



A DISCUSSION ON THE IMPORTANCE OF THE NATIONAL RADON PROGRAM

Jing Chen

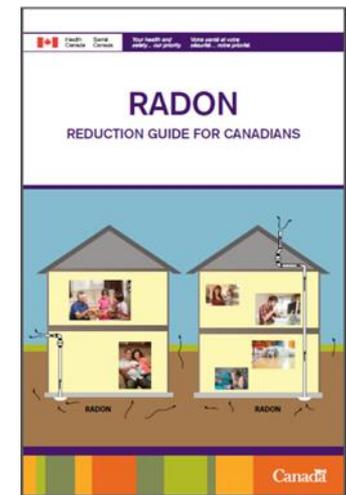
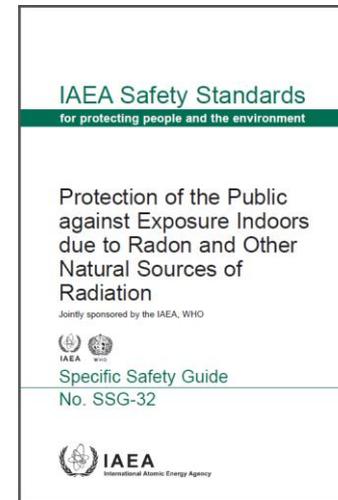
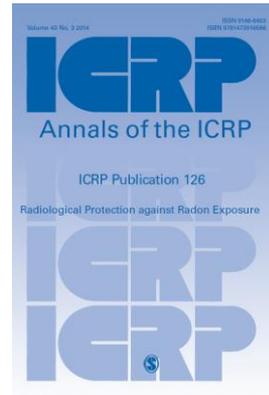
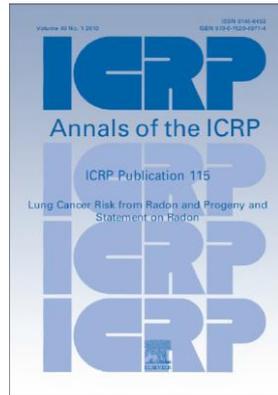
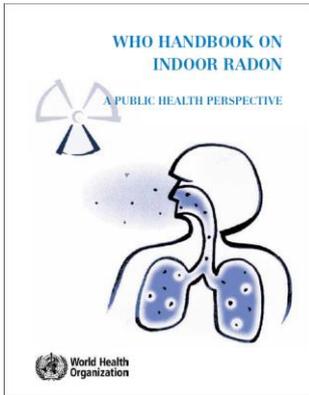
Radiation Protection Bureau, Health Canada



WHY SO IMPORTANT

In addition to all well known facts

- Canadian population risk of radon induced lung cancer assessed with different risk models
- Compare radon exposure in Canadian homes and uranium mines



RADON RISK ASSESSMENT

- Epidemiological studies have confirmed that radon in homes increases the risk of developing lung cancer in the general population.
- To address public concerns regarding radon risk and variations in risk estimates based on various risk models in the literature, lifetime lung cancer risks were calculated with five well-known risk models, and the results were compared.
- Variations in population risk estimation among various models are presented and discussed.



- EPA/BEIR-VI risk model:
a radon risk model developed by USEPA,
a reasonable average of the estimates from the two BEIR
VI preferred models resulting from the joint analysis of 11
cohort studies of radon exposed miners ($\beta=0.0634/\text{WLM}$).

$$e(a) = \beta(W_{5-14} + 0.78W_{15-24} + 0.51W_{25+})\phi_{age}(a)$$

- Risk model of European miners:
the joint analysis of three European cohorts of uranium
miners in the Czech Republic, France and Germany
($\beta=0.052/\text{WLM}$).

