



Occupational
Cancer
Research
Centre

Radon exposure and cancers other than lung among Ontario uranium miners

Garthika Navaranjan, Colin Berriault, Minh Do, Paul J Villeneuve, Paul A Demers

IARC

June 9, 2016

Towards a cancer-free workplace

Ontario uranium miners



- Uranium mining in Ontario began in the mid-1950's and continued until 1996
- Earliest evidence for increased risk of lung cancer among uranium miners in 1974
- Led to subsequent epidemiological cohort studies of Ontario uranium miners
 - Examined lung cancer mortality
 - Last follow-up of miners from 1954 to 1986



Uranium mining and health effects



Source: Morrison, 1959, *Report of the Special Committee on Mining Practices at Elliot Lake*

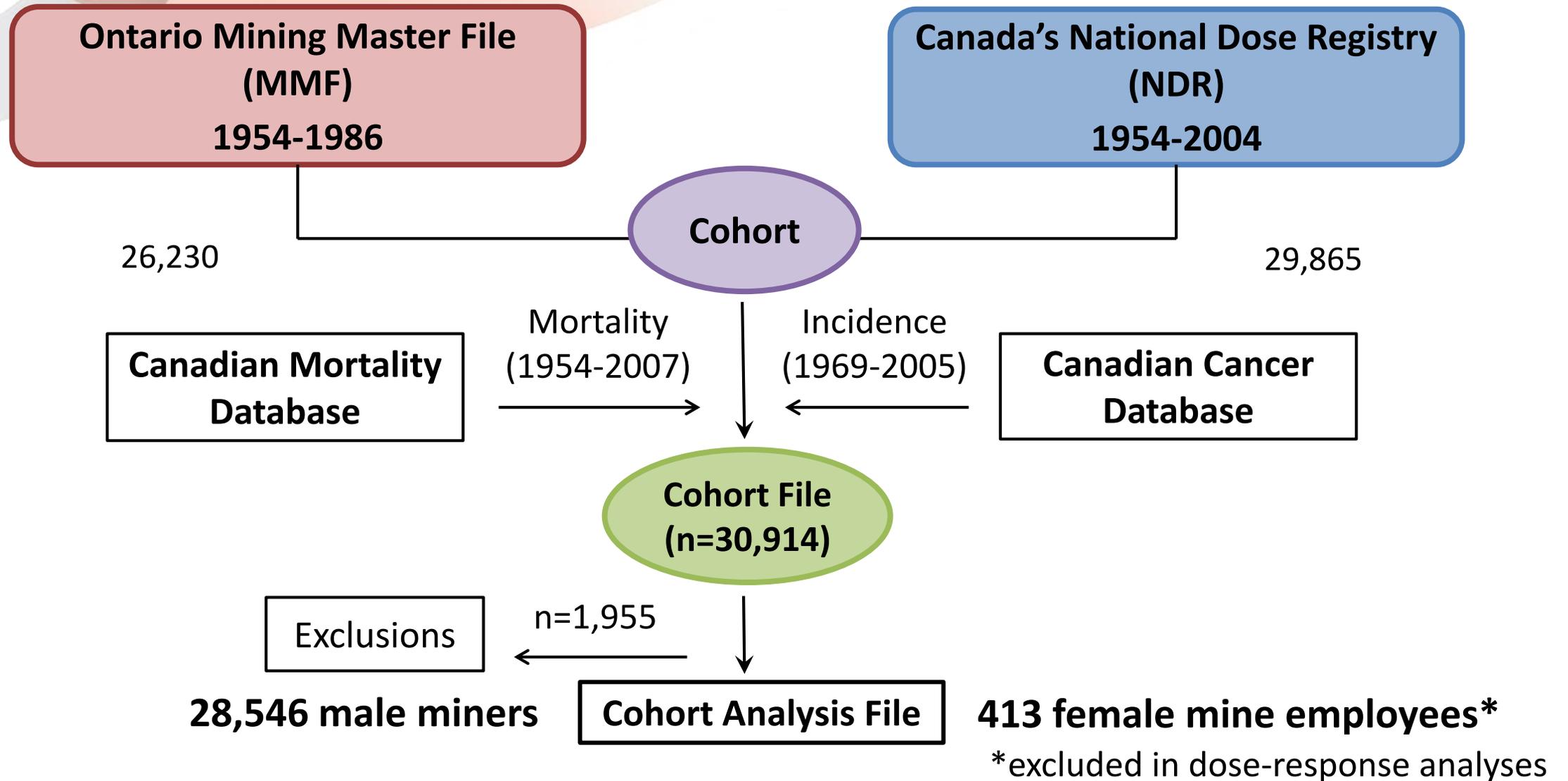
- Radon classified as Group 1 human lung carcinogen by IARC (1988)
- Association between radon exposure and other cancer sites seldom examined
- Dosimetry studies show that radon reaches other sites (kidney, stomach, bone marrow)
- Some epidemiological studies demonstrate excess mortality for other cancer sites (stomach, kidney)

