



Occupational  
Cancer  
Research  
Centre

# Exploring New Models for Occupational Cancer Surveillance in Canada

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# Occupational Cancer Research Centre's Research Program 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

# What is Surveillance?

from the US Centers for Disease Control:

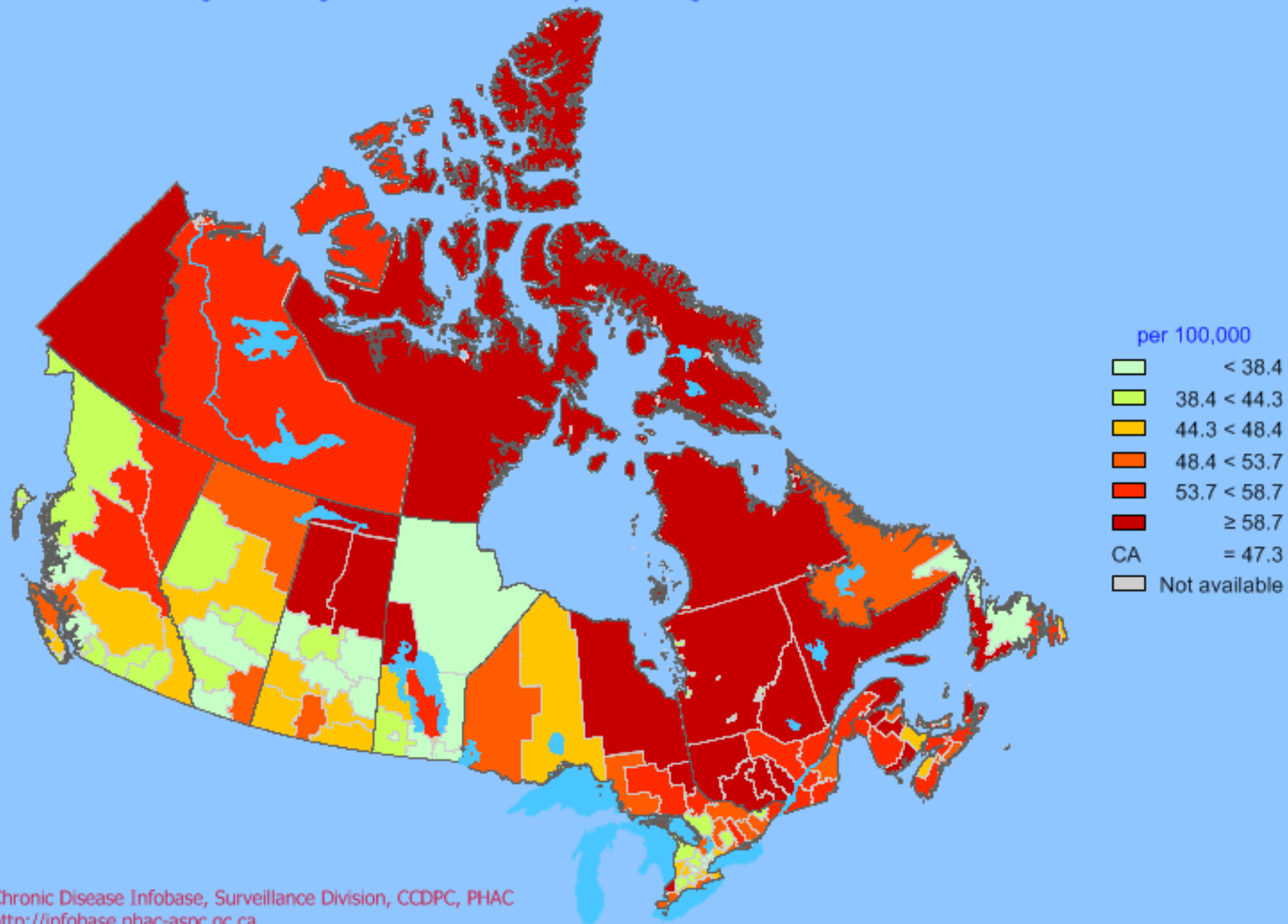
“Epidemiological surveillance is the ***on-going, systematic collection, analysis, and interpretation*** of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the ***timely dissemination*** of these data to those responsible for prevention and control”

# What is Surveillance?

from the *Dictionary of Epidemiology*:

“the ***ongoing scrutiny*** [of the occurrence of disease, injury, or hazards] generally using methods distinguished by their ***practicality, uniformity, and frequently their rapidity, rather than by complete accuracy.*** Its main purpose is ***to detect changes in trends or distributions*** in order ***to initiate investigative or control measures***”

Lung cancer, age-standardized mortality rate, all ages, both sexes, 2001

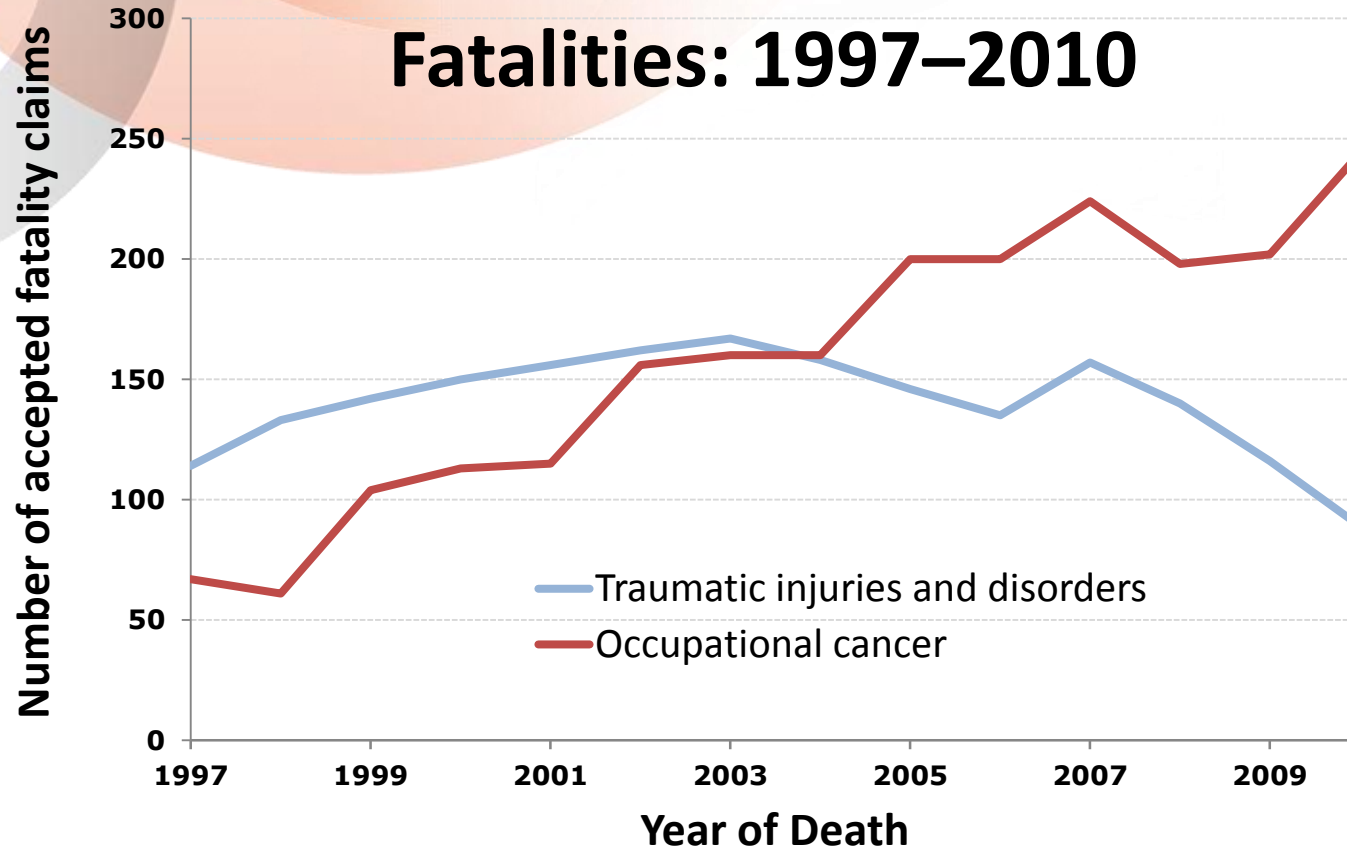


# Why Occupational Cancer Surveillance?



- Monitoring of patterns and trends
- Quick data to answer policy relevant questions
- Address new hypotheses
- Generate new hypotheses
- Provide preliminary data before more rigorous study