$$e(a) = \beta(W_{5-19} + 0.42W_{20-34} + 0.14W_{35+})\phi_{age}(a)$$



Radon Risk Models

- Model of European pooling analysis of 13 case–control studies on radon in homes in exposure time window (ETW) of 5-34 yr: $e(a) = \beta W_{5-34}$
using $\beta=0.006/\text{WLM}$ for measured radon, and $\beta=0.012/\text{WLM}$ adjusted for year-to-year random variability in indoor radon concentration.
- Model of North American pooling analysis of 7 case–control studies on radon in homes in ETW of 5-30yr: $e(a) = \beta W_{5-30}$
using $\beta=0.0097/\text{WLM}$ for all data and $\beta=0.014/\text{WLM}$ for males and $\beta=0.016/\text{WLM}$ for females derived from the analyses restricted to individuals who lived in only one or two homes in the ETW with at least 20 years covered by dosimetry
- Model of Chinese pooling analysis of 2 case–control studies on radon in homes in ETW of 5-30yr: $e(a) = \beta W_{5-30}$
using $\beta=0.012/\text{WLM}$ for all data and $\beta=0.028/\text{WLM}$ derived from the analyses restricted to individuals who lived in only one home in the ETW of 5-30 yrs prior to recruitment with complete dosimetry coverage.

Population Attributable Risk

Attributable risk of lung cancer due to radon exposure for Canadian males and females based on various risk models:

Risk model	males	females
EPA/BEIR-VI	14%	15%
European Miner	16%	17%
North American Residential Pooling (all data)	6.8%	7.0%
North American Residential Pooling (restricted data)	9.5%	11%
European Residential Pooling (measured radon)	5.0%	5.1%
European Residential Pooling (adjusted radon)	9.5%	9.7%
Chinese Residential Pooling (all data)	8.3%	8.5%
Chinese Residential Pooling (complete dosimetry)	17%	18%



The results showed that the Canadian population risk of radon induced lung cancer can vary from 5.0% to 17% for men and 5.1% to 18% for women based on the radon risk models considered.

Averaged over all risk models and sub-models with restricted data, 11% of lung cancer deaths among Canadians were attributable to indoor radon exposure.

If only considering residential risk models with improved dosimetry, on average, 13% of lung cancer deaths among Canadian males and 14% of lung cancer deaths among Canadian females were attributable to long-term indoor radon exposure.



For many people, the risk predicted by models is often viewed as a “theoretical” or “hypothetical” risk which may not be real.

Various models are mathematical descriptions of epidemiologically observed *real* risks in different environmental settings, such as in mines and in residential homes.

It is perfectly normal that large variations exist for observed outcomes in different environmental settings and also in changing environment.

While living with such large variations, we should always remember the fact that *long term exposure to elevated radon concentrations increases the risk of developing lung cancer.*



COMPARE RADON EXPOSURE IN HOMES AND IN MINES

- The history of lung cancer in uranium miners is well known for over hundreds of years when the disease was referred to as “miner’s disease” or “mountain sickness”.
- Only recent scientific studies have provided strong evidence to link an increased risk of developing lung cancer to levels of radon found in homes.
- With the lowering of radon guideline, a National Radon Program was developed and implemented.
- Significant progress has been made in the Program since its inception in 2007.
- However, the Program is still facing challenges to further increase radon awareness, to encourage more Canadians to take appropriate actions to reduce radon exposure.



Radon in Canadian Homes

- From 2009 to 2011, a national radon survey was carried out in roughly 14,000 homes in 121 health regions across Canada.

GM = 41.9 Bq/m³, GSD = 2.8, AM = 72 Bq/m³

- A later radon and thoron survey in 33 Canadian cities and 4000 homes confirmed the radon distribution observed in the cross Canada radon survey.

