene and Total Hydrocarbon Exposures in the Downstream Petroleum Industries', AIHAJ, 62:2, 176-194 www.carexcanada.ca

Number of People Exposed to Ionizing Radiation by Industry in Ontario

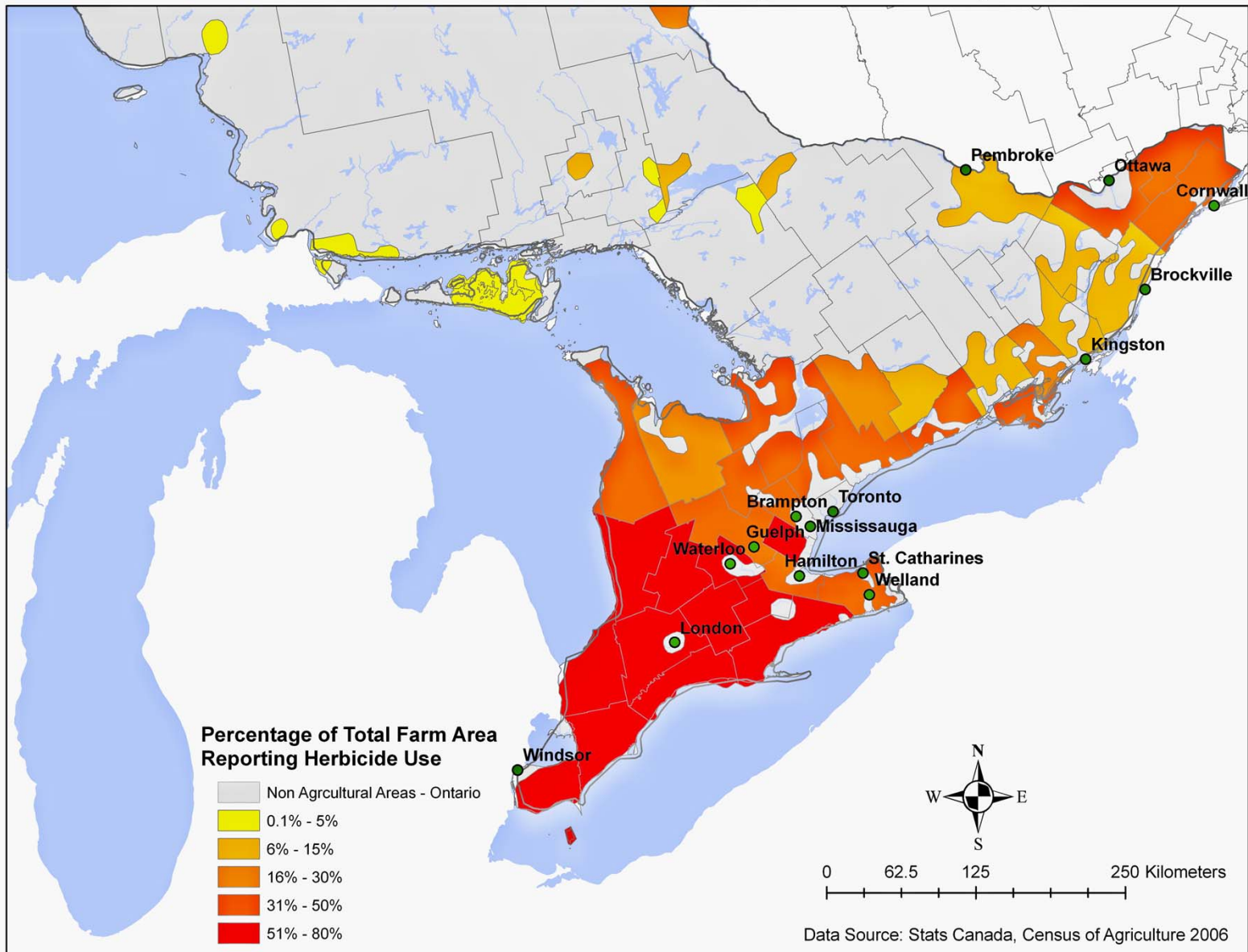
Industrial group	Number monitored by NDR (2005)	Number exposed*
Nuclear power	18,600	7,320
Medicine	27,700	4,280
Professional, scientific services	6,950	2,570
Uranium mining	18	2
Public administration	2,500	475
Other	13,000	2,900

