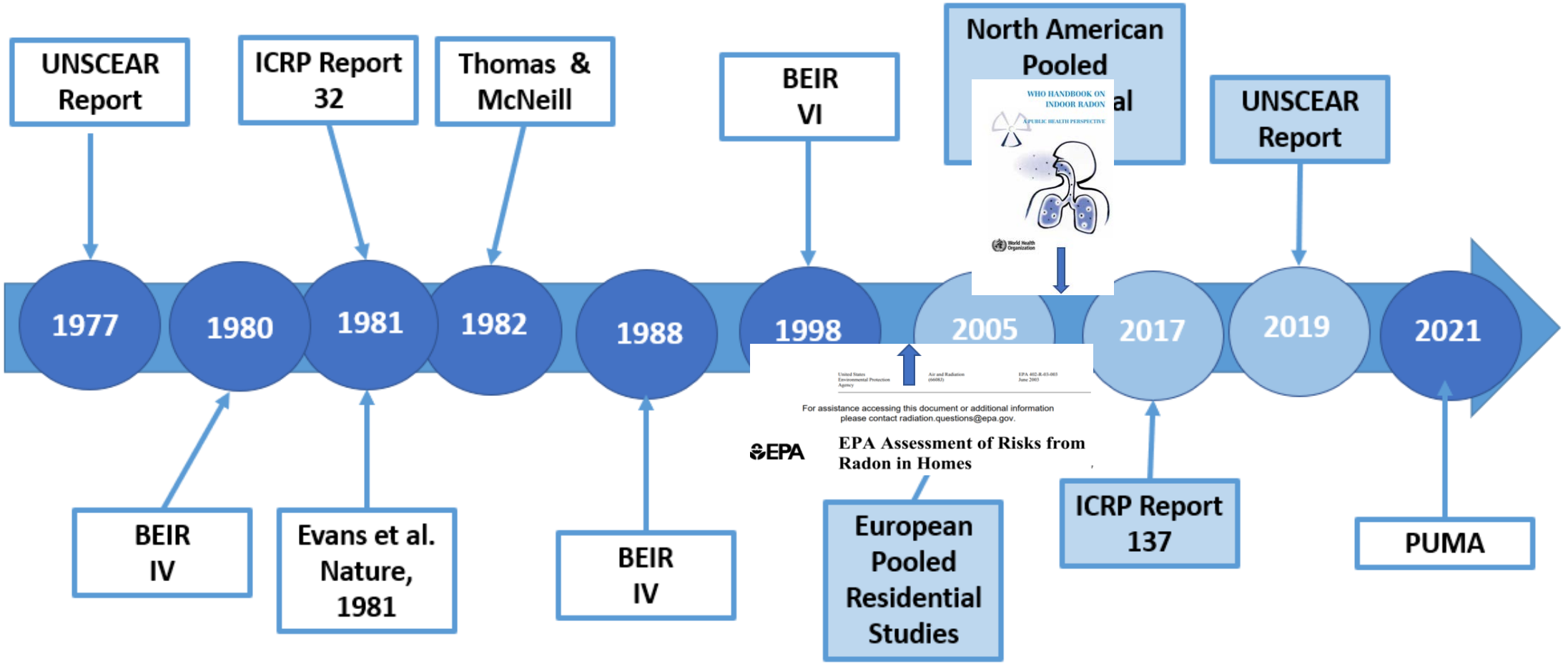
AFTER BEIR VI and BEIR VII
GILBERT W. BEEBE WEBINAR SERIES

What We Don't Know About Radon Today

October 20, 2021

Bill Field, PhD, MS
Department of Occupational and Environmental Health
Department of Epidemiology
College of Public Health
The University of Iowa

Timeline of Radon Lung Cancer Risk Assessment



Lubin, REH, Vol 25 (1): 2010

Pooled Analyses – Residential Studies

European (13)

