

**Alternative Regression Models for Assessing Lung Cancer Risk on Residential Radon Exposure: A Case-Control Study Conducted in Worcester County, Massachusetts**

Richard E. Thompson<sup>1</sup>, Donald F. Nelson<sup>2</sup>, Joel H. Popkin<sup>3</sup>, and Zenaida Popkin<sup>3</sup>

<sup>1</sup> Biostatistics Department, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

<sup>2</sup> Department of Physics, Worcester Polytechnic Institute, Worcester, MA

<sup>3</sup> St. Vincent Hospital and Fallon Clinic, Worcester Medical Center, Worcester, MA

We present an analysis of a case-control study of lung cancer risk on residential radon exposure in Worcester County, Massachusetts, carried out between 1990 and 1999. Data were considered on a total of 200 cases (58% male and 42% female) and 397 controls matched on sex and age to within  $\pm 2.5$  years. All subjects were recruited from a single health maintenance organization. Emphasis was placed on accurate and extensive year-long dosimetry with etch-track detectors in conjunction with careful questioning about historic patterns of in-home mobility. A detailed demographic profile including data on education, income, years of residency in the home, occupational exposure, and smoking history of the number and type (unfiltered or filtered) of cigarettes smoked per day for each year in the subject's life was obtained. Because of illness or recent death, a surrogate (a spouse or offspring) was interviewed for 21.5% of cases and 3.3% of controls. Conditional logistic regression was used to model the outcome of lung cancer on radon exposure, while controlling for years of residency, smoking, education, income, and years of job exposure to known or potential carcinogens. Smoking was accounted for by nine categories: never smokers, four categories of current smokers, and four categories of former smokers. Several alternative methods were used to model radon exposure including categorization of this variable, a linear slope, parametric non-linear functions, and use of natural and linear spline terms with various degrees of freedom. When radon was categorized, it was found that those with exposures between 50 and 75 Bq m<sup>-3</sup> had a statistically lower adjusted odds of cancer as compared to those with < 25 Bq m<sup>-3</sup> of exposure (adjusted OR [95% CI] = 0.31 [0.13, 0.73]). Similarly, a regression model using natural spline terms with 2 degrees of freedom to model radon exposure gave adjusted odds ratios that were substantially less than 1.0 with borderline statistical significance ( $0.048 \leq p \leq 0.050$ ) between approximately 85 and 125 Bq m<sup>-3</sup> as compared to a reference of 4.4 Bq m<sup>-3</sup> (the lowest exposure recorded in the study). These results were entirely unexpected. Nevertheless, they support the conclusion that a hormetic or protective effect on lung cancer at low radiation doses can not be entirely dismissed.