CAREX CANADA

# Radon
# Methods for Lifetime Excess Cancer Risk Estimates
## Environmental exposures

## Table of Contents

1. Methods Overview .................... 2

2. Calculating Lifetime Cumulative Exposure .................... 2

3. Standard Assumptions .................... 2

Unit Risk Factors .................... 3

4. Lifetime Excess Cancer Risk .................... 4

# 1. Methods Overview

Lifetime excess cancer risk due to exposure to radon is calculated by combining data on measured concentrations in outdoor air and indoor air with standard inhalation rates to calculate lifetime cumulative exposure.

Multiplying the estimated cumulative intake by a unit risk factor produces an estimate of the lifetime excess cancer risk.

LIFETIME CUMULATIVE INTAKE (DOSE) X UNIT RISK FACTOR = LIFETIME EXCESS CANCER RISK

# 2. Calculating Lifetime Cumulative Exposure

Lifetime cumulative exposure is calculated for each exposure pathway (outdoor air and indoor air). First, the cumulative intake is calculated for each of five lifestages (adult, teen, child, small child, and infant). These are then weighted by the amount of time spent in each lifestage and summed to produce the lifetime cumulative exposure for each pathway.

FOR EACH LIFESTAGE:

CONCENTRATION IN OUTDOOR AIR X DETECTION FREQUENCY* X AMOUNT OF AIR INHALED PER DAY WHILE OUTSIDE X NUMBER OF DAYS IN LIFESTAGE = **TOTAL INTAKE** FOR LIFESTAGE

FOR EACH LIFESTAGE:

- ADULT (20 to 70 )
- TEEN (12 TO 19)
- CHILD (5 TO 11)
- SMALL CHILD (6 MO TO 4)
- INFANT ( 0 TO 6 MO)

WEIGHT EACH **TOTAL INTAKE** BY PERCENTAGE OF LIFETIME SPENT IN LIFESTAGE, THEN SUM = **LIFETIME CUMULATIVE INTAKE**

* Detection frequency indicates how often the substance is present:
1.0 = always present
0.1 = present only 10% of the time

# 3. Standard Assumptions

We assume these characteristics remain constant for each lifestage. This is rarely true for any single individual, but using a standard set of assumptions allows us to provide a relative ranking for known and suspected carcinogens across different exposure routes.

| CHARACTERISTIC (age) | Adult (20 to 70) | Teen (12 to 19) | Child (5 to 11) | Small Child (6 months to 4) | Infant (0 to 6 months) |
|---|---|---|---|---|---|
| Bodyweight (kg) | 70 | 57 | 27 | 13 | 6 |
| Breathing ($m^3$ per day) | 23 | 21 | 12 | 5 | 2 |
| Drinking water (litres per day) | 1.5 | 1.3 | 0.9 | 0.8 | 0.75 |
| Ingestion of dust (milligrams per day) | 0.02 | 0.02 | 0.035 | 0.05 | 0.035 |
| Time outdoor (percent of day) | 6.25 | 6.25 | 8.2 | 8.2 | 8.2 |
| Time indoor (percent of day) | 93.75 | 93.75 | 91.8 | 91.8 | 91.8 |

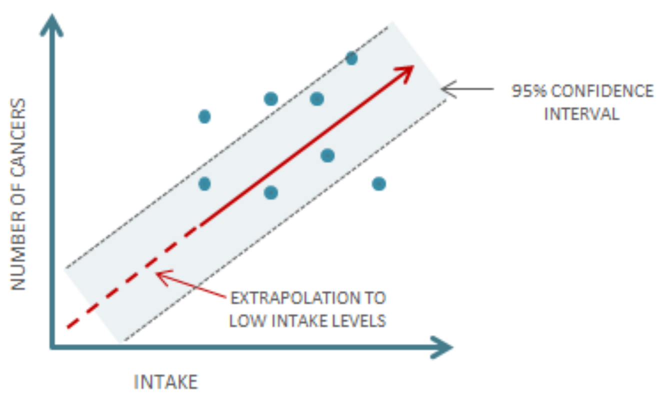
Bodyweights and ingestion rates for air, drinking water and dust*: Investigating Human Exposure to Contaminants in the Environment: A Handbook for Exposure Calculations. Health Canada. 1995.

*assumed to be the same as ingestion rates for soil

Time spent indoor and outdoor: Federal Contaminated Site Risk Assessment in Canada Part VI: Guidance on Human Health Detailed Quantitative Radiological Risk Assessment ($DQRA_{RAD}$). Health Canada. 2010.

## Unit Risk Factors

There is a lot of uncertainty in predicting excess cancer risk in humans, but by using standard cancer potency factors, we can make relative comparisons between substances and exposure routes.

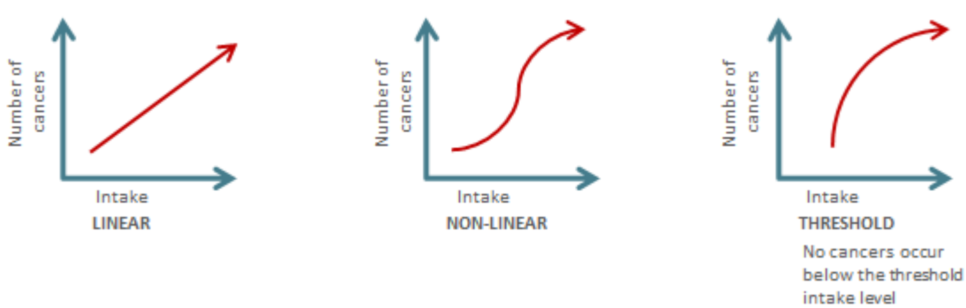



When the number of cancers increases in direct proportion to the intake (dose), it is possible to predict the number of cancers expected for any given intake, using the slope of the line that is the best fit for the data. Cancer potency factors are also called oral or inhalation slope factors.

Cancer potency factors are often developed using data that reflect relatively high intake levels. When intake levels are low, the best fit line must be extrapolated below the point of any observed data.

The cancer potency factors used by Health Canada, US EPA and California OEHHA assume a linear relationship and reflect the slope of the upper bound of the 95% confidence interval.

The real relationship between intake and the number of cancers may not always be linear. This adds uncertainty to the extrapolation of the cancer potency factor to intakes lower than those observed in the existing studies.



# 4. Lifetime Excess Cancer Risk

The potential lifetime excess cancer risk assumes that pollutant concentrations and intake rate remain the same for an entire lifetime of 70 years. Radon levels may change from place to place due to geological factors and individual building conditions. For any one person, these exposures may change as they move from place to place. Using potential lifetime excess cancer risk allows us to make comparisons between pollutants and exposure routes, but does not allow us to estimate the actual risk for any one individual.

Potential lifetime excess cancer risk indicates how many *additional* cases of cancer would be expected in a population of 1 million people, given the input pollution concentrations and intake levels.

| LIFETIME EXCESS CANCER RISK | | |
|---|---|---|
| 10,000 per million people | = | One extra cancer per 100 people |
| 1,000 per million people | = | One extra cancer per 1,000 people |
| 100 per million people | = | One extra cancer per 10,000 people |
| 10 per million people | = | One extra cancer per 100,000 people |
| 1 per million people | = | One extra cancer per 1,000,000 people |
| 0.1 per million people | = | One extra cancer per 10,000,000 people |
| 0.01 per million people | = | One extra cancer per 100,000,000 people |
| 0.001 per million people | = | One extra cancer per 1,000,000,000 people |
| 0.0001 per million people | = | One extra cancer per 10,000,000,000 people |