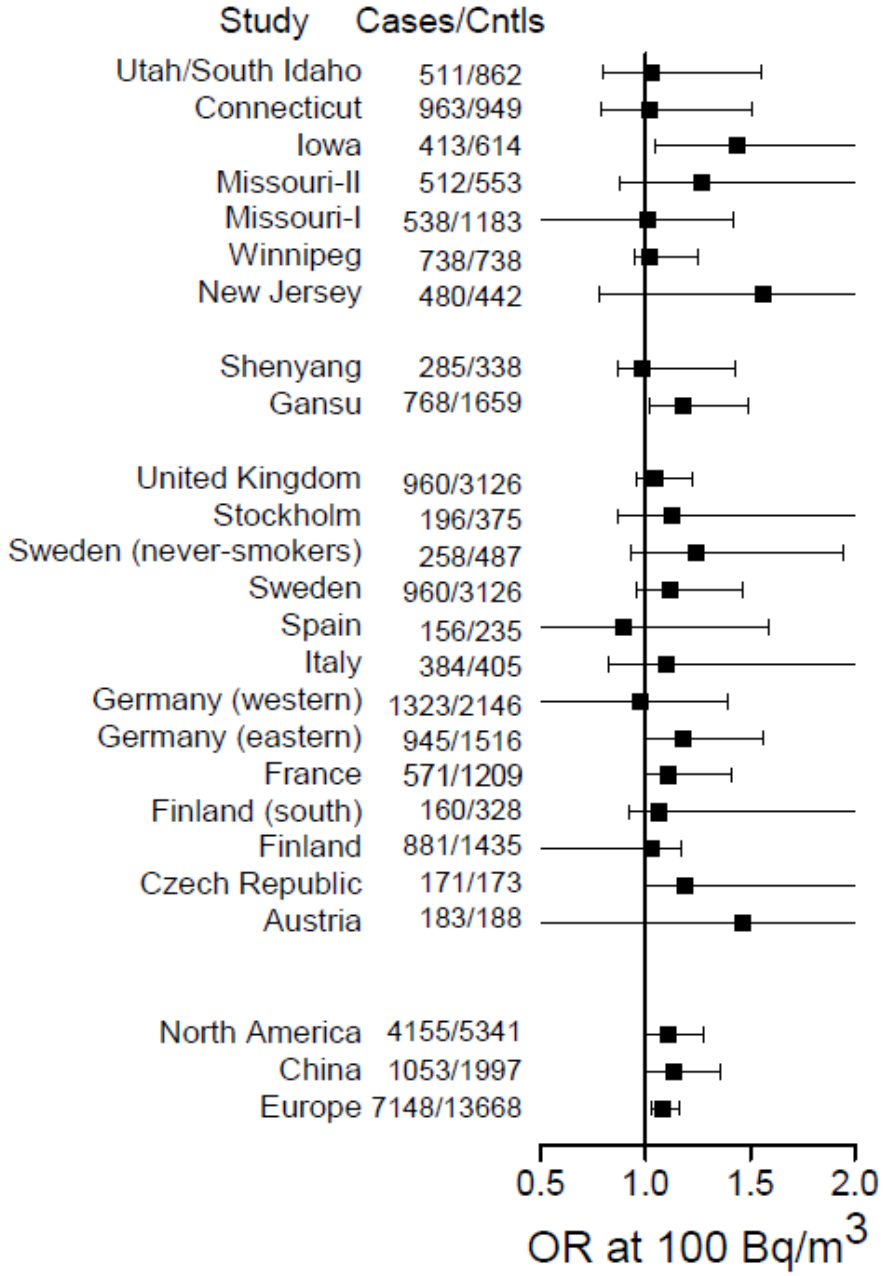
- Austria, Czech Republic, Finland (nationwide), Finland (south), France, Germany (eastern), Germany (western), Italy, Spain, Sweden (nationwide), Sweden, Sweden (Stockholm), United Kingdom

North American (7)

- Connecticut, Iowa, Missouri I, Missouri II, New Jersey, Winnipeg, Utah-South Idaho

Chinese (2)

- Shenyang, Gansu



Pooled Residential Radon Studies

Excess relative lung cancer risk per 100 Bq m^{-3} (95% CI)

Study	Primary Analysis	Restricted Analysis	Uncertainty Adjusted
European	0.084 (0.03, 0.158)	0.094 (0.034, 0.175)	0.16 (0.05, 0.31)
North American	0.11 (0.00, 0.28)	0.18 (0.02, 0.43)	
Chinese	0.133 (0.01, 0.36)	0.319 (0.07, 0.91)	
Combined	0.093 (0.04, 0.15)	0.11 (0.05, 0.19)	

Restricted Analysis - Individuals living in at most two residences during the past 30 years