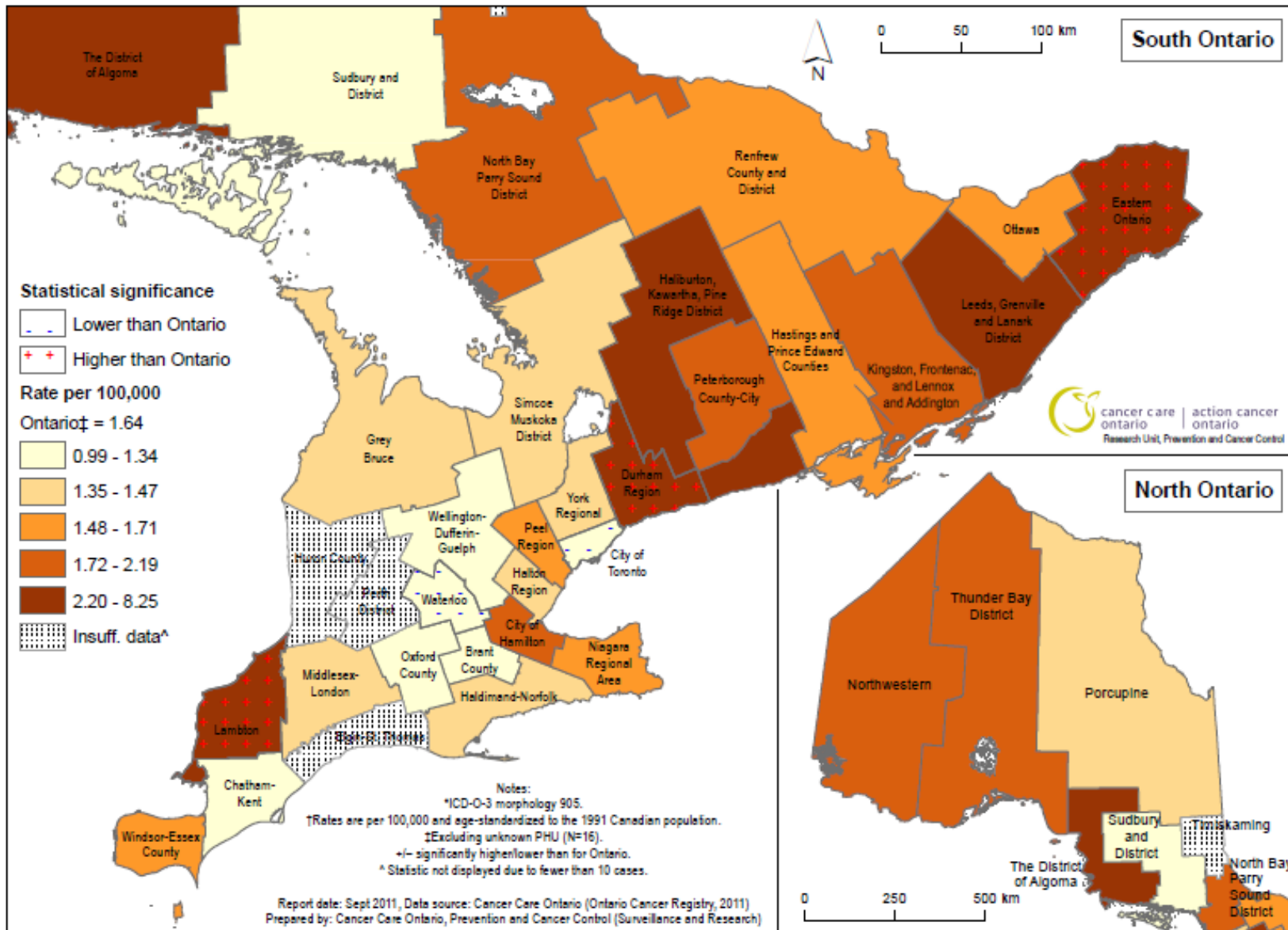
# WSIB Accepted Workplace Fatalities: 1997–2010



Source: Association of Workers' Compensation Boards of Canada (AWCBC) National Work Injury, Disease and Fatality Statistics 1997–2010.

*Any interpretations made from the data provided by the AWCBC are from the Occupational Cancer Research Centre and do not necessarily reflect the views of the AWCBC or any of its member Boards or Commissions.*