For radon: AM = 96 Bq/m³

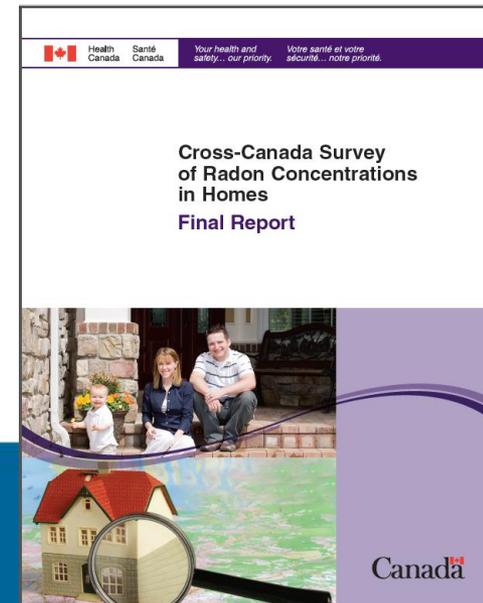
- Weighted from the two surveys

AM = 77 Bq/m³

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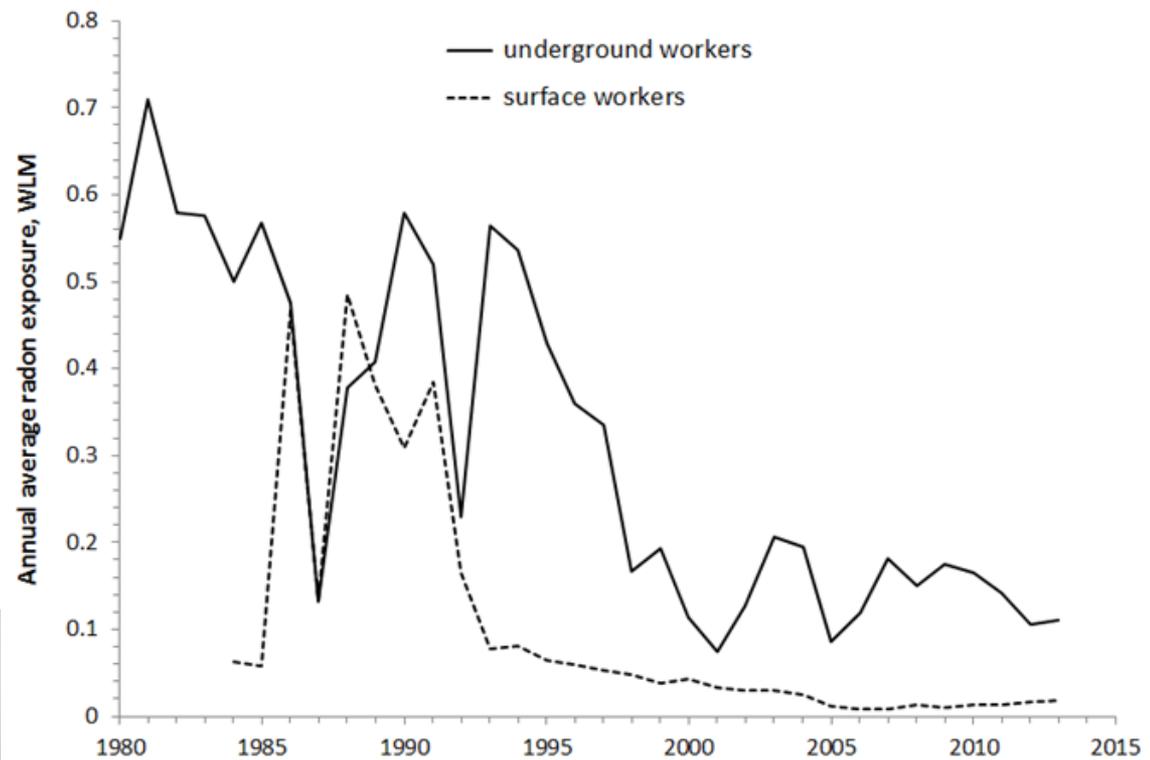
RESULTS OF SIMULTANEOUS RADON AND THORON MEASUREMENTS IN 33 METROPOLITAN AREAS OF CANADA

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Radon in Canadian Uranium Mines

- In the NDR, exposure to radon decay products has been recorded in WLM for all registered workers in the mining industries.
- Average radon exposures in WLM for workers in underground and surface activities from 1980 to 2013, see Figure:
- In the recent decade, radon exposure in uranium mines was rather stable.
- The annual WLMs avg over 2004 – 2013
underground workers: 0.14 WLM
surface workers: 0.014 WLM.