Objective



To examine the dose-response relationship between occupational radon exposure and incidence of leukemia, stomach, and kidney cancer

Creation of the Ontario uranium miners cohort



Methods



Exposure Assessment:

- Cumulative exposure to radon progeny in air measured in Working Level Months (WLM)
- Exposure data available in the NDR and MMF

Statistical Analysis:

- Poisson regression to estimate relative risks with models adjusted for calendar period and attained age
- Different lag periods (2, 5, 10, 15, 20 years) applied to cumulative radon exposure

Results



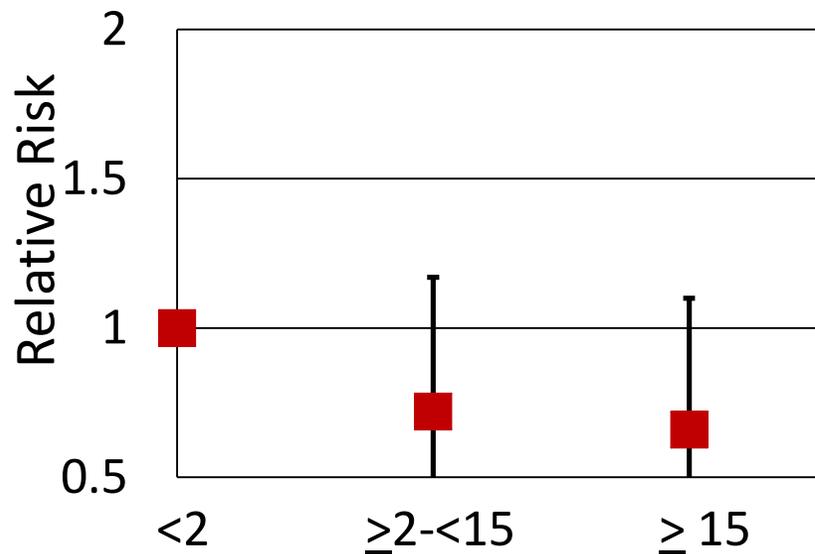
- Male miners had a mean cumulative exposure of 21 WLM over an average of five years of total employment in uranium mining
- Number of cancers observed among male miners:

Site	Incidence	Standardized Incidence Ratio (95% CI)
All Cancers	3,976	0.79 (0.77-0.82)
Lung Cancers	1,291	1.30 (1.23-1.37)
Stomach Cancers	127	0.81 (0.67-0.96)
Kidney Cancers	100	0.63 (0.51-0.76)
Leukemia	114	0.81 (0.67-0.97)