# Mesothelioma\* age-standardized incidence rates† by Public Health Unit, Males, 1986–2007

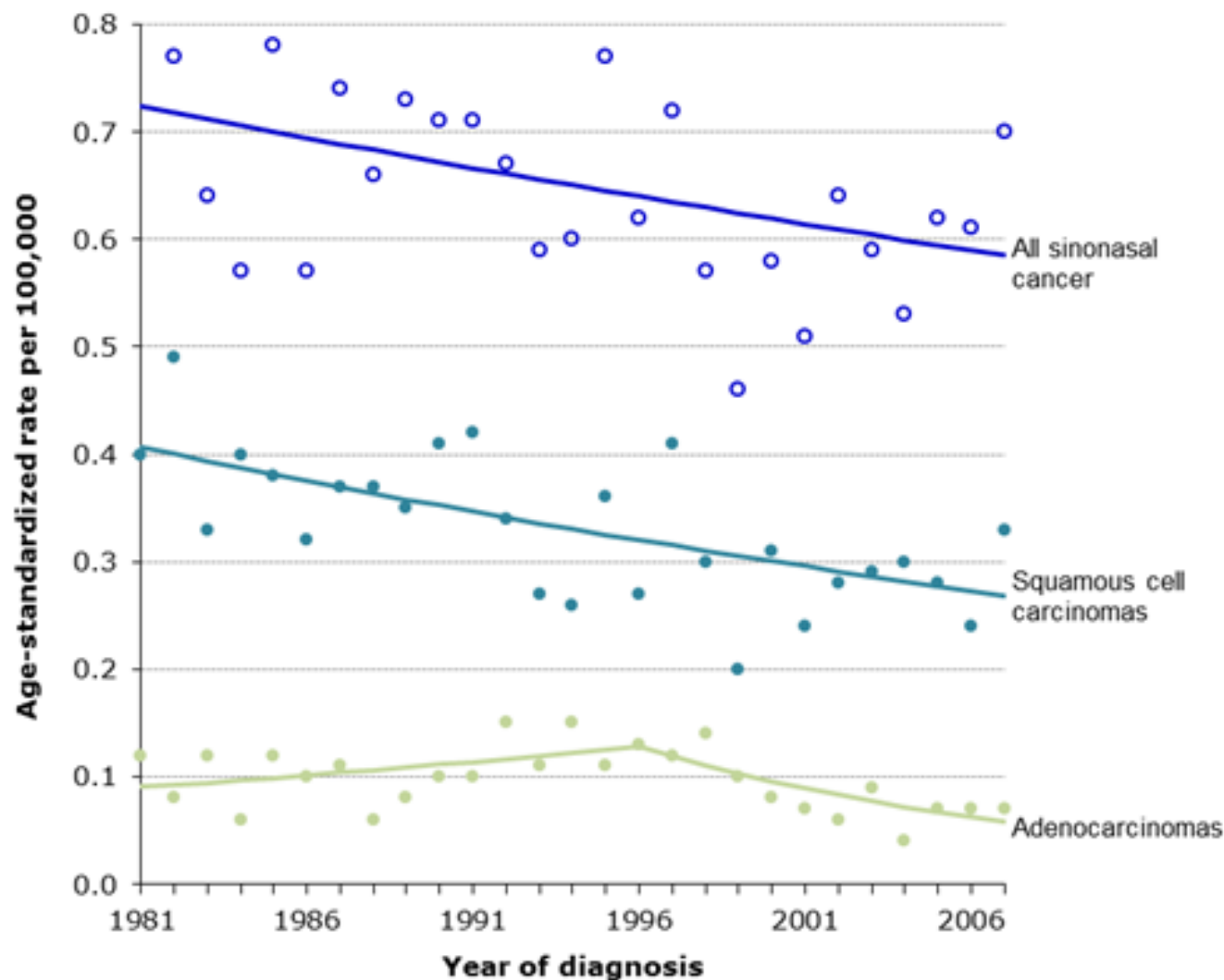


## North Ontario

Map Created: 2/Nov/11



**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

# Occupational Cancer Surveillance:

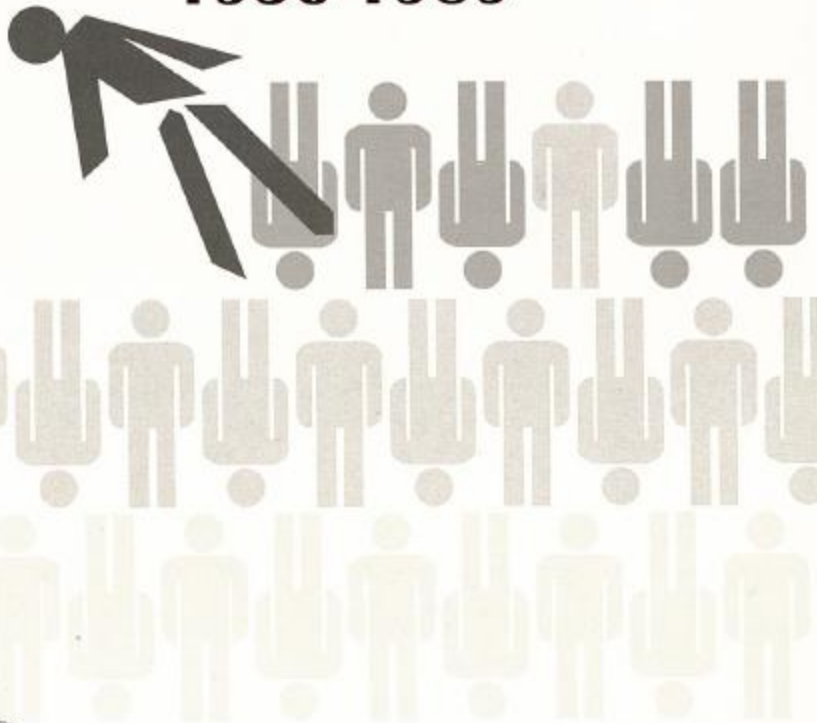
## Major Challenges

- Clinical and pathological expression of cancers do not generally differ by cause
- Compensation records only capture a small fraction of occupational cancers
- Administrative health data do not include information on occupation and industry
- Relevant time period for exposure is 10-40 years prior to diagnosis

# Occupational Cancer Surveillance based on Death Certificates

**NIOSH**

## **Occupational Mortality in Washington State 1950-1989**



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Public Health Service  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health



# Occupational Cancer Surveillance based on Death Certificates



- Occupational Mortality in British Columbia\*
  - Death Certificates coded from 1950-1984

<u>Population</u>	<u>Sinonasal Cancer PMR (obs, 95% CI)</u>
Cabinet and Furniture Makers	0.00 (0 observed)
Carpenters	0.77 (3, 0.15-2.24)
Sawyers	3.11 (1, 0.07-17.32)
Woodworking Machine Operators	7.96 (1, 0.20-44.37)

\* Gallagher et al. NCI Monograph 1985;69:163-167.

NIOSH Safety and Health Topic:

## National Occupational Mortality Surveillance (NOMS)



# NOMS



### Overview of the NOMS System

National Occupational Mortality Surveillance (NOMS) is the ongoing systematic collection, analysis, and dissemination of death data to monitor the extent and severity of occupationally related acute and chronic disease and injury in association with industrial or occupational settings. Statistical results from the proportionate mortality analysis of these data are available in the form of a query system for access to precalculated PMRs by occupation or industry. Recently, PMR Charts and Tables were added that present proportionate mortality for cancer, neurologic, cardiovascular, diabetes, and renal disease and other chronic disease. [More Information on the NOMS System.](#)

### Topic Index:

• [Overview of the NOMS System](#)

[PMR Charts and Tables for Cancer and Chronic Disease](#)

[PMRs by Occupation and Cause of Death](#)

[PMRs by Industry and Cause of Death](#)

[Bibliography](#)

[NOMS-Related Links](#)

### Occupational Mortality Statistics

#### NOMS PMR Query System

- [PMR Charts and Tables for Cancer and Chronic Disease \(New!\)](#)
- [PMRs By Occupation and Cause Of Death](#)
- [PMRs by Industry and Cause of Death](#)

#### About NOMS PMRs

- [Methods and Data Sources](#)
- [Suggested Citation](#)
- [Note to Users](#)
- [Industry/Occupation Coding](#)

# Occupational Cancer Surveillance based on Death Certificates



- Questions regarding validity for occupation and industry on death certificates
- Limited cancer information and questions regarding data quality
- Proportionate mortality ratios (PMRs) may be difficult to interpret
  - SMRs sometimes used but Census a poor match with death certificates



## Current Subject

## Science and Research

### Science & Research

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### Activity Highlights

## Team Links Cancer Risks to How and Where We Live

### Diseases & Health Conditions



Traditionally, surveillance systems have provided information on the prevalence of a disease or condition. Although helpful, this kind of system can't provide clues as to why these rates are higher, nor point to potential solutions.

### Food, Drugs & Consumer Products

Health Canada's National Enhanced Cancer Surveillance System (NECSS) provides information on geographic and behavioural factors that may influence the prevalence of disease.

### Health & the Environment

### Health Protection & Promotion

### Microbial Research Activities

## Explore...

Headed up by Dr. Yang Mao, the NECSS was built by collecting information from a Canada-wide sample of 20,755 recently diagnosed patients with cancer and 5,039 population controls. Each individual completed a detailed, risk factor questionnaire. In parallel, the Environmental Quality Database was developed, which facilitates the examination of the relationships between cancer and the quality of air and water in Canada.

### Main Menu

### A-Z Index

### It's Your Health

### Just For You

### Site Map

Together, this enhanced surveillance system helps the department study both the influence of environmental factors on cancer in Canada, as well as behavioural risk factors.

## Proactive Disclosure

## Environment-Related Cancer Surveillance

The geographic component of the NECSS is very important in determining potential environmental risk factors for cancer and creating the potential to reduce the associated health risks. For example, Dr. Mao's team has conducted a study of residential proximity to industrial plants and non-Hodgkin's lymphoma.

# National Enhanced Cancer Surveillance System



- NECSS was a collaborative project of Health Canada and provincial cancer registries
- Included individual data from 21,020 Canadians with 1 of 19 types of cancers and 5,039 population controls ages 20 to 76
- Data collected 1994 to 1997 in 8 provinces
- A one time effort



# Linkage of Census or other large Cohorts & Cancer Records



- Large, hopefully representative populations
- Mimics a prospective cohort study
- Occupation and industry more reliable (although only for a single point in time)
- Lacks information on potential confounders

# Large Cohort Linkage in Canada



Survey of 10% of the Canadian labour force in 1965

Annual surveys 1965-69 & 1971

~700,000 cohort members

Mortality follow-up to 1991

143,000 deaths

28,000 comparisons (specific occupation-cause of death pairs)





Authors login

### Nocca project

- ▼ Main page
- Study protocol
- Description of the data files
- Congress abstracts
- Principles for use of data

### Cancer incidence by occupation

- Acta Oncologica 2009
- Press release
- Download full-text article
- Download appendix tables
- Editorial by Dr. Aaron Blair
- Table downloads (English)
- Table downloads (Nordic)
- Occupational categories
- Utilities





only search NOCCA web

Course material from the NIVA-course held in Mariehamn, Åland 29-31 Aug 2011 can be found [here](#)

## Nordic Occupational Cancer Study (NOCCA)

We present up to 45 years of cancer incidence data by occupational category for the Nordic populations. The study covers the 15 million people aged 30-64 years in the 1960, 1970, 1980/1981 and/or 1990 censuses in Denmark, Finland, Iceland, Norway and Sweden, and the 2.8 million incident cancer cases diagnosed in these people in a follow-up until about 2005.

Further studies will focus on associations between specific work-related factors and well-defined cancer diseases with the aim to identify exposure-response patterns. In addition to the cancer data demonstrated in the incidence publication, the NOCCA project produces a Nordic Job Exposure Matrix (JEM) that transforms information about occupational title histories to quantitative estimates of specific exposures. The third essential component is methodological development targeted at better interpretation of results based on averaged information of exposures and co-factors in the occupational categories.

This study was financially supported by the Nordic Cancer Union and Scientific Council In Sweden.