Comparisons

- Use an equilibrium factor of 0.4 and an occupancy of 2000 hours per year at work and 7000 hours per year at home,
- Continue exposure to 1 Bq/m³ results in an annual exposure of
1.26x10⁻³ WLM at work 4.4x10⁻³ WLM at home
- Average radon exposures in homes and in uranium mines:

Environmental setting	Average radon level Bq/m ³	Annual radon exposure WLM, mSv
Residential homes	77	0.34 WLM, 4.1 mSv
Surface workers in uranium mines	11	0.014 WLM, 0.17 mSv
Underground workers in uranium mines	111	0.14 WLM, 1.7 mSv



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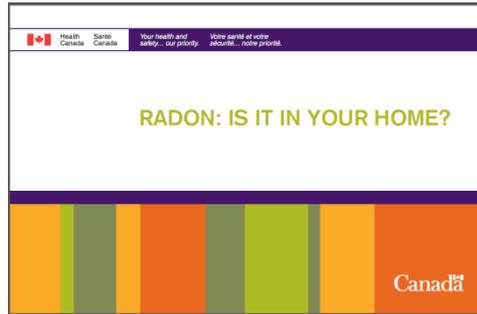
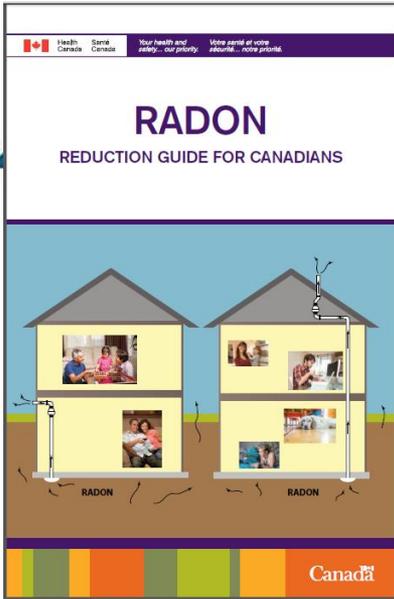
- Average radon concentration in residential homes is comparable to the average radon levels in uranium mines.
- Workers in uranium mines are not necessarily exposed to higher radon level in their workplace than in their homes.
- For a miner, annual effective dose from exposure to radon at home could be more than twice the dose received from radon in the mine.



- Nowadays, radon exposure in the average Canadian home is higher than that for the average underground miner.
- While living with large variations in risk assessment for different environmental settings, we should always remember the fact that long term exposure to elevated radon concentrations increases the risk of developing lung cancer.
- The former “miner’s disease” is a risk for all of us at home.
- With an effective National Radon Program, the risk of radon induced lung cancer can be significantly reduced in residential settings as has been achieved in workplaces for miners.



Thanks for your attention!



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Canadian - National Radon Proficiency Program (C-NRPP) is a certification program designed to establish guidelines for training professionals in radon services.

Radon is a gas which can be found in concentrated levels inside homes. When people are exposed to concentrated amounts of radon gas it can increase their chance of developing lung cancer. If a *non-smoker* reduces radon levels in their home and workplace it may prevent their chance of developing lung cancer. If a *smoker* reduces radon levels in their home and workplace it may reduce their chances of developing lung cancer.

Consumers - [Find a Professional](#)

As a consumer you will benefit finding a C-NRPP certified professional because they have been trained to a recognized standard of practice and are held accountable for working to established guidelines.

Professionals - [How to become a C-NRPP Professional](#)



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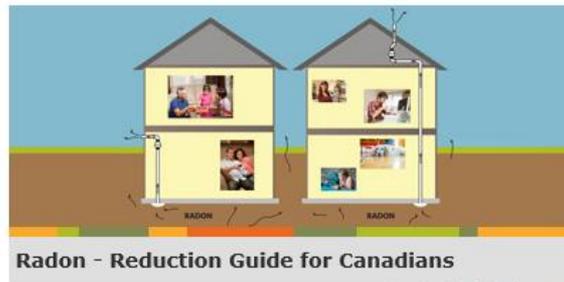
Radon testing is relatively simple and inexpensive. Radon test devices can be purchased by phone or over the internet and are available at some home improvement retailers across Canada. For more information on do- it-yourself radon test kits contact Health Canada's Radiation Protection Bureau at radon@hc-sc.gc.ca or 613-946-6384.

You can also hire a certified radon measurement professional to come and test your home. Health Canada recognizes the Canadian certification program, [the Canadian National Radon Proficiency Program \(C-NRPP\)](#) 1-855-722-6777. Lists of certified Canadian measurement and mitigation professionals are available through the [Canadian National Radon Proficiency Program](#).

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Radon



Take The Lung Association's radon quiz

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