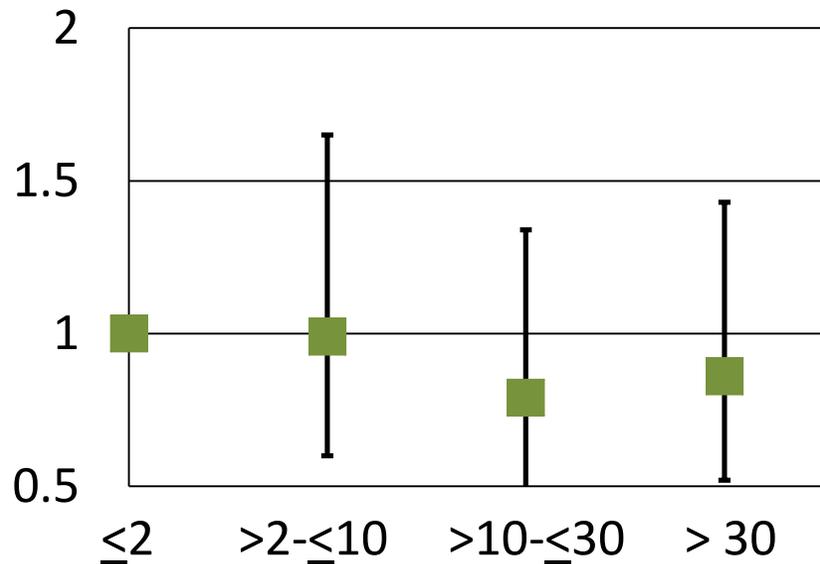
Risk of cancer incidence by cumulative radon exposure



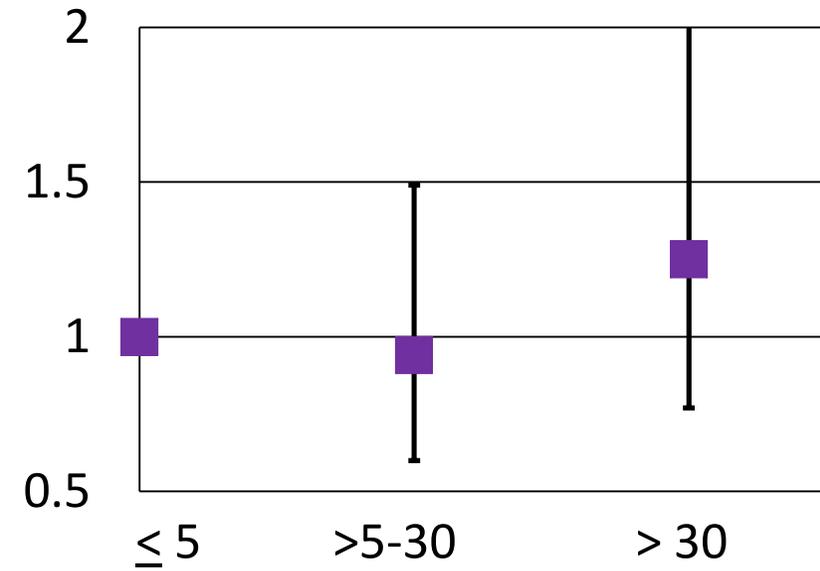
Kidney Cancer



Stomach Cancer



Leukemia



Cumulative exposure* (WLM)

* no lag applied to cumulative exposure

Discussion of findings



- No increased incidence of leukemia, stomach and kidney cancer, at low levels of cumulative respiratory radon exposure
- For stomach cancer, ingestion of water contaminated with radon can cause high levels of exposure to stomach lining
- Increased risks of leukemia observed in Life Span Study, which represents acute moderate to high doses
- Need better dose estimation of radon to organs other than lung

Conclusions



- Limitations:

- Lack of smoking data
- Limited data on co-exposures (diesel engine exhaust, silica, arsenic, nickel)

- Strengths:

- Large sample size and long period of follow-up
- National cancer incidence linkage
- High quality exposure data

The Ontario uranium miners cohort continues to be a valuable resource for studying the health effects from relatively low dose radon exposure.

Acknowledgements



- Colin Berriault
- Minh Do
- Paul Villeneuve
- Paul Demers
- Loraine Marrett
- John McLaughlin
- Sang-Myong Nahm
- Robert Semenciw
- Douglas Chambers

This study was funded by the Canadian Nuclear Safety Commission

Contact

Garthika.Navarajan@occupationalcancer.ca