- 1 Finnish Cancer Registry
- 2 School of Public Health, University of Tampere
- 3 Cancer Registry of Norway
- 4 University of Copenhagen
- 5 Center of Public Health Sciences
- 6 Karolinska Institute
- 7 Icelandic Cancer Registry
- 8 Samfundet Folkhälsan
- 9 University of Tromsø
- 10 Finnish Institute of Occupational Health
- 11 National Institute of Occupational Health
- 12 Danish Cancer Society
- 13 Administration of Occupational Safety and Health
- 14 University of Oulu

- New: Yrke og kreft i Norge
- Full-text incidence article
- Full study description

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<http://astra.cancer.fi/NOCCA/>

# The Nordic Occupational Cancer Study (NOCCA)



- Collaboration of the Finnish Cancer Registry, Norwegian Cancer Registry, Karolinska Institutet, University of Copenhagen, and Icelandic Cancer Registry
- Follow-up of 15 million age 30-64 in the 1960, 1970, 1980, and 1990 Census of Sweden, Finland, Denmark, Norway, and Iceland
- 45 years of follow-up and 1.4 million cancers observed

# Cancer Among Firefighters

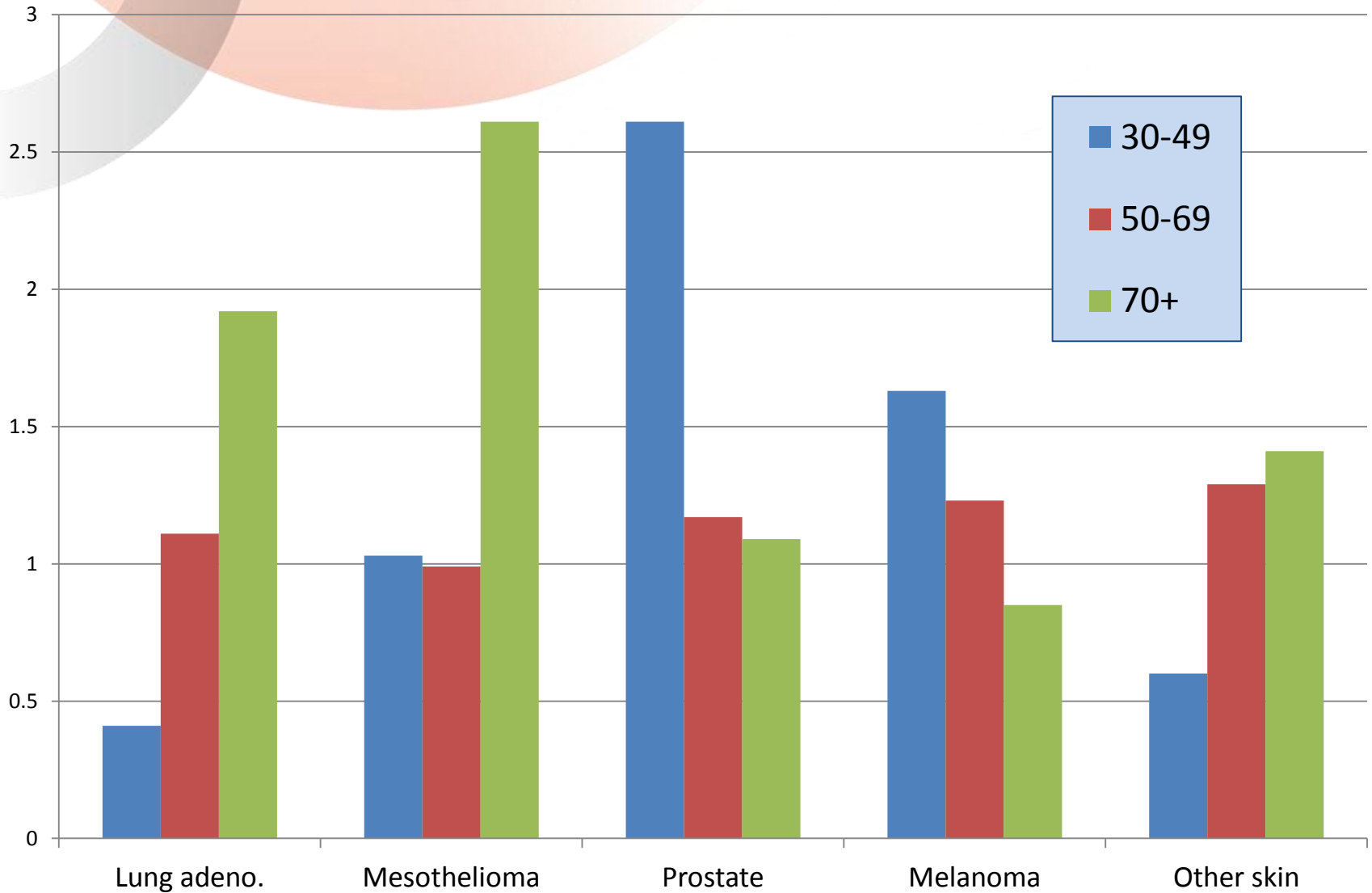


# Cancer Incidence for Suspected Sites\*

Cancer Site	Obs	SIR	95% CI
Stomach	128	1.10	0.93-1.31
<b>Colon</b>	<b>198</b>	<b>1.15</b>	<b>1.00-1.32</b>
Rectum	117	0.98	0.82-1.18
Larynx	31	1.07	0.73-1.52
Lung	307	0.98	0.87-1.09
<b>Mesothelioma</b>	<b>17</b>	<b>1.59</b>	<b>0.91-2.50</b>
<b>Prostate</b>	<b>654</b>	<b>1.14</b>	<b>1.05-1.23</b>
Testicular	8	0.46	0.20-0.91
<b>Malignant melanoma</b>	<b>108</b>	<b>1.25</b>	<b>1.03-1.51</b>
<b>Other skin cancer</b>	<b>116</b>	<b>1.33</b>	<b>1.11-1.59</b>
Brain	63	0.86	0.66-1.09
Non-Hodgkin's lymphoma	81	1.04	0.83-1.29
Leukemia	54	0.91	0.69-1.19

\* Male Swedish, Finnish, Norwegian, and Danish Firefighters Towards a cancer-free workplace

# Cancer Incidence by Age at Risk



# Methods: 1991 Canadian Census Linkage Cohort



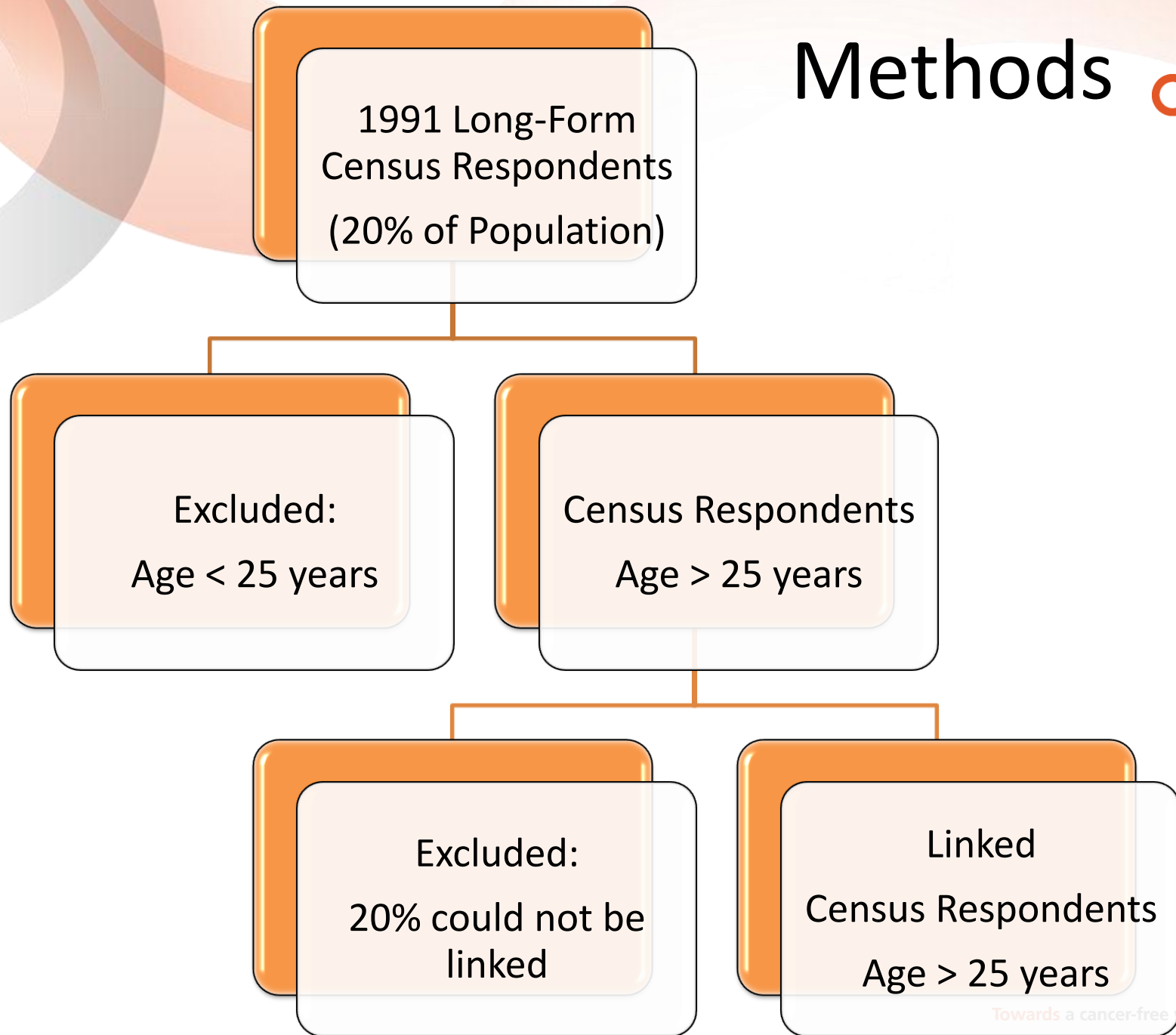
- 1991 Long-Form Census
  - Representative 20% sample of population
- Linked to:
  - Canadian Mortality Database
    - Vital statistics
  - Canadian Cancer Database
    - Cancer incidence registry
  - Tax Summary Files
    - Derived from personal tax returns
- Follow-up: 1991 – 2003 (to be extended to 2008 later this year)

