United Nations Scientific Committee on the Effects of Atomic Radiation

UNEP

International Conference on
RADIATION PROTECTION IN MEDICINE
Setting the Scene for the Next Decade

Uncertainties in cancer risk estimates for exposure to ionising radiation

Peter Jacob

Lead writer for the UNSCEAR Uncertainty Report

Sources of uncertainty in epidemiology

- Statistical fluctuations
- Uncertainties in effect information:
  selection bias, information bias, confounding, changes in information over time
- Uncertainties in exposure and dose assessment
- Uncertainties of model assumptions in evaluating the data

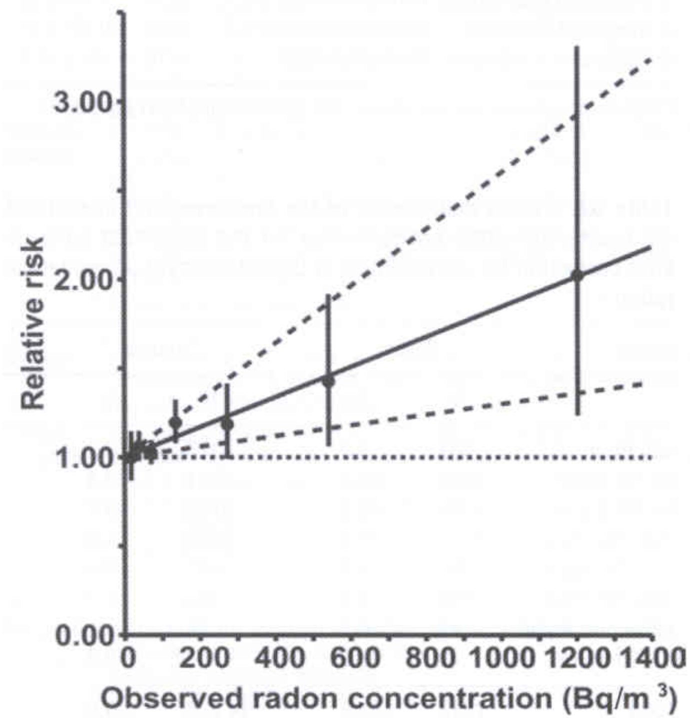
Many analyses underestimate uncertainty
or **even the risk itself**

Correcting for exposure uncertainty

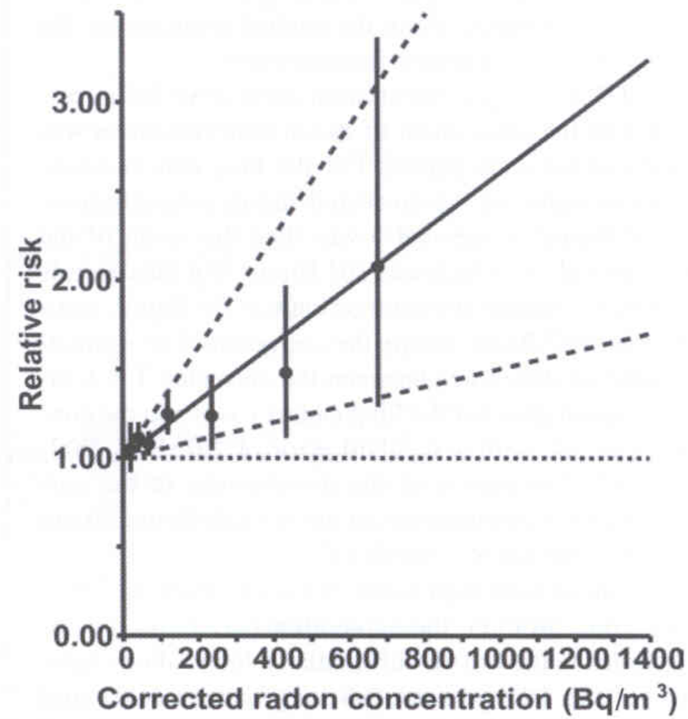
Lung cancer from residential radon (Darby, Scand J Work Environ Health 2006)

Relative risk for difference in residential radon of 100 Bq m^{-3}

without correction
1.08 (95%CI: 1.03; 1.16)



with correction
1.16 (95%CI: 1.05; 1.30)



Uncertainties due to model assumptions

Excess relative risk for leukemia 10 years after exposure of 7-year old LSS members, bone marrow dose of 1 Gy (Walsh, Radiat Environ Biophys 2011)

Reference for model	ERR with 95% confidence interval
BEIR VII, Phase II (2006)	20 (-12; 38)
Little, Radiat Res (2008)	19 (0.2; 36)
Preston, Radiat Res (2004)	11 (4; 22)
Richardson, Radiat Res (2009)	86 (12; 582)
Schneider, Adv Space Res (2009)	19 (2; 37)
UNSCEAR 2006 Report (2009)	18 (0.9; 35)
Multi-model inference	18 (0.6; 36)

