Radon testing in exposure and contribution of radon to lung cancer and social determinants

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Abstract

Tobacco use is a major public health concern in Kentucky, as nearly one-quarter of adults report current tobacco use and one-third of Kentucky households with children do not have regulations restricting smoking in the home. Radon, a colorless, odorless radioactive gas, occurs naturally from the decay of uranium found in rocks and soil and can be harmful when trapped indoors. When inhaled, radioactive particles settle in the lungs and irradiate cells in the respiratory tract.

Indoor exposure of radon is a cause of lung cancer among smokers and nonsmokers; However, there is a synergistic effect between tobacco smoke exposure and radon on the development of lung cancer, with smokers or individuals exposed to tobacco smoke having a 10 times greater risk of developing lung cancer than non-smokers. Smoke. This paper has three components; Systematic review of the literature, prospective study of Appalachian residents, and secondary analysis of state radon and other population-level data.

First, a search of the published literature on the risk of radon-induced lung cancer was conducted through PubMed for all relevant studies published in English between 2008 and 2018. Second, using the teachable moment model (McBride et al., 2003) as a theoretical framework, an exploratory, prospective study design was used to examine the relationship between teachable moment model. Third, an ecological, descriptive research

design was used to conduct secondary data analysis of 54,683 observed radon values from Kentucky homes. Data from 1995–2016 were obtained from the statewide radon database. Multivariate linear regression was used to examine the association between county-level social determinants of health and environmental exposures and household radon testing units.

Results of a review of the literature described four models of excess relative risk commonly used to estimate population attributable risk associated with indoor exposure of radon, including those proposed by the Environmental Protection Agency, the BEIR-VI exposure-age-concentration model. BEIR-VI exposure-age-period model, and the European Pooling Study model. There was no difference in lung cancer, lung cancer concerns, or synergistic risk perception between those who completed home radon testing and those who did not. Although 29% of those tested had high radon levels at home, many participants reported a low personal risk of lung cancer.

Studies determining the risk of radon-induced lung cancer vary in methodology. To provide additional evidence for the use of residential radon models over models developed from surveys of miners, the uncertainty associated with results obtained from miners to the general population should be considered. Providing free home radon testing kits as an indicator of activity in the primary care setting holds promise for stimulating radon testing in Appalachia. As the risk of radon-induced lung cancer emerges over time, efforts are needed to promote home radon testing among younger individuals.

Introduction

Exposure to radon gas and smoking are among the leading causes of lung cancer, with tobacco use being the leading cause. Radon is a colorless, odorless radioactive gas that occurs naturally from the decay of uranium found in rocks and soil. Various devices

are available to measure the concentration of radon in the air. Devices are classified as balanced, integrating or continuous. Despite public awareness, completion units for home radon testing remain low, ranging from 3-15% of those surveyed.

The American Cancer Society estimates that in 2020, lung cancer will account for more new cases and deaths in Kentucky than any other cancer. The aim of the thesis was to: 1) review the literature on methods used to estimate the population risk of residential exposure of radon in the development of lung cancer; 2) examine predictors of home radon testing in rural Appalachia; and 3) examine the relationship between health and environmental exposures and county-level community determinants of household radon testing units

Home Radon Testing in the Social Determinants of Health, Environmental

This study sought to examine the relationship between county-level measures of social determinants of health, environmental exposures, and household radon testing units. Each of the following factors made an individual significant contribution to the prediction of household radon testing: median house value, RUC index, upper quartile of the distribution of radon values, and adult smoking prevalence. Zahnd et al. (2017), median home value was a significant predictor of county-level units of home radon testing in our study. As county-wide median home values increased, county-wide home radon testing units also increased. Additionally, county-level median home value is strongly associated with county-level median household income and the percentage of the population over 25 with at least a high school diploma.

As housing quality has implications for people's health, these findings are concerning and demon’s unit potential disparities in indoor air quality between the affluent and the less affluent. Given the high burden of cancer deaths in low-income people reaching

low-income people are needed. People with low income and low educational attainment are also more likely to use tobacco products (CDC, 2019), raising concerns about tobacco and radon synergism in low-income people. The World Health Organization (2018) recommends that national radon programs work with tobacco control personnel to raise public awareness of the health risks of exposure of radon.

Contrary to the hypothesis and study by Jant et al. (2017) found that in Illinois, home radon testing units increased as rurality increased. Zahnd (2017) used USDA's Rural-Urban Commuting Area (RUCA) indices to determine ZIP code status and ZIP code status rurality. RUCA codes are used to classify U.S. Census tracts using urbanization, population density, and daily commute. 1 represents the most urban and population density and 10 represents the most rural and least population density

In contrast, we considered a range of RUC indices from 1 to 9 to measure urbanity and rurality in each Kentucky county. County-level units of household radon testing were calculated per 10,000 households in each county, so it was a function of the underlying population. The upper quartile of the distribution of county-level residential radon values showed a strong, mode unit, positive correlation with the annual residential radon testing unit. As county-level radon risk potential increased, so did residential radon testing units. This finding is similar to the research by Wang et al. (2000) and Zahnd et al. (2017)

This study is the first to assess adult smoking prevalence as a county-level predictor of household radon testing, and it is not surprising to find that smokers often do not engage in preventive health behaviors (Zhang et al., 2017). We found a modeunit, negative association between adult smoking and household radon testing units and linear regression. As county-level adult smoking prevalence increased, home radon testing units decreased. Contrary to hypothesis, higher county-level lung cancer incidence was not associated with higher county-level units of household radon testing. Although not statistically significant,

this finding is concerning and has practical implications.