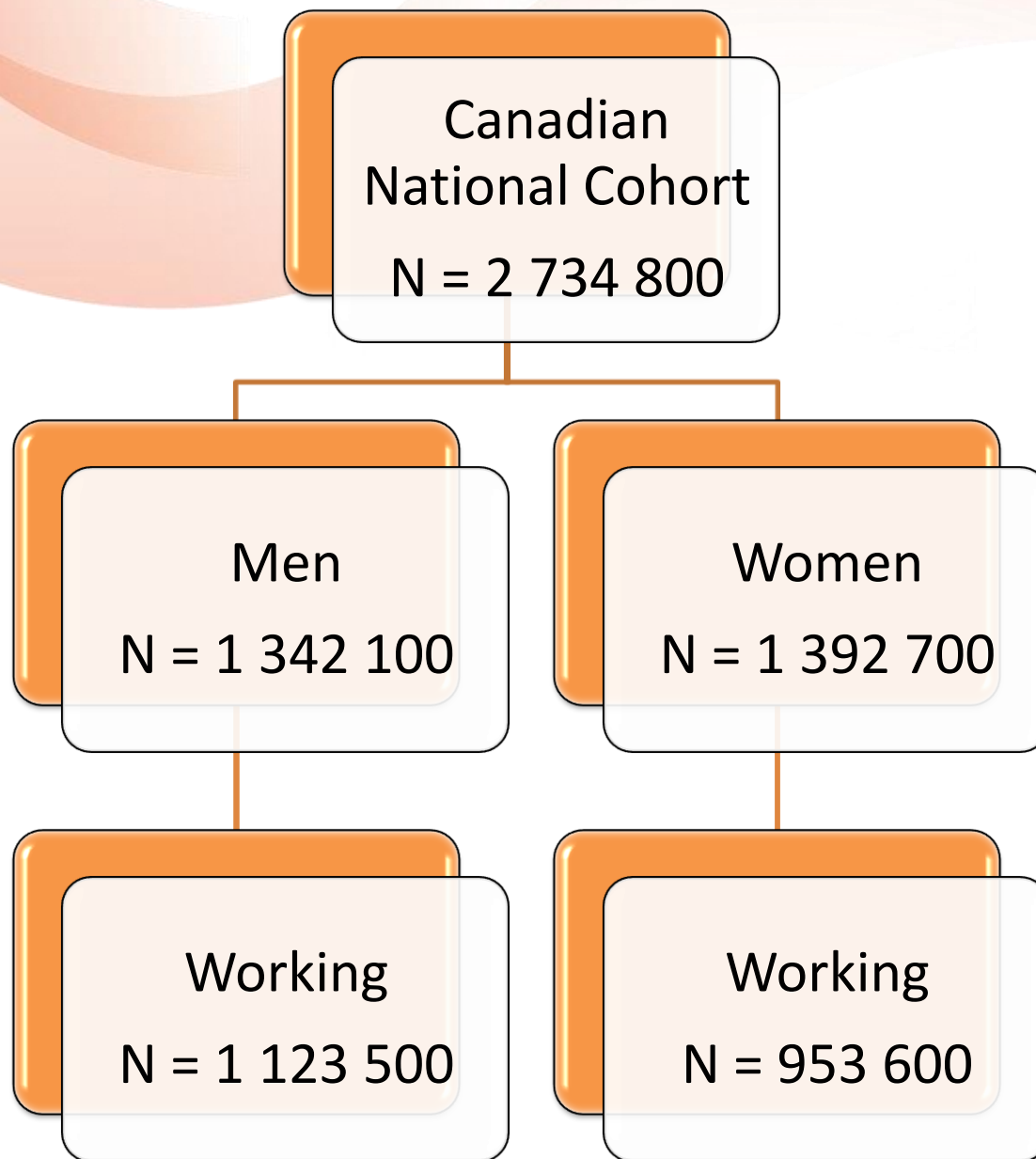


# Methods: Occupation & Industry

- Occupation determined by:
  - Job or business in the week prior to the 1991 Census
- If no job in the last week:
  - Recorded job of longest duration since 1/1/1990
- If more than 1 job:
  - Recorded job where most hours were worked
- Coding:
  - Canadian “Standard Occupational Classification”
  - Canadian “Standard Industrial Classification”

# Methods





# Analysis

- Survival analysis:
  - Cox proportional hazards modeling
  - All analyses within the linked cohort
- Base models: sex, age and province
- Socioeconomic status
  - Income - Ratio of neighborhood quintiles
    - 1 (lowest) → 5 (highest) quintile
  - Education - Highest level of schooling
    - 1 (no high school) → 4 (university degree)
- Parity - Number of liveborn births

# Pilot Projects



- Cancer (many sites) among firefighters and police
  - Restricted to men, compared to other working men
- Lung cancer among welders
  - Analyses restricted to men, compared to other blue collar occupations
- Ovarian cancer among many groups
  - Compared to other working women
- Sinonasal cancer among wood workers
- Laterality of upper limb melanomas among drivers compared to other occupations

# Preliminary Firefighters (n=4300) and Police (n=9700)

Cancer site	Fire fighters	95% CI	Police	95% CI
Colon	1.19	0.78 – 1.81	1.08	0.78 – 1.49
Rectum	1.17	0.69 – 1.98	1.19	0.81 – 1.75
Prostate	0.94	0.71 – 1.24	1.18	0.97 – 1.43
Testicular	1.94	0.87 – 4.34	1.60	0.90 – 2.84
Brain	1.18	0.53 – 2.63	0.37	0.14 – 0.99

# Lung Cancer among Welders



- Overall there were 10,300 lung cancers among men in the cohort
- There were 125 lung cancers among 12,900 male welders
- Comparisons were made to all working men and blue collar men