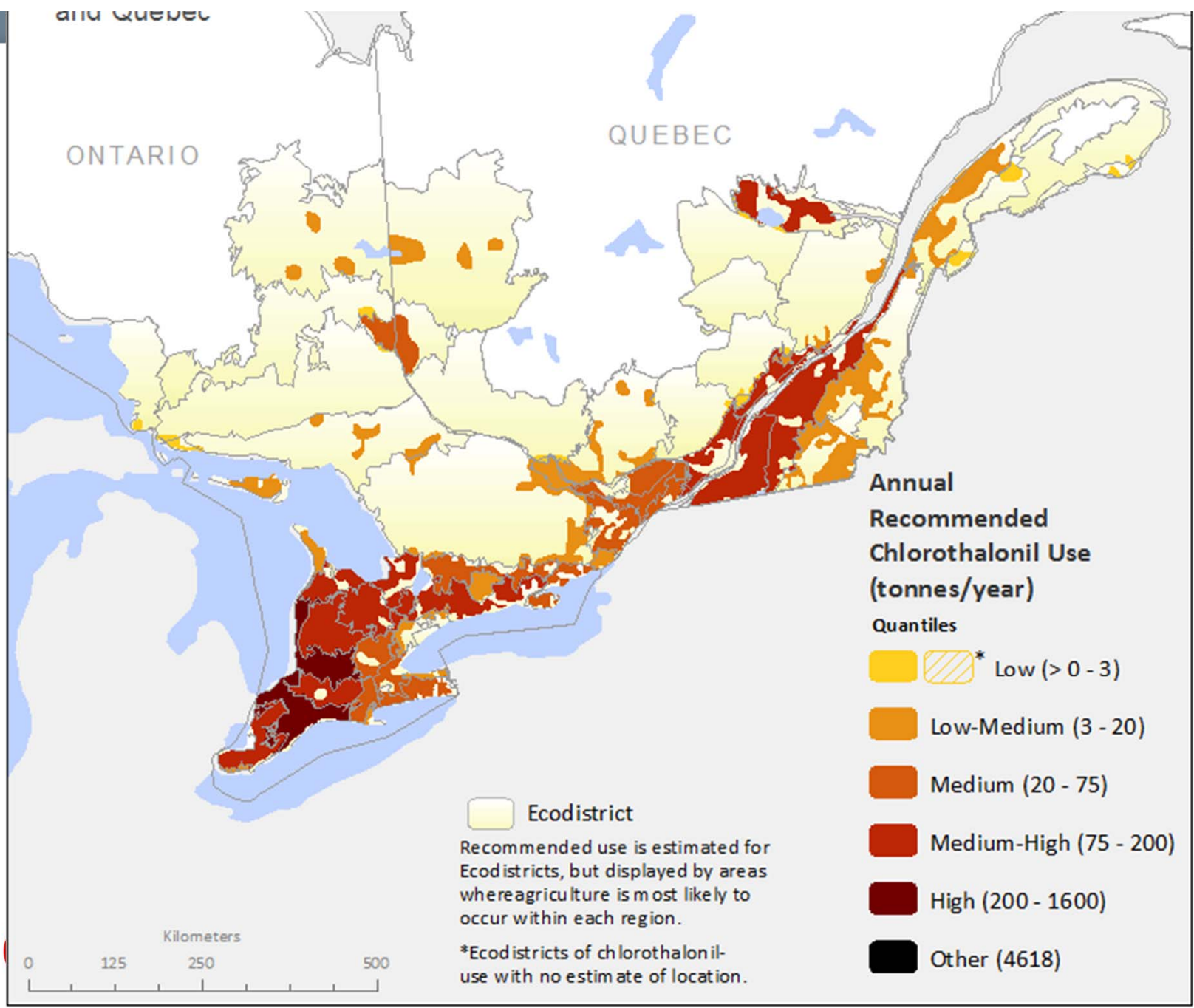
*Exposure is defined as having an annual ionizing radiation dose of >0 mSv

Night, Evening & Rotating Workers in Ontario Industries with the Highest Prevalence