The Paper ‘s Discussion, and Conclusions

Despite being recognized as a carcinogen by the International Agency for Research on Cancer (World Health Organization [WHO], 1998) 30 years ago, radon gas continues to be a major threat to public health. In the United States, lung cancer is the leading cause of cancer death for both men and women (American Cancer Society [ACS], 2020), yet this disease is preventable. Although tobacco use is the leading cause of lung cancer, small cohort and case-control residential studies around the world provide sufficient evidence to confirm that exposure of radon is the leading cause of lung cancer. Additionally, evidence suggests that individuals exposed to radon and tobacco smoke are at increased risk of developing lung cancer (National Research Council, 1999).

Testing one's home for radon is a primary prevention stunting for reducing lung cancer, yet the proportion of Americans who have completed home radon testing is low. In Kentucky, evidence suggests that less than 1% of homes are tested for radon annually. Additionally, many Kentuckians are exposed to tobacco smoke.

Public policies to strengthen tobacco and radon control have been recommended, although home radon testing is voluntary in Kentucky and there are no laws mandating radon control in new construction or rental properties. Additionally, only about a third (36%) of Kentuckians are protected by smoke-free policies that cover all indoor workplaces and public spaces.

As the nation's leader in lung cancer incidence and mortality, Kentucky would benefit from additional population-based studies of exposure of radon in lung cancer and the results could be used to inform radon control policies, health practices, and health promotion. This will help public health workers target people that would benefit most from

radon control interventions.

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Systematic Review for the Attributable Risk of Radon-induced Lung Cancer

The aim of the first manuscript was to: (a) identify recent studies evaluating the unit of lung cancer due to residential exposure of radon; (Social Determinants of Health, Environmental Exposures and Home Radon Testing (b) describe the variables and methods used to estimate the population-attributable risk of radon-induced lung cancers, taking into account smoking status and sex; and (c) examine the potential effects of radon mitigation on mortality reductions related to population exposure of radon.

A systematic review of the literature was performed using PubMed using key phrases such as radon and causal hazard; Lung cancer and causal risk; Radon and attribute fractionation; Pulmonary and characteristic fraction; Risk due to radon and population. Nine articles published between 2008 and 2018 met the inclusion criteria and were retained for analysis.

Nine studies used descriptive epidemiological designs to determine the population-attributable risk of radon-induced lung cancer. Four models were used to calculate excess relative risk, including BEIR-VI exposure-age-concentration (EAC); BEIR-VI Exposure-

Age-Duration (EAD); European Pooling; and the Environmental Protection Agency (EPA) model.

All estimates of PAR were calculated using lung cancer mortality data. In all but one study, observed radon values were collected from nationally representative surveys. Correction for radon measurement uncertainty is variable and smoking data include estimates of the number of lung cancers caused by smoking or smoking.

Predictors of Home Radon Testing

The second manuscript aims to: 1) examine differences in sociodemographic characteristics, individual risk perception of lung cancer, lung cancer anxiety, and collective risk perception among residents of rural Appalachia. A free long-term screening kit at a rural primary care clinic; and 2) examine the relationship between a teachable moment model of personal risk perception, emotional response, and overall risk perception and home radon testing. The teachable moments model was selected as the theoretical framework to provide insight into how teachable moments can improve residential radon testing in Appalachia, Kentucky. The TMM suggests that when individuals experience a health event, reflect on their beliefs and knowledge about their own health, increase their perception of personal risk, and develop a strong affective or emotional response, they are more likely to take action.

In addition, this subjective evaluation of health phenomena may be influenced by an individual's sociodemographic characteristics (McBride et al., 2003). Multiple logistic regression was used to determine demographic and personal characteristics associated with home radon testing in a convenience sample of 58 participants aged 18 years and older. As the risk of radon-induced lung cancer emerges over time, efforts to promote screening among younger individuals are needed. Given the historically high incidence of lung cancer, high levels of tobacco use, and low home radon testing units in the region, further

research using a larger sample is needed to further examine predictors of home radon testing.

Home Radon Testing on the Social Determinants of Health, Environmental

The purpose of the third manuscript was to examine the association between county-level social determinants of health, environmental exposures (eg, exposure of radon risk potential, lung cancer units, and adult smoking) and home radon testing units. The average district-wide total annual residential census unit is 13.4 per 10,000 households. The upper quartile of the distribution of county-level residential radon values had a very strong, mode unit, positive association with annual residential radon testing unit.

Percent living below the poverty level, adult smoking, and lung cancer incidence units were negatively associated with annual residential radon testing units. Multiple linear regression to estimate predictors of county-level residential radon testing units was overall significant. County-level median home value, rural-urban status, upper quartile of the distribution of radon values, and adult smoking each made statistically significant individual contributions to predicting home radon testing units.

For every 1-unit increase in the RUC value, the annual test unit increased by 1.95 per 10,000 households. For each additional exposure of radon risk at the county level, annual units of residential radon testing increased by 1.36 per 10,000 homes. Finally, for every 1% increase in county-level adult smoking prevalence, the annual unit of residential radon testing per 10,000 households decreased by 0.50.

Social determinants of health and environmental exposures should be considered when designing public health interventions to increase home radon testing to create healthier home environments for all. Because of the association between smoking and exposure of radon, counties with low median home values and high adult smoking units

may benefit most from radon and tobacco control public health interventions.

Conclusion

In summary, this article adds to the body of research on radon-induced lung cancer and the risk of residential radon testing as a means of lung cancer prevention. The findings of this paper can be used to inform researchers, health care providers, public health officials, and legislators about the potential risks of exposure of radon, particularly among individuals exposed to tobacco smoke, as well as predictors of individual and population-level household radon testing. Such information can be used to guide the development, implementation, and evaluation of public health initiatives and policies aimed at reducing the burden of radon testing and lung cancer.

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