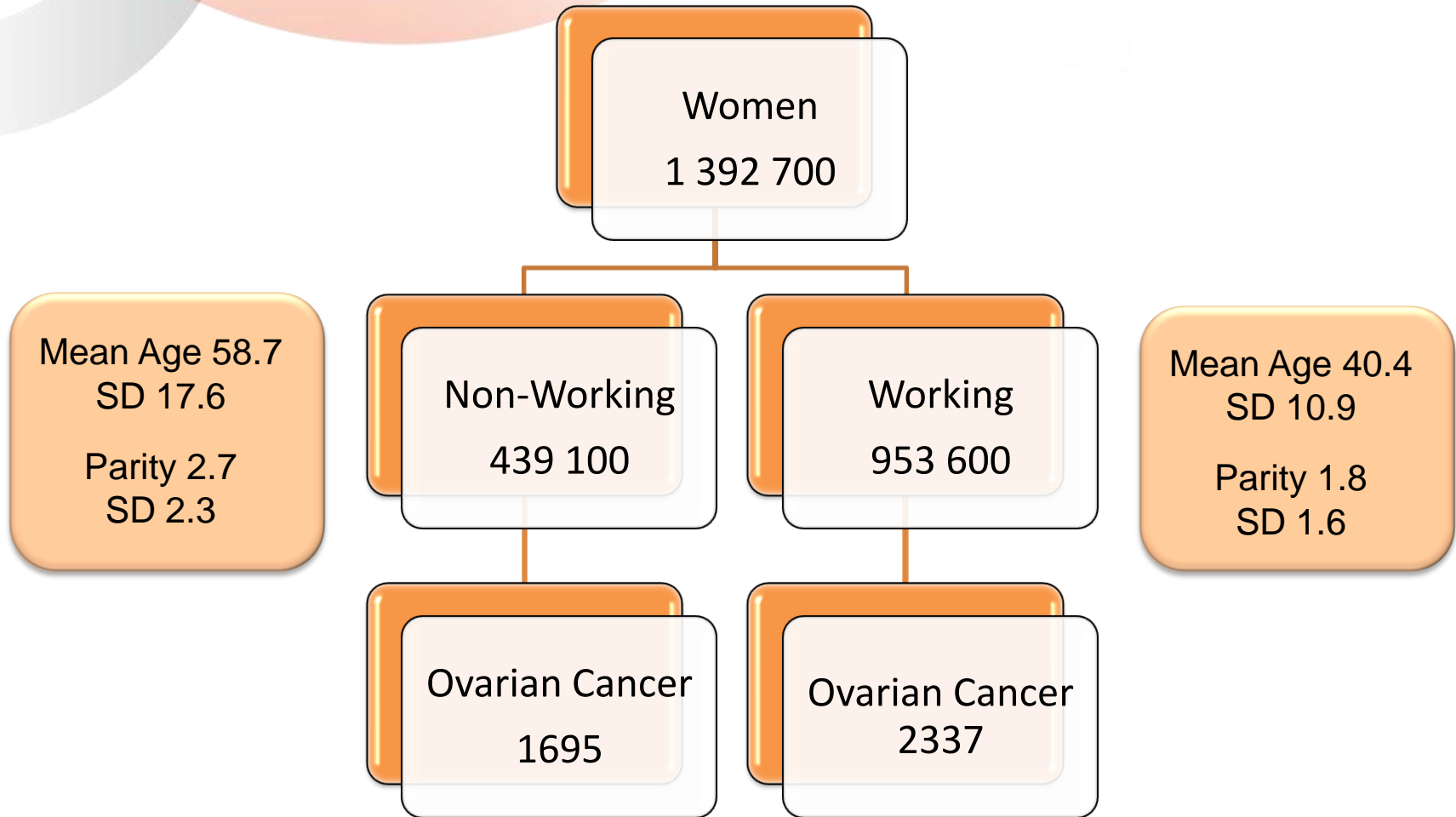
# Lung Cancer among 12,900 Male Canadian Welders



	Cases	Base Model HRR (95% CI)	Full Model HRR (95% CI)	Blue Collar HRR (95% CI)
All Welders	125	1.25 (1.05-1.50)	1.14 (0.95-1.36)	1.04 (0.87-1.25)
Construction	17	1.32 (0.82-2.13)	1.25 (0.78-2.01)	1.09 (0.68-1.76)
Metal Product Manufacture	46	1.49 (1.11-1.99)	1.32 (0.99-1.77)	1.24 (0.93-1.65)
Other Manufacture	18	1.02 (0.64-1.62)	0.93 (0.59-1.48)	0.85 (0.53-1.35)
Manufacture & Repair	36	1.08 (0.77-1.50)	0.98 (0.70-1.36)	0.90 (0.65-1.25)
Other Maintenance	8	1.60 (0.80-3.19)	1.46 (0.73-2.92)	1.33 (0.66-2.66)



# Ovarian Cancer Analyses



# Ovarian Cancer Hazard Ratios



Occupation/ Exposure	Base Model	95% CI	Fully Adjusted Model	95% CI
Hairdressers/Barbers	0.72	0.41 – 1.28	0.74	0.42 – 1.30
Managers	1.10	0.95 – 1.28	1.06	0.91 – 1.24
Secretaries	1.00	0.86 – 1.15	1.00	0.87 – 1.16
Sales Agents	0.93	0.79 – 1.10	0.97	0.83 – 1.14
Textile Workers	0.87	0.65 – 1.15	0.93	0.70 – 1.23
Printers/Graphics	0.92	0.38 – 2.21	0.92	0.38 – 2.21
Librarians	1.69	0.88 – 3.26	1.51	0.78 – 2.92
Cooks and Stewards	0.90	0.65 – 1.26	0.98	0.71 – 1.37
Religious Workers	1.73	1.09 – 2.74	1.30	0.81 – 2.07
Nurses	0.99	0.84 – 1.16	0.96	0.82 – 1.13
Teachers	1.15	0.97 – 1.37	1.04	0.86 – 1.25

# NOCCA\* versus Canada: Sinonasal Cancer in Woodworkers



- All: Sweden, Denmark, Norway, Finland, Iceland
  - Men: SIR=1.8, 95% CI=1.7-2.0, 355 cases
  - Women: SIR=1.9, 95% CI=0.9-3.5, 10 cases
- Adenocarcinoma (excluding Iceland)
  - Men: SIR=5.5, 95% CI=4.6-6.6, 122 cases
  - Women: SIR=0, 95% CI=0-11.9
- All: Canada
  - Men: HR=0.85, 95% CI=0.4-1.9, 6 cases

\*Pukkala et al. Acta Oncologica 2009;48: 646-790.

# 1991 Census Linkage: New analyses

- Shift type and breast, prostate, and other cancers
  - Development of JEM using the 1993 SLID
- Sedentary work and colorectal cancer
  - Canadian Health Measures Survey?
- Cancer among agricultural workers
  - Assessment of geographic patterns
- More analyses using quantitative Job Exposure Matrixes with data from CAREX Canada

# 1991 Census Linkage: New Methods

- Assessing methods for indirectly controlling for smoking and other potential confounders
  - In collaboration with Rick Burnett and other at Health Canada
- Comparison of results using Cox modelling versus SIR approach (used in NOCCA)
- Re-run analyses with follow-up through 2008

