Residential Radon and Lung Cancer Mortality in U.S. Women who Predominantly Never Smoked: An Ecological Study

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Mean levels of residential radon (Rn) in U.S. counties have been observed to exhibit a negative ecologic association with corresponding age-adjusted lung-cancer mortality (LCM) rates. This association may be erroneous due to (A) confounding unaddressable by any county-level ("ecological") study design, (B) county-level Rn/smoking or Rn/age correlations, and/or (C) exposure misclassifications arising from previous reliance on age-adjusted LCM data and disparate sources of exposure data. In an attempt to address issues B and C, a comparison was made between age-specific 1950–54 LCM rates for white women in 2,821 U.S. counties vs. estimates of corresponding county Rn levels based on a new analysis of U.S. Rn, climatic and geological-survey data. Statistically significant negative ecological LCM vs. Rn associations were found for women who died at age 40+ (~11% of whom ever smoked; $p \leq 0.05$ in 209 of 210 analyses done), and also for women who died at age 60+ (~5% of whom ever smoked; $p \leq 0.05$ in 207 of 210 analyses done), after adjusting for age and subsets of 21 county-level socioeconomic, climatic and other factors. These negative associations were strengthened in analyses restricted to 2,520 counties estimated to have average residential Rn levels ≤100 Bq m^{-3} ($p < 0.001$ in all 420 analyses done). However, relative risk (RR_{adj}) of LCM in all women (i.e., who died at age 40+) was found to be significantly elevated ($1 <$ [95% conf. limits on RR_{adj}] < 1.5) in 42 of 210 comparisons of counties with Rn levels of >150 vs. 65–100 Bq m^{-3}. Each of these 42 comparisons involved adjustment for age in combination with climatic and other factors likely to have influenced exposure to indoor air contaminants, such as Rn and (secondary) cigarette smoke. Among these 42 comparisons, those that included latitude as an adjustment factor resulted in the greatest amount of observed significantly elevated RR_{adj}. This observation of significantly elevated LCM risk associated with residential Rn is the first ever to be reported based on an ecological analysis of nationwide U.S. county-level data. The magnitudes of significantly positive ecological LCM vs. Rn associations observed in this study are consistent with those previously estimated from case-control data. However, results from the present study are not consistent with a significant radon-related increase in 1950-54 LCM among white women who predominantly never smoked and who died in U.S. counties with mean residential Rn concentrations ≤100 Bq m^{-3}. [Work performed under auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.]