Iowa Radon Lung Cancer Study

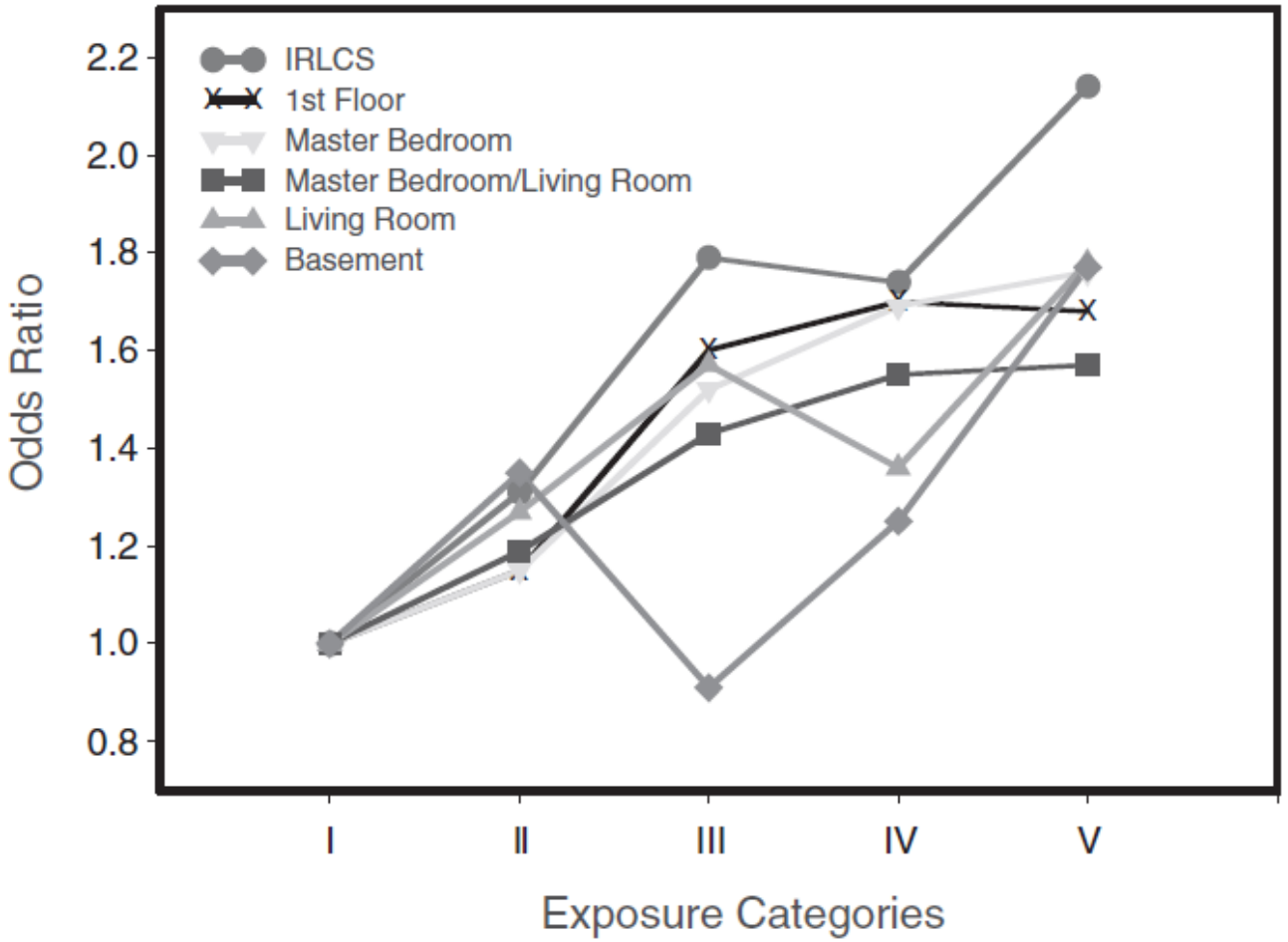
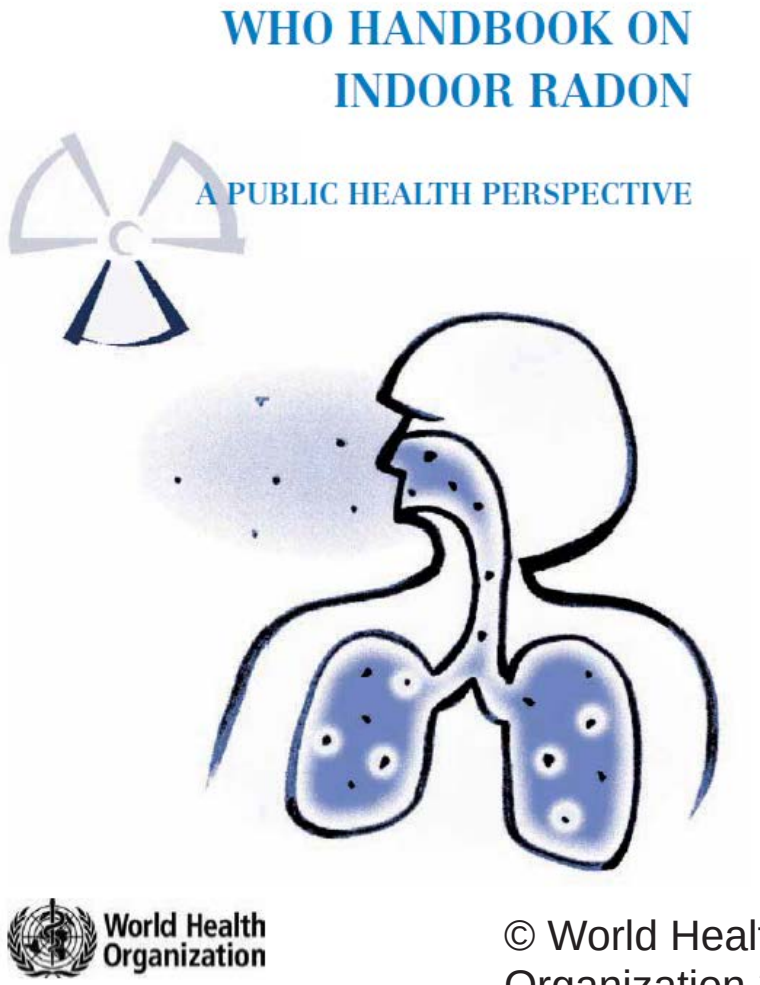