# Limitations



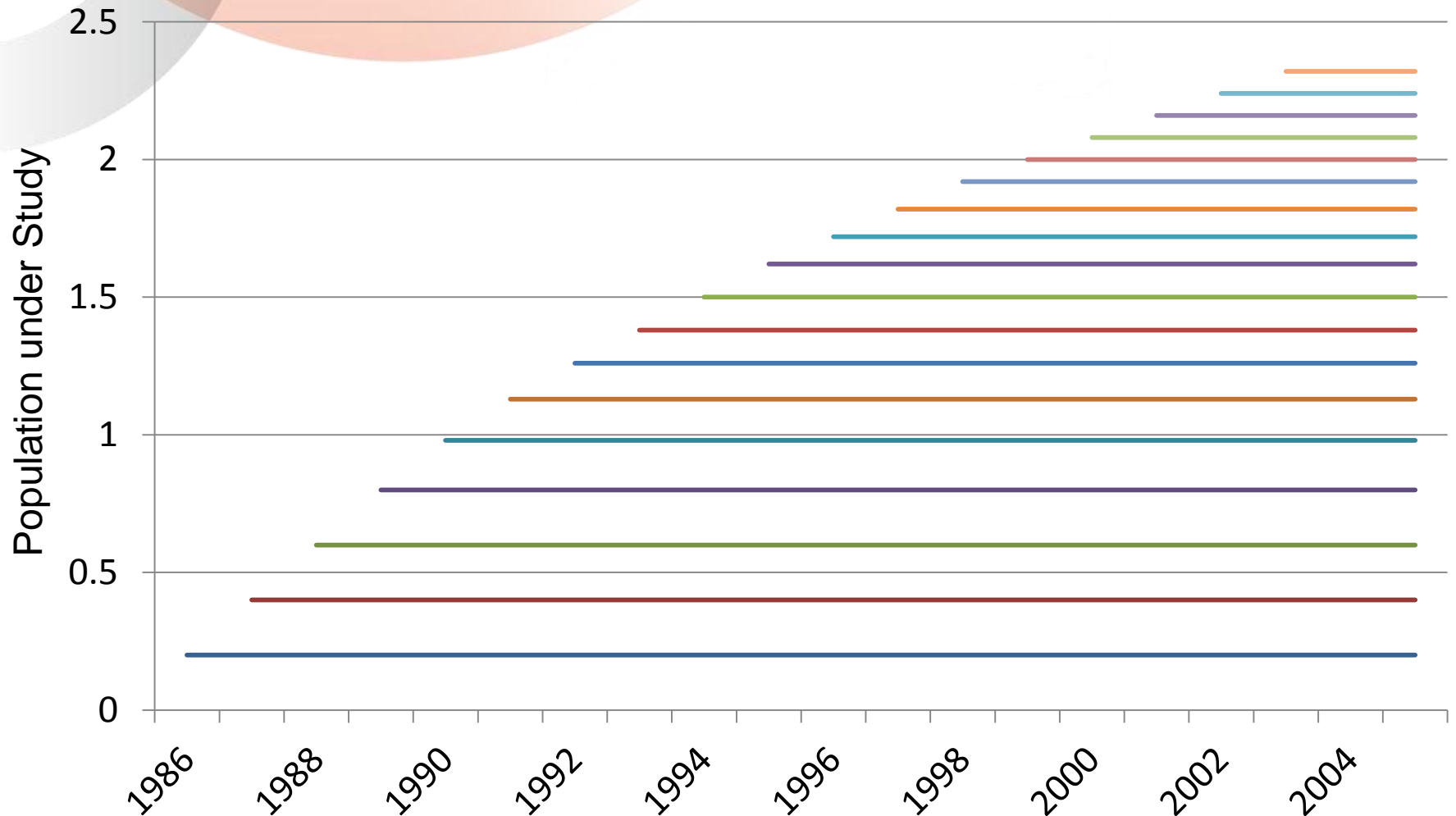
- Power: inability to look at rare cancers and rare occupational groups
  - Women in blue collar jobs
  - Specific industries in Ontario
- Potential for Confounding: how good of surrogates are income and education?
- Completeness and consistency of data across provinces

# Alternative Model: Linkage of Tumour Registry & Workers' Comp Records



- Occupation & Industry in electronic records for all lost-time
- Large Ontario cohort, but not representative
  - Skewed sample of labour force towards higher risk industries and occupations
  - Skewed sample of labour force (example: in 1991 84% < 50 years old and 71% male)

# WSIB Lost Time Injury to Ontario Tumour Registry Linkage





# Census versus Workers' Comp Records

- National versus Provincial Sample
  - Increased ability to study Ontario industries?
- Representative versus skewed cohort
  - Skewed towards exposed populations?
- Operate by Statistics Canada rules versus Ethical Review and data sharing agreements
  - Greater capabilities and speed?

# Acknowledgements



- Anne Harris, Jill Hardt, Lua Eiriksson
- Collaborators:  
Paul Peters, Michael Tjepkema, Stats Can  
Rick Burnett, Health Canada  
Eero Pukkala and NOCCA
- Funders:





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# **Towards** a cancer free workplace

<http://occupationalcancer.ca>



### 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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# History of Census Linkage for Occupational Surveillance in Canada



- Linkage of “Long Form” Census (~15% of working population) with national mortality database
  - Cancer still based on death certificates
  - Analyses of all occupations/industries without use of other Census data or a priori hypotheses
    - versus -
  - Hypothesis driven analyses

# Previous Studies of Firefighters

- Intermittent high exposure to carcinogens
- Meta-analysis of 21 cancer in 32 studies in 2006<sup>1</sup>
  - Multiple myeloma, NHL, prostate & testicular probably associated
  - Skin, brain, rectum, buccal cavity and pharynx, stomach, and colon cancer, as well as malignant melanoma and leukemia possibly related
- 2007 IARC monograph working group review of 42 studies<sup>2</sup>
  - Strongest evidence was for testicular cancer, prostate cancer & NHL

1. LeMasters et al. J Occup Environ Med. 2006;48:1189-1202.

2. IARC. Monograph Volume 98. Lyon, France, 2010.



[www.carexcanada.ca](http://www.carexcanada.ca)

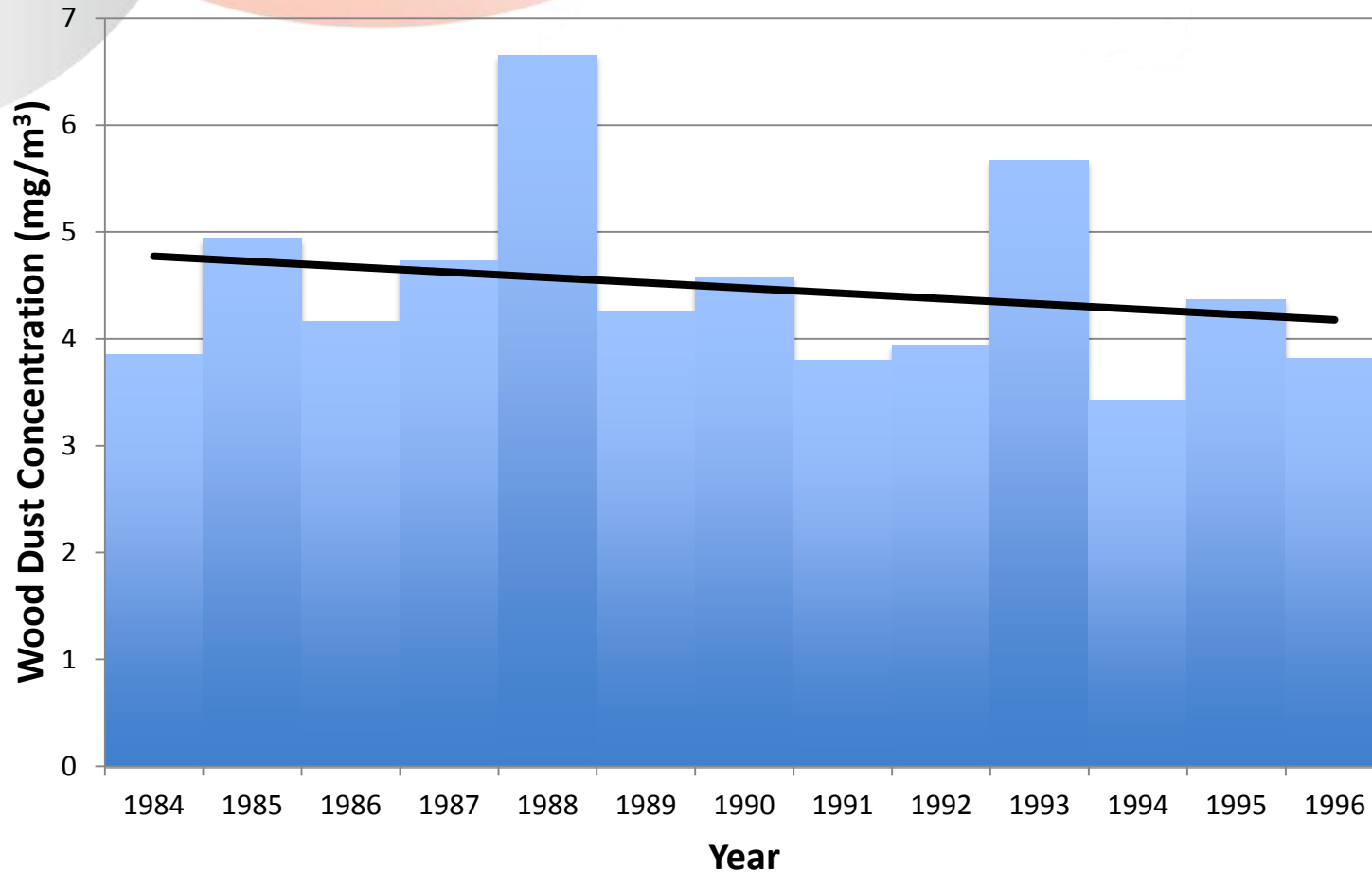
Surveillance of environmental & occupational exposures for cancer prevention