Distribution of Herbicide Use - Ontario - High Agricultural Activity Areas





Estimated Number of Farm Operators Potentially Exposed to Chlorothalonil

Province (Avg # Farm Operators/ Farm)	BC (1.47)	AB (1.37)	SK (1.30)	MB (1.35)	ON (1.39)	QC (1.37)	NB (1.32)	NS (1.29)	PE (1.29)	NL (1.38)	ALL PROVINCES
Fruit	3,269 (39%)	5 (<1%)	--	--	1,518 (18%)	1,650 (20%)	507 (6%)	1,098 (13%)	232 (3%)	65 (<1%)	8,344
Vegetables	1,319 (31%)	449 (11%)	--	--	1,661 (39%)	227 (5%)	198 (5%)	266 (6%)	73 (2%)	49 (1%)	4,242
Potatoes	528 (12%)	580 (14%)	324 (8%)	362 (9%)	--	917 (22%)	544 (13%)	124 (3%)	657 (16%)	145 (3%)	4,181
Pulses	178 (1%)	3,824 (21%)	13,875 (75%)	663 (3%)	7 (<1%)	12 (<1%)	--	--	--	--	18,559
Grains/ Cereals	835 (1%)	19,326 (23%)	32,911 (39%)	11,549 (14%)	17,728 (21%)	1,718 (2%)	--	--	--	--	84,067
Mushrooms	85 (100%)	--	--	--	--	--	--	--	--	--	85

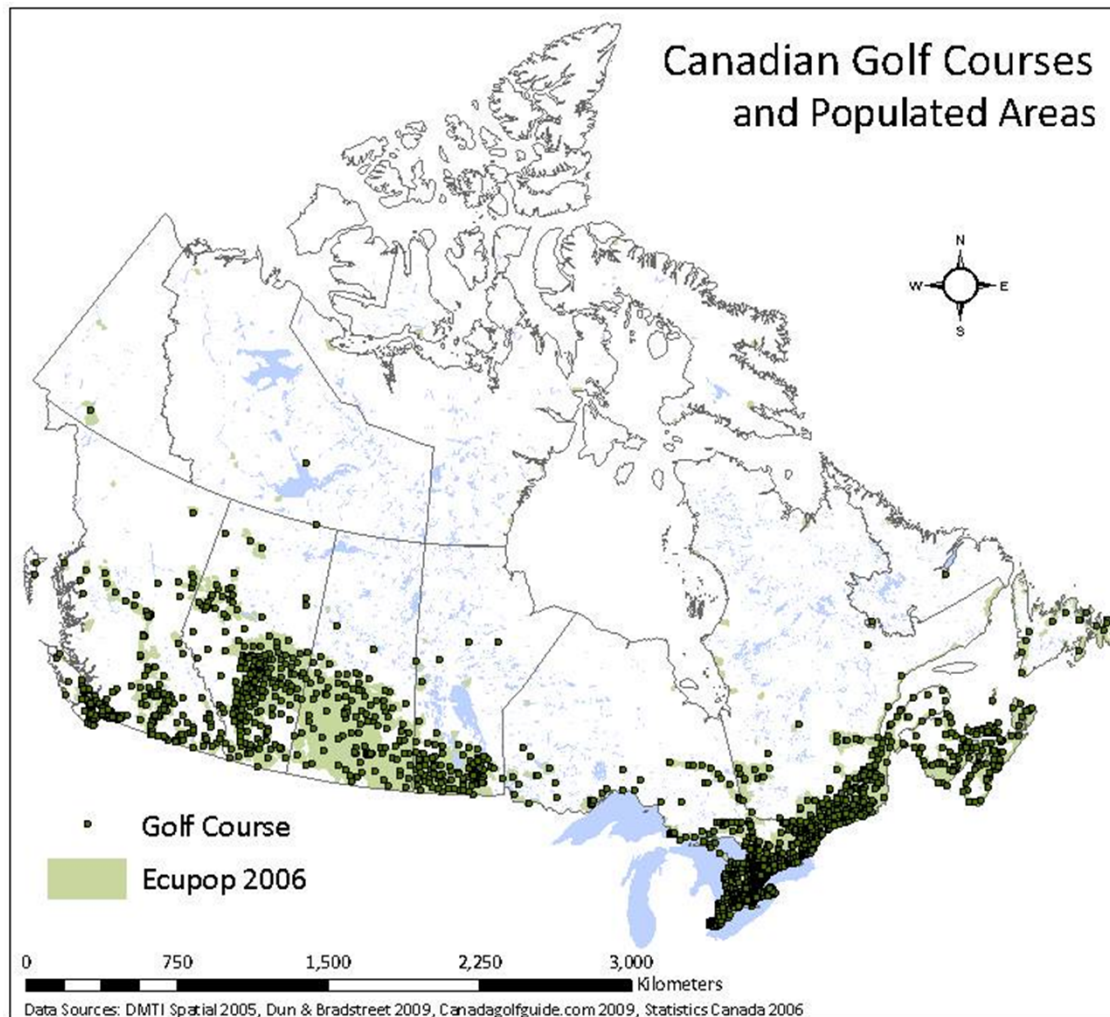
Estimated Number of Farm Workers Potentially Exposed to Chlorothalonil