Figure 3. Estimated odds ratios under alternative radon dosimetry models for live cases and controls.

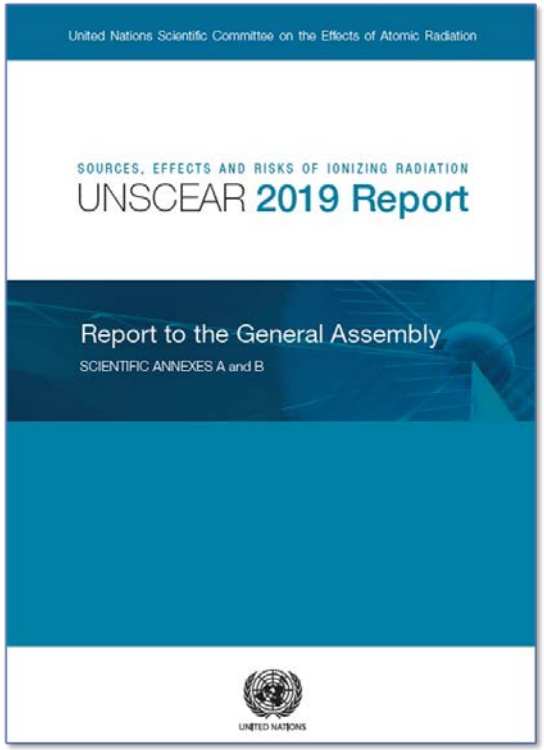
Journal of Exposure Analysis and Environmental Epidemiology (2002) 12(3)

"The consistency of the findings from the latest pooled analyses of case-control studies from Europe and North America as well as China provides a strong argument for an international initiative to reduce indoor radon risks".



To limit the risk to individuals, a national reference level of 100 Bq/m^3 is recommended. Wherever this is not possible, the chosen level should not exceed 300 Bq/m^3.

Future Research Needs



- Further research is needed for subgroups:
  - Smokers versus non-smokers
  - Ages, including childhood, and sex
  - Working environments/conditions
  - Low dose and dose-rate exposures
  - Time since exposure
- Residential studies:
  - Combined analyses to assess modifying factors, such as age and sex
- Uranium miner studies:
  - Exposure rate effect
  - Other possible confounding factors such as asbestos, crystalline silica, diesel engine exhaust, nickel, chromium, and lead merit further research
- UNSCEAR's updated review of the radon literature also highlighted a need for further research investigating the effects of thoron

COPD

Are there other types of cancer and non cancer adverse health outcomes causally associated with protracted radon decay product exposure?

