Predictors and Spatial Hotspots of Licensed and Home Kit Radon Testing in Illinois, 2005-2012

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Impetus for Study

- Our previous work indicated that rural southern Illinois had higher lung cancer incidence rates even when controlling for smoking.
- Focus groups participants in southern Illinois identified radon as an exposure--beyond smoking—that contribute to their high smoking rate.



Introduction

An estimated 15,000 to 22,000 lung cancer are attributed to radon annually.¹

- Leading cause of lung cancer among nonsmokers.²
- Causes more cancer deaths than liver, esophagus and other cancers.²
- 900 Illinoisans are estimated to be at risk for radon-attributed lung cancer annually. ³





Introduction

- Radon is the largest source of background radiation (37% of Americans' total annual radon exposure).⁴
- Radon can enter a home or other buildings through cracks in the foundation and/or other structural openings.
- Radon levels can vary from home-tohome, so the EPA recommends that all homes be tested, and subsequently mitigated if levels are above 4.0 pCi/L.



Introduction

- Factors associated with greater knowledge, intention to test, and/or testing completion:⁵⁻⁸
 - Knowing someone who has tested
 - Greater educational attainment
 - Higher income
 - Female gender
 - Younger age
 - Home ownership
- Factors associated with less knowledge, intention to test, and/or testing completion:⁹
 - Rural location
 - Low income



Study Objective

 To explore what factors were associated with radon testing and what geographic areas of Illinois underutilized testing and may therefore be key targets for intervention.



Methods-Radon Testing Data

- Illinois Emergency Management Agency Data on Radon Testing:
 - Licensed Professional
 - Home Kit Testing
 - Used Data from 2005-2012
 - Data include testing date, address, type, testing value, etc.



Methods-Radon Testing Data

- All tests were geocoded
- Tests were excluded from analysis for the following reasons:
 - Missing testing date
 - Had an invalid or missing radon test value
 - Had an invalid zip code
 - Had an out-of-state, business only, or PO Box zip code
 - Had an invalid geocode
- 147, 328 unique testing locations
 - 125,689 locations tested by a licensed professional
 - 23,572 locations tested by a home test kit
 - 1,933 locations tested by both methods
- Summed all testing locations within each zip code





Methods- Additional Data Sources

- American Community Survey (zip code level)
 - % living in poverty
 - % of adults 25+ with at least a high school education
 - Median household income
 - # of occupied housing units
 - Total units
 - Owner occupied
- United States Department of Agriculture
 - Rural Urban Commuting Area codes
 - Approximated to zip code
 - Dichotomized into rural and urban
- EPA
 - Radon Zones (Predicted risk for average levels to be >4.0 pCi/L)
 - High, moderate, and low risk
 - County level measure approximated at the zip code level





Methods-Statistical/Spatial Analysis

- We calculated rates of testing in a zip code:
 - (# of tests performed/ # of occupied residences)
 *1,000
 - Separate rates were calculated for the following:
 - All Tests Combined
 - Licensed Tests Only
 - Home Kit Tests Only
- We compared testing rates across EPA zone, socioeconomic, and geographic characteristics
- We performed Hotspot Analysis for all testing types to see what areas of the state had less or more testing than anticipated by random chance



Methods-Statistical/Spatial Analysis

- We calculated incidence rate ratios (IRRs) to determine the association between EPA zone, socioeconomic, and geographic characteristics and zip code level counts of all testing combined, licensed professional testing, and home kit testing
 - Univariate (i.e. looking at each characteristic separately)
 - Multivariable (i.e. looking at each characteristic while accounting for all other factors)



All Testing Rates per 1,000 Occupied Homes by Zip Code



- Quartiles of testing rates (Red=highest levels, blue=lowest levels)
- 158 zip codes (11%) did not have any testing performed between 2005 and 2012
- Highest testing rates concentrated in Springfield, Bloomington/Normal, Peoria, Metro East and Chicago suburbs



Licensed Testing Rates per 1,000 Occupied Homes by Zip Code



- Quartiles of testing rates (Red=highest levels, blue=lowest levels)
- 22.0% of zip codes did not have licensed testing performed during the time period
- Locations of high and low testing rates are very similar to All Testing Rates