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





# Mean Wood Dust Concentration by Year: Ontario



\* Data limited to measurements  $\leq 50 \text{ mg/m}^3$

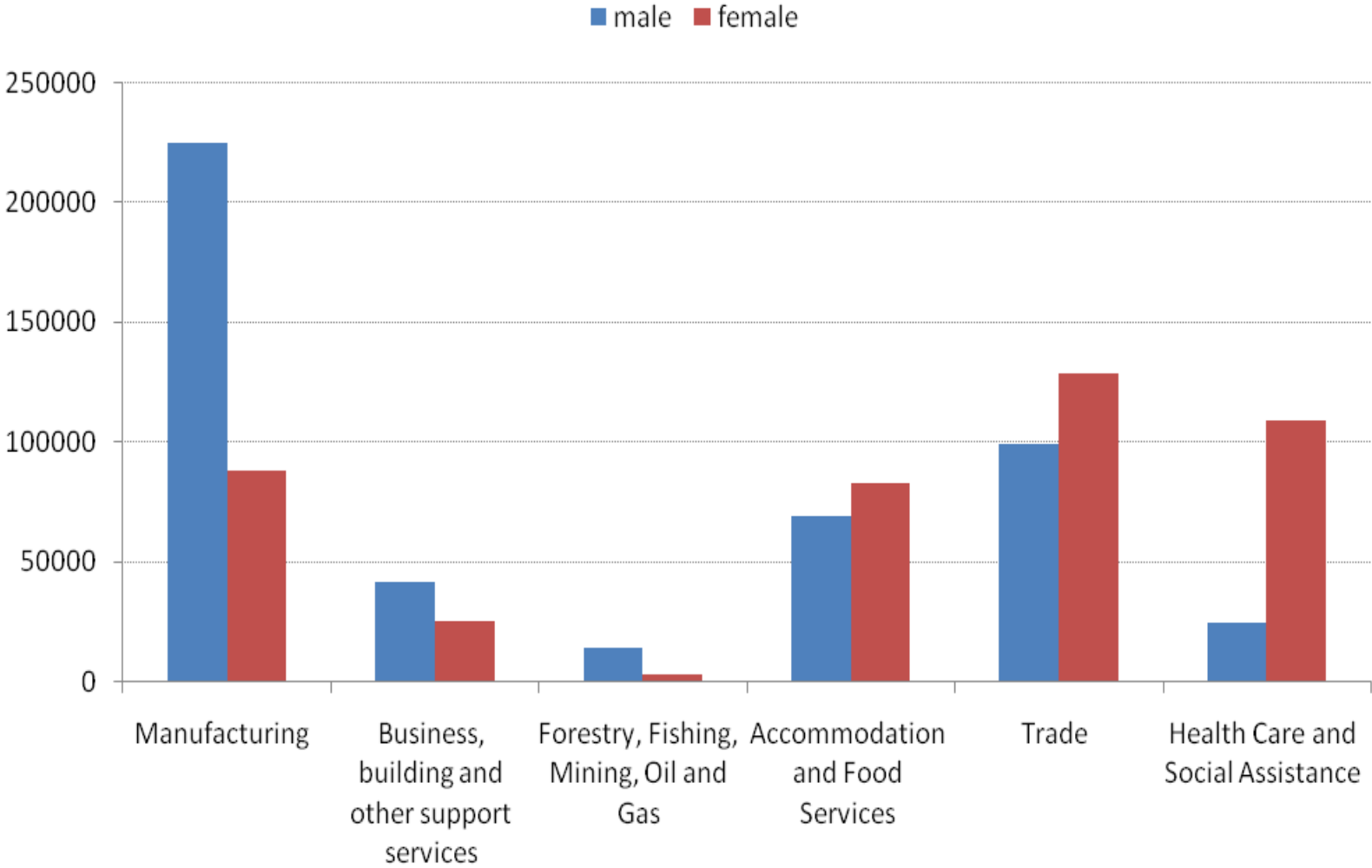
Towards a cancer-free workplace

# Wood Dust Concentration by Industry

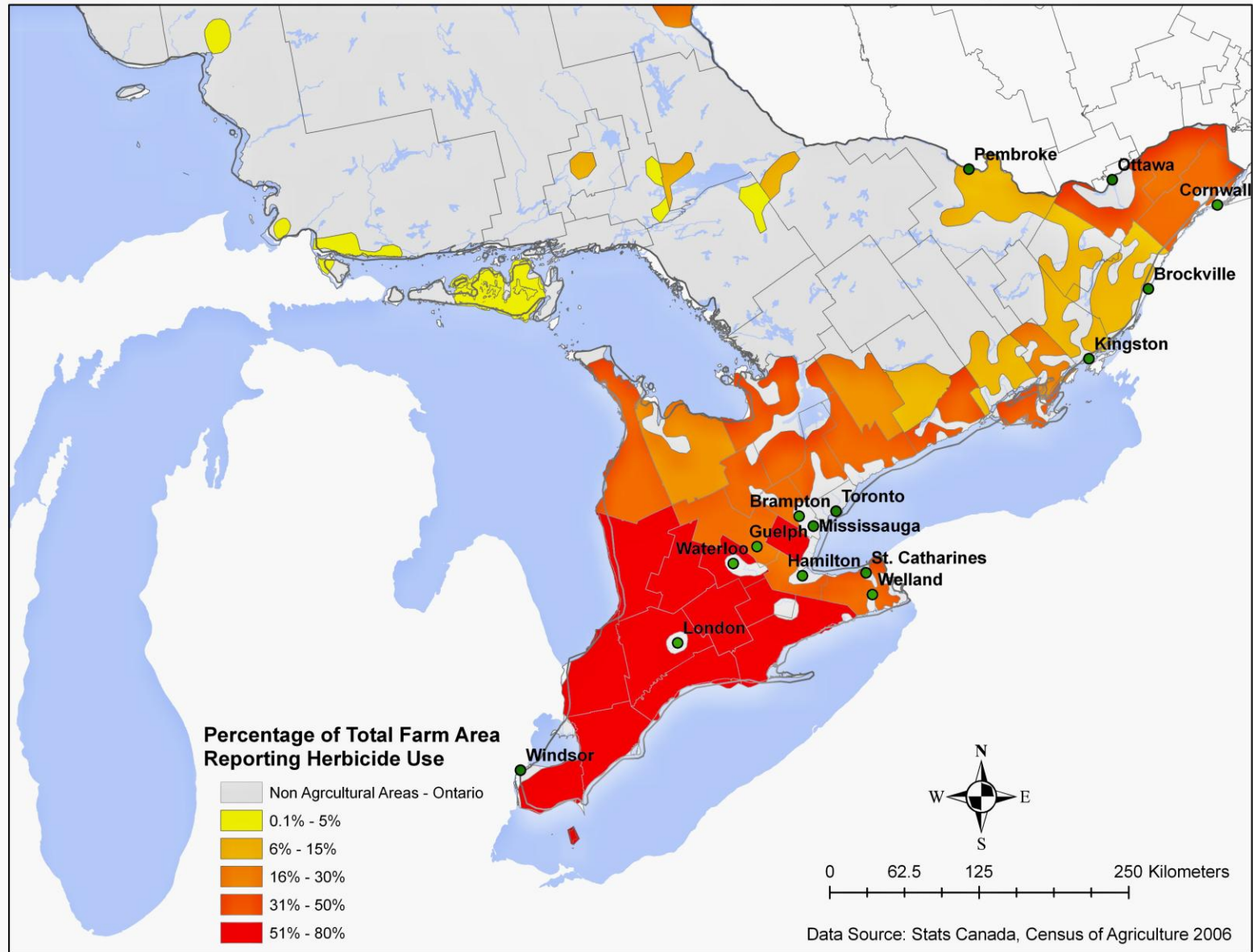


	N	Range	GM	GSD
Mining and oil and gas extraction	6	0.05-2.9	0.7	4.3
Construction	162	0.02-41	2.0	4.4
Manufacturing	2975	0.02-50	2.1	3.6
Wholesale trade	74	0.13-28	1.7	3.3
Retail trade	17	0.10-10	1.6	4.1
Real estate and rental and leasing	14	0.05-32	4.0	5.4
Professional, scientific and technical	23	0.05-10	0.7	3.2
Administrative and support	41	0.02-12	1.3	4.1
Educational services	211	0.02-43	2.0	4.0
Health care and social assistance	87	0.03-38	2.0	5.3
Arts, entertainment and recreation	8	0.17-9.3	0.6	5.2
Other services	30	0.63-20	3.9	2.6
Public administration	21	0.5-20	3.6	2.7

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



# Distribution of Herbicide Use - Ontario - High Agricultural Activity Areas



ONTARIO

QUEBEC