Examples of suggestive non cancer adverse health outcomes

Eur Respir J 2012; 39: 1113–1119
DOI: 10.1183/09031936.00058211

Radon and COPD mortality in the American Cancer Society Cohort

Michelle C. Turner*,#, Daniel Krewski#,¶,+, Yue Chen¶, C. Arden Pope III§, Susan M. Gapstur/ and Michael J. Thun/

ABSTRACT: Although radon gas is a known cause of lung cancer, the association between residential radon and mortality from non-malignant respiratory disease has not been well characterised.

The Cancer Prevention Study-II is a large prospective cohort study of nearly 1.2 million Americans recruited in 1982. Mean county-level residential radon concentrations were linked to study participants' residential address based on their ZIP code at enrolment (mean±SD 53.5±38.0 Bq·m^{-3}). Cox proportional hazards regression models were used to estimate adjusted hazard ratios (HR) and 95% confidence intervals (CI) for non-malignant respiratory disease mortality associated with radon concentrations. After necessary exclusions, a total of 811,961 participants in 2,754 counties were included in the analysis.

Throughout 2006, there were a total of 28,300 non-malignant respiratory disease deaths. Radon was significantly associated with chronic obstructive pulmonary disease (COPD) mortality (HR per 100 Bq·m^{-3} 1.13, 95% CI 1.05–1.21). There was a significant positive linear trend in COPD mortality with increasing categories of radon concentrations ($p<0.05$).

Findings suggest residential radon may increase COPD mortality. Further research is needed to confirm this finding and to better understand possible complex inter-relationships between radon, COPD and lung cancer.

Examples of suggestive non cancer adverse health outcomes

Are there other types of cancer and non cancer adverse health outcomes causally associated with protracted radon decay product exposure?

Observational Study

Medicine

OPEN

The prevalence of stroke according to indoor radon concentration in South Koreans

Nationwide cross section study

Soo Han Kim, MD[a], Jeong Mee Park, MD, PhD[b], Hee Kim, OT, PhD[c,*]