Home Kit Testing Rates per 1,000 Occupied Homes by Zip Code



- Quartiles of testing rates (Red=highest levels, blue=lowest levels)
- 19.5% of zip codes had no home kit tests performed during the study period
- Highest testing rates are scattered throughout the state



Hot Spot Analysis of All Testing Rates



- Dark Red=Hot Spots (areas with higher rates than anticipated by chance)
 - 25.5% of all zip codes
- Dark Blue=Cold Spots (areas with lower rates than anticipated by chance)
 - 31.1% of all zip codes



Hot Spot Analysis of Licensed Testing Rates



- Dark Red=Hot Spots (areas with higher rates than anticipated by chance)

 31.7% of all zip codes
- Dark Blue=Cold Spots (areas with lower rates than anticipated by chance)
 - 26.7% of all zip codes



Hot Spot Analysis of Home Kit Testing Rates



- Dark Red=Hot Spots (areas with higher rates than anticipated by chance)
 - 17.8% of all zip codes
- Dark Blue=Cold Spots (areas with lower rates than anticipated by chance)
 - 19.6% of all zip codes



Testing Rates per 1,000 Occupied Homes by EPA Zone





Testing Rates per 1,000 Occupied Homes by Poverty Quartile





Testing Rates per 1,000 Occupied Homes By Median Home Value





Testing Rates per 1,000 Occupied Homes By Median Household Income





Testing Rates per 1,000 Occupied Homes By % Owner Occupied





Testing Rates per 1,000 Occupied Homes By Rural Urban Status





Univariate Analysis

- All Testing, Licensed Testing, and Home Kit Testing
 - EPA Zone 1 higher incidence rate ratio (IRR) compared to Zone 2/3
 - With increasing quartile of income, home value, and education, there was an increased magnitude in IRR
 - With decreasing quartile for poverty (i.e. more affluence), there was an increased magnitude in IRR
 - With an increase in the percentage of homes that were owner occupied, there was an increased magnitude in IRR
 - Non-Rural Zip Codes had an higher IRR than Rural Zip Codes



Multivariable Analysis

- All Testing
 - EPA Zone, Median household income and education had a significant, positive association (i.e. IRR above 1) with testing
 - EPA Zone had the strongest association with testing
 - Rural status had a significant, negative association (i.e. IRR below 1) with testing
 - No statistically significant association between poverty, percent of homes that were owner occupied, and median home value and testing
- Licensed Testing
 - EPA Zone, Median household income and education had a significant, positive association (i.e. IRR above 1) with licensed testing
 - Poverty, and rural status had a significant, negative association (i.e. IRR below 1) with testing
 - No statistically significant association between percent of homes that were owner occupied and licensed testing
- Home Kit Testing
 - EPA Zone, education, and percent of homes that were owner occupied had a significant, positive association (i.e. IRR above 1) with home kit testing
 - No statistically significant association between poverty, median home value, and rural status and home kit testing



Implications of Findings

- Analyses May Help Direct/Geographically Target Interventions
 - Areas with low testing rates could be opportunities for home kit tests promotion by local health departments, outreach to increase the number of licensed mitigators, and other efforts
 - Areas with Lower % of Owner Occupied Homes (i.e. high % of renters) may be a place for interventions to promote use of the IEMA "Radon Guide for Tenants"
 - Areas with low testing rates may be geographic targets for implementation of Illinois Comprehensive Cancer Control Plan strategies
 - Southern Illinois has lower testing rates and higher smoking rates, which are key areas for cost-effective radon interventions ⁹



Implications of Findings

- Analyses May Help Guide Future Research
 - Our study was the first, to our knowledge, to look at statewide testing patterns, differentiate between testing type, and consider EPA zone in analyses
 - Our next steps may include additional analysis on these data to determine:
 - Evaluate geographic variation in EPA actionable radon levels
 - Trends in testing relative to changes in radon policy
 - If people who have elevated levels are getting their homes mitigated



Summary

- Different factors are associated with radon testing at the zip code level including median income, poverty, median home value, EPA zone, ruralurban status, and percent of owner occupation
- Low testing rates are concentrated in the southern part of Illinois
- Spatial analysis of testing patterns can help determine where public health interventions can be targeted



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Questions?



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