Province	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	ALL PROVINCES
Total Provincial Recommended Use for Chlorothalonil (annual tonnes)	4,865 (9%)	10,969 (20%)	29,113 (54%)	6,445 (12%)	2,453 (4%)	448 (1%)	77 (<1%)	68 (<1%)	121 (<1%)	2 (<1%)	54,113
General Farm* Workers (n)	11,235 (11%)	16,150 (15%)	12,355 (12%)	9,430 (9%)	26,785 (26%)	20,415 (20%)	2,515 (2%)	3,060 (3%)	1,805 (2%)	755 (<1%)	104,505
Harvesting* Labourers (n)	3,415 (42%)	185 (2%)	65 (1%)	135 (2%)	2,630 (32%)	1,050 (13%)	185 (2%)	275 (3%)	130 (2%)	140 (2%)	8,210
Nursery and Greenhouse* Workers (n)	5,355 (24%)	2,100 (10%)	870 (4%)	655 (3%)	8,690 (39%)	2,800 (13%)	615 (3%)	670 (3%)	80 (<1%)	160 (1%)	21,995

*Note: This occupational data is from the Statistics Canada Labour Force Survey (2006); the number of workers by crop type is not available for these agricultural jobs, so we are not able to estimate the number at risk of exposure to Chlorothalonil.

Golf Course Pesticide Applicators by Province

Province/Region	Total
BC	1056
AB	999
SK	426
MB	399
ON	2493
QC	1083
NFL	66
PEI	84
NB	174
YT	6
NT	3
NU	0
Canada	7017