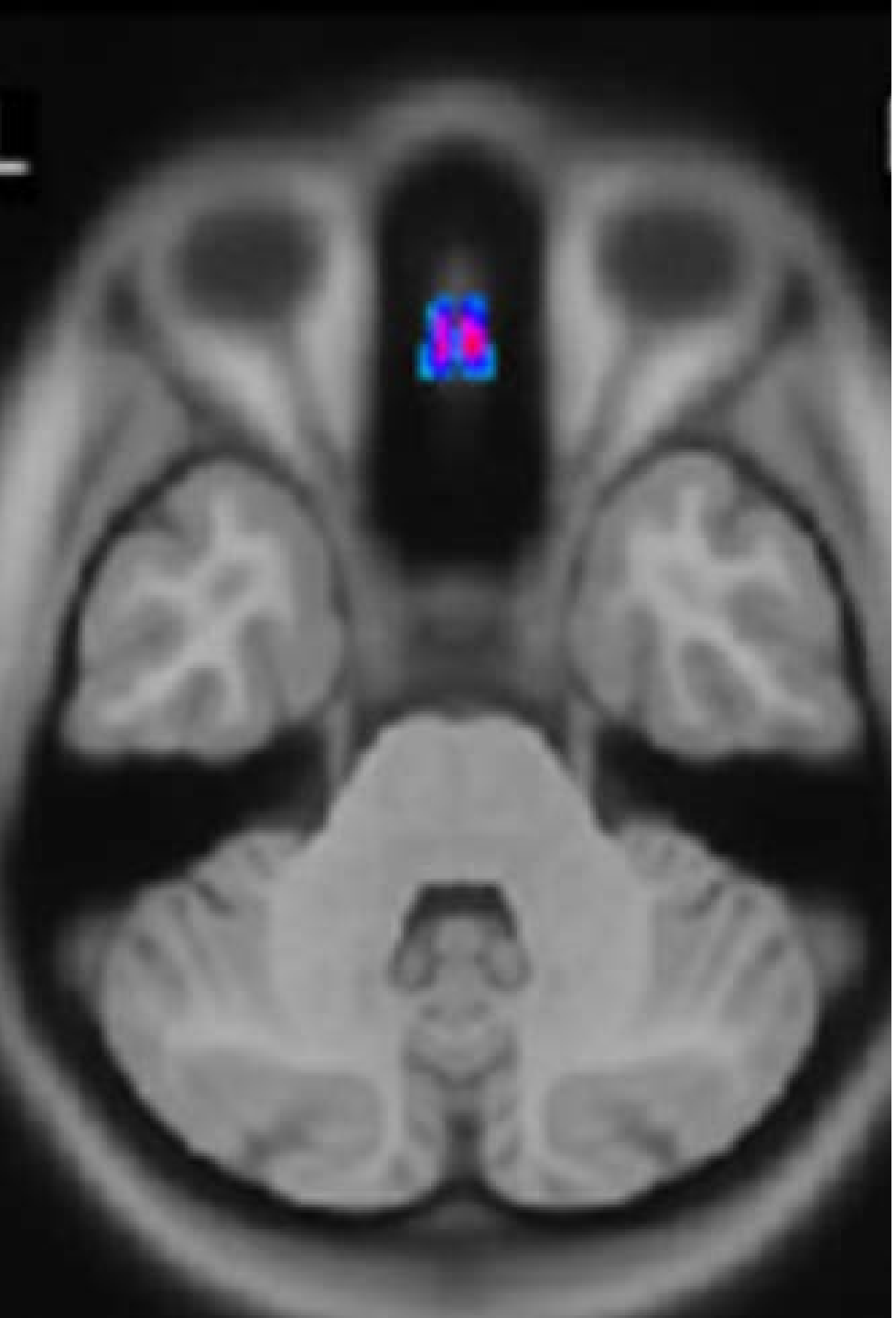
Abstract

To investigate the relationship between indoor radon level and stroke, which is a major factor for background radiation.

This study combines 2 nationwide studies. Demographic characteristics and medical history of participants were obtained from Korean National Health and Nutrition Examination Survey (KNHANES) from 2007 to 2012. Participants over 40 years old and who completed the questionnaire were included in the study. Indoor radon concentration was analyzed using the mean value of winter housing radon concentration from 2012 to 2016 published by the National Institute of Environmental Research. The average values of each metropolitan city and province were assigned to the residence of the participant. To eliminate the potential confounding factors, participants' age, sex, hypertension, diabetes, dyslipidemia, ischemic heart disease, education level, occupation, smoking, drinking, exercise, and dietary intake were adjusted in multivariable logistic regression.

Total of 28,557 participants were included in this study. Indoor radon levels were significantly higher in the participants with stroke, and the prevalence of stroke increased as indoor radon levels increased ($P < .001$, P for linear trend $< .001$). Indoor radon level was associated with stroke even after adjusting potential confounding factors (OR: 1.004 [95CI: 1.001–1.007], $P = .010$) and high radon exposure (indoor radon over 100Bq/m3) was also associated with stroke (OR: 1.242 [95CI: 1.069–1.444], $P = .005$). Trend analysis showed linear correlation of increased odds between radon quartile and stroke (P for linear trend $< .001$). In subgroup analysis, elevated indoor radon was most strongly associated in participants with age over 76(OR: 1.872[95%CI:1.320–2.654], $P < .001$).

High indoor radon concentration may be associated with stroke. Specifically, elevated radon was associated with stroke in participants over 76 years old. In high-risk population, home modification to reduce indoor radon may help decreasing the risk of stroke.



Dose (other than to lung)

Potential adverse health effects other than lung cancer

- Chronic exposure to radon gas
- Translocation of radon decay products to different parts of the body
- Transport of radon decay products from the olfactory epithelium to the olfactory bulbs and into the brain