Transfer of risk estimates

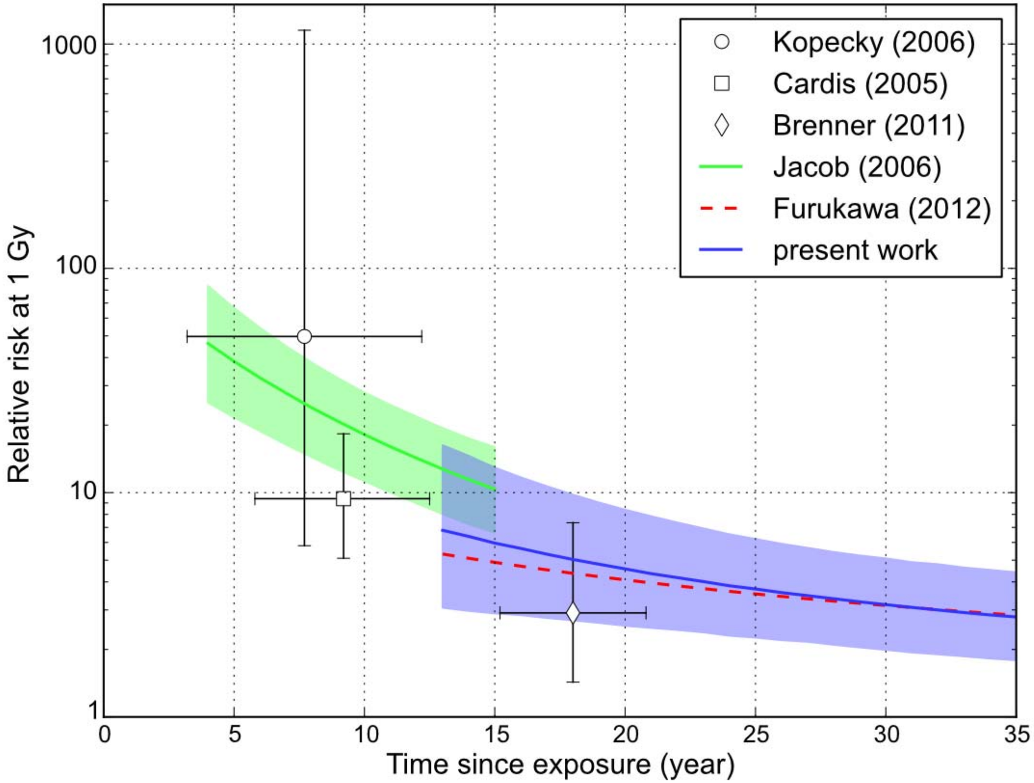
Often the population of interest differs from the population, for which risk was estimated in an epidemiological study, e.g. by

- baseline rate (e.g., different country, calendar year)
- age distribution
- gender distribution
- dose or dose rate
- type of radiation

Knowledge on individual sensitivity is limited

Thyroid cancer risk model

Excess relative risk for thyroid cancer
after exposure of ten-year old children with a thyroid dose of 1 Gy



Thyroid cancer cases

Number of thyroid cancer cases in a hypothetical group of 10 000 Ukrainians having been exposed at age of 10 years with a thyroid dose of 200 mGy

Period	Sex	Baseline	Excess	Total
1986-2004	male	1 (-)	0.6 (0.1; 2)	2 (1; 3)
1986-2004	female	6 (-)	5 (1; 15)	11 (7; 20)
Lifetime	male	14 (-)	7 (1; 21)	20 (15; 35)
Lifetime	female	62 (-)	59 (11; 210)	120 (73; 270)

Uncertainty dominated by uncertainty in risk model for LSS, and by uncertainty in transfer from acute to protracted exposure

Solid cancer incidence

Solid cancer in hypothetical group of 100 male nuclear workers in UK after exposure in age period 30 to 44 years with whole body dose of 100 mGy

Total cancer cases	Excess cases	Attributable fraction (%)
42 (39; 44)	0.8 (0.3; 1.6)	2 (0.8; 4)

Attributable fraction decreases
from 3.6 (1.6; 6.4)% for cancer at age of 45 to 49 years
to 1.7 (0.6; 3.3)% for cancer at age of 75 to 79 years

Uncertainty in transfer from acute to protracted exposure most important

Conclusions

UNEP

Uncertainty of risk estimate for solid cancer after exposure with 100 mSv: about a factor of 2-3 up or down from best estimate

Uncertainty of excess risk for specific cancer types is considerably larger than for all solid cancer

Uncertainty of cancer risk estimates after exposure to ionizing radiation is often underestimated

Uncertainties need to be fully addressed for
•attributing effects to radiation exposure
•informed decision making

THANKS FOR YOUR ATTENTION