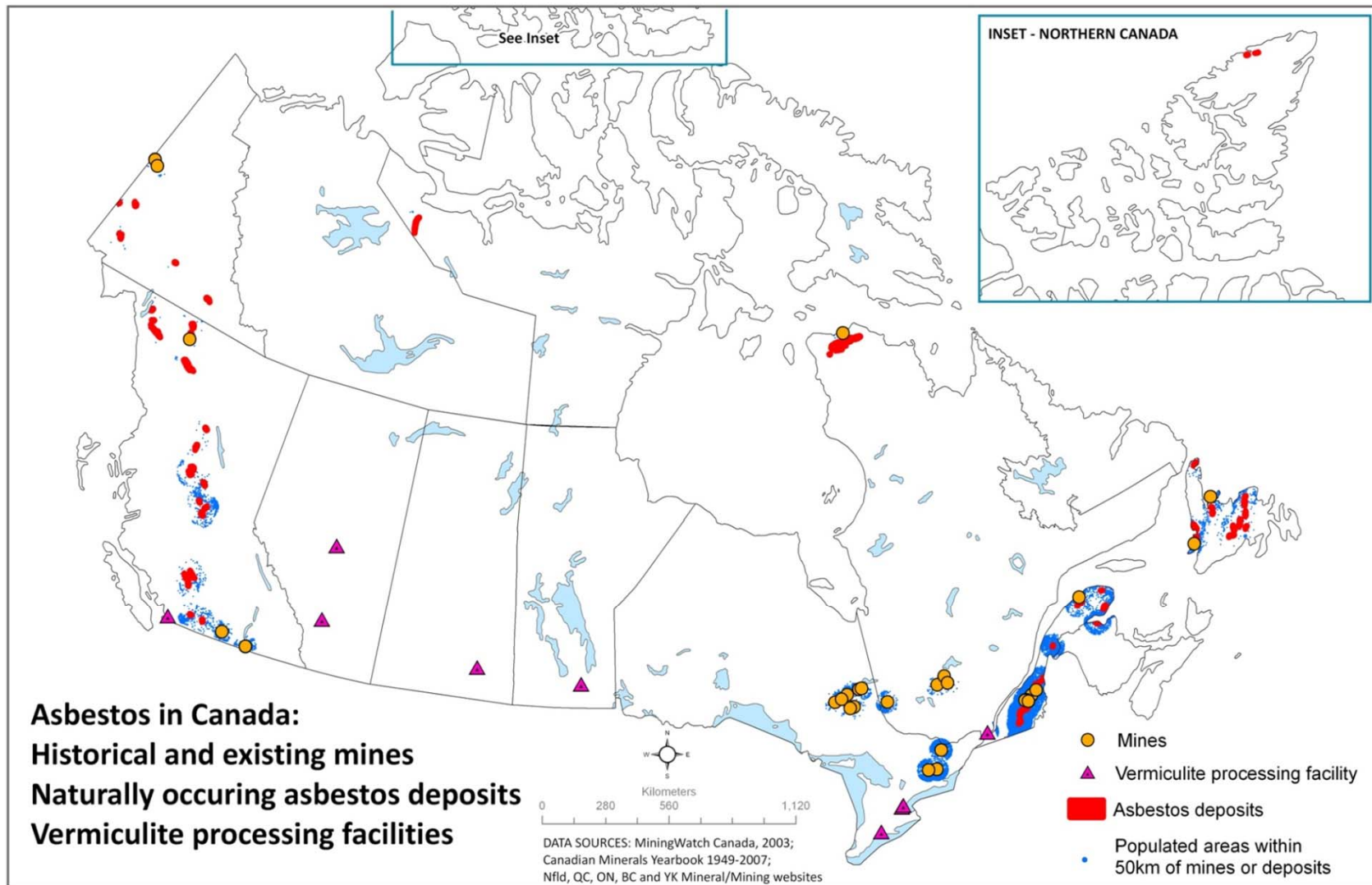


Registered Nurses (RNs), Licensed Practical Nurses (LPNs), and Laundry Workers with Potential for Exposure to Antineoplastics Drugs in Canada



Province/Territory	RNs	LPNs	Laundry Workers
Canada	14,700	170	1,600
BC	1,700	20	300
AB	1,600	10	200
SK	500	20	150
MB	600	0	150
ON	5,300	100	400
QC	3,500	0	200
NB	500	20	50
NS	500	10	70
PE	100	*	20
NL	300	0	80
YT	20	0	<10
NT, NU	70	10	10





Building Capacity: the CAREX Canada Team

A young, inter-disciplinary staff
(epidemiology, occupational hygiene,
geography, environmental sciences,
information sciences, journalism)

3 PhD Students with awards from
CCSRI, CIHR, MSFHR, other

Over a dozen other students working
on pieces of the project, many using
CAREX data as part of the research



CAREX Canada is an excellent research platform for occupational & environmental cancer studies in population health & exposure sciences



www.carexcanada.ca



Surveillance of environmental & occupational exposures for cancer prevention

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CAREX Canada is developing estimates of the number of Canadians exposed to [known, probable and possible](#) carcinogens in workplace and community environments. These estimates will provide significant support for targeting exposure reduction strategies and cancer prevention programs. By bringing together data from across Canada on sources and levels of exposure, we will identify regional differences and vulnerable populations. CAREX Canada will create a significant new resource for policy makers and researchers to prevent cancer.

[View Carcinogen Profiles & Estimates](#) ►



Towards advancing occupational cancer research

News & Events

Student Research Prize for Occupational Cancer Research September 23, 2010

OCRC is accepting applications for its annual Student Research Prize, a competition that recognizes the work of one student who has made a significant...

Students recruited to OCRC September 23, 2010

OCRC continues to recruit students to work on several occupational cancer research projects. Manisha Pahwa is an occupational/environmental health graduate...

[More News](#)

About OCRC

The Occupational Cancer Research Centre (OCRC), established in 2009, is the first of its kind in Canada. The Centre was established to fill the gaps in our knowledge of occupation-related cancers and to translate these findings into preventive programs to control workplace carcinogenic exposures and improve the health of workers.

The Centre is establishing and leading a program of integrated research that will involve collaborations between researchers, worker organizations and employers.

[Read More](#)

Featured Profile



Shelley Harris Scientist

[Biography](#)

[List of Projects](#)

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