https://doi.org/10.1117/12.2580354

U.S. Preventive Services TASK FORCE

Final Recommendation Statement

Lung Cancer: Screening

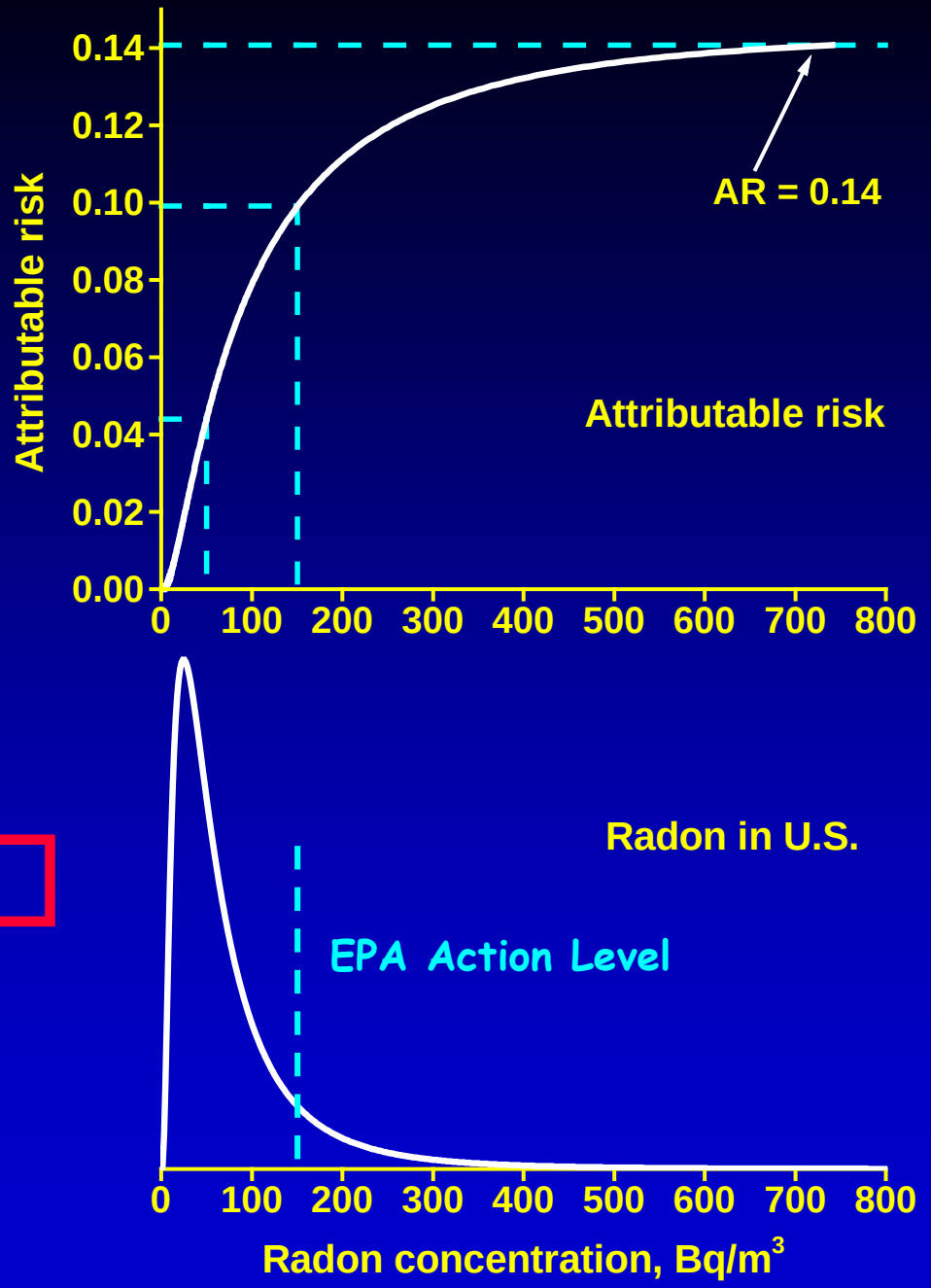
March 09, 2021

Adults aged 50 to 80 years who have a 20 pack-year smoking history and currently smoke or have quit within the past 15 years:

- **Screen** for lung cancer with low-dose computed tomography (CT) every year.

Radon Exposure – medical follow-up ?

Cumulative AR for Radon



~ 1/3 from houses above EPA action level

Radon Decay Products - Worker Regulations

Federal Agency	Worker Coverage	Annual Level (WLM)
OSHA	Workers not covered by the DOE, MSHA, or NRC (i.e., most of the American Workforce)	Up to 12
DOE	DOE Workers	10
NRC	Licensee Workers	4
MSHA	Underground Miners	4

https://heartland.public-health.uiowa.edu/wp-content/uploads/2021/03/AARST_Radon_Reporter-OSHA.pdf