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Exploring Householder Status and Residence Type as Correlates of Radon Awareness and Testing Behaviors

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Abstract

Objective—The primary aim of this research was to assess radon awareness and testing across two housing types.

Design—Cross-sectional prevalence study with time trends.

Sample—National, probabilistic sample of 18,138 and 29,632 respondents from the 1994 and 1998 National Health Interview Surveys respectively.

Results—Odds ratio estimates confirmed that occupants of single family homes/townhomes were twice as likely to have ever heard of radon (1994: OR = 2.18; CI = 2.01 – 2.36) (1998: OR = 2.26; CI = 2.09 – 2.44) and also more likely to know if their household air had been tested for radon (1994: OR = 2.04; CI = 1.57 – 2.65) (1998: OR = 1.38; CI = 1.19 – 1.59) as occupants of apartments/condominiums. Time trend analyses revealed that radon awareness improved from 69.4% to 70.7% and home testing among those with knowledge of radon increased from 9.7% to 15.5% over the four-year period.

Conclusions—Housing type provided fairly stable estimates of radon awareness and testing. Findings demonstrate that housing status may be a useful variable to differentiate risk for radon awareness and testing. Public health nurses should consider their client's housing type when assessing families for environmental risks.

Keywords

Housing tenure; householder status; socioeconomic status; environmental health; radon

Introduction

Indoor radon exposure accounts for 21,000 deaths (10–14% of lung cancer deaths) in the U.S. each year and is the second leading cause of lung cancer behind smoked tobacco (Environmental Protection Agency, 2008a). Nearly 3,000 of these annual deaths are among people who never smoked (Environmental Protection Agency, 2008b), and emphysema and pulmonary fibrosis caused by radon can be a source of significant additional morbidity (Agency for Toxic Substances and Disease Registry, 2008). Responding to the preventable nature of radon related disease, former U.S. Surgeon General Carmona issued a national health advisory encouraging families to test their homes for radon gas. Public health nurses have a unique opportunity to spread this important health message as they work within communities with differential patterns of risk. Differential risk arises from both geographical patterns of radon distribution and also protective behaviors like radon testing and mitigation. Public health nurses must understand both the geographic distribution of radon and known behavioral determinants in order to leverage their practice to address the problem. However, while geographic distributions of radon are well known and easily understood little information exists about what factors relate to radon testing behaviors. In this secondary data analysis (SDA), housing variables associated with radon testing behaviors were explored in order to understand their utility in differentiating vulnerability within the population.

Radon gas is a colorless, odorless, radioactive gas that occurs from the natural decay of uranium and a number of common minerals throughout the world. Indoor radon levels are a function of the localized geologic factors, the permeability of the ground underlying the dwelling, and structural characteristics of the dwelling (Sundal, Henriksen, Soldal, & Strand, 2004). Atmospheric pressure systems, wind, indoor and outdoor temperature, and ventilation practices also affect indoor radon concentrations (Sesana & Begnini, 2004).

Radon gas enters homes by way of exposed dirt or cracks in the concrete of basements, cracks in walls and floors, constructions joints, and around pipes and foundations (Agency for Toxic Substances and Disease Registry, 2008). Respiratory issues are exposed to ionizing radiation through inhalation of the radioactive alpha and beta particles which are released during this decay cycle (Agency for Toxic Substances and Disease Registry; Brill et al., 1994; Council on Scientific Affairs, 1987). A synergistic effect on lung tissues is thought to occur as radioactive radon particles bind to tobacco combustion particulate matter during inhalation likely accounting for much greater disease rates when the two exposures are combined (Finkelstein, 1996; National Academy of Sciences, 2005; National Research Council, 1998).

Risk of radon exposure is also increased as time spent indoors increases. Spatial mobility studies have estimated that Americans spend 90% of their time indoors—75% inside the home and 15% inside the workplace (Field et al., 1998; Hancock, 2002).

Apart from structural characteristics and spatial mobility, the demographic variable of householder status (i.e. rent or own) has been reported in a few other studies. For example,

the Environmental Risk Reduction through Nursing Intervention and Education (ERRNIE) project reported that home ownership was positively associated with ever having tested for radon (Hill, Butterfield, & Larsson, 2006). Similarly, Cohen's (1991) analysis of 34,900 University of Pittsburgh Radon Project respondents found that only 1100 (3.2%) of those who completed first-time radon testing rented their homes. Finally, in a study of radon abatement, Wang et al. (1999) reported that 60% ($n = 668$) of respondents who were homeowners took actions to reduce radon levels in their homes, compared to 32% ($n = 22$) of respondents who were not homeowners.

Householder status has been similarly related to other environmental health protective behaviors in addition to radon testing (Cohen, 1991; Sargent et al., 1995; Severtson, Baumann, & Brown, 2006; Wang et al., 1999). While arsenic and lead are different environmental agents than radon, studies support the assertion that environmental health protective behaviors occur more often in owner-occupied homes. In a study of arsenic risk protective behavior, Severtson and colleagues noted that only 8 of 565 (1.41%) survey respondents who had tested their well water were renting their home (Severtson et al., 2006). This low prevalence was despite residence in an arsenic advisory area and groundwater conditions that accelerated the release of arsenic into the groundwater. Similar results were found in Massachusetts for lead poisoning where the percentage of homes not owner-occupied was one of seven variables used to create a logistic model for case-identification at the community level (Sargent et al., 1995). Results of this study suggested that children in neighborhoods where 40–60% of the houses were not owner occupied had an adjusted OR of 4.0 (95% CI; 3.7–6.3) for lead poisoning and where more than 60% of homes were not owner-occupied those odds increased to 6.7 (95% CI; 5.2–8.5). When taken together, these studies support the idea that householder status may relate broadly to environmental health risk through housing conditions or individual behaviors such as testing.

Weinstein and Sandman developed the Precaution Adoption Process Model (PAPM) as a stage theory for explaining and changing health behaviors (Weinstein & Sandman, 1992). The PAPM, like other stage theories, excludes the use of a single prediction equation for precaution adoption and instead breaks precaution adoption down into a series of stages for which individual prediction equations may be appropriate (Weinstein, Lyon, Sandman, & Cuite, 1998). The PAPM distinguishes itself from other stage theories by differentiating between people who are unaware of an issue and those who know something about an issue but have never taken action.

Research questions addressed in this paper were framed according to preliminary work conducted as part of the Environmental Risk Reduction through Nursing Intervention and Education study (ERRNIE, 1 RO1 NR009239-01A1), designed to investigate participants' stage of environmental risk reduction behaviors for a variety of household exposures. The main goal of the ERRNIE study is to investigate the utility of a home-based intervention designed to improve knowledge and self-efficacy and improve environmental precaution adoption. The six stages of the PAPM as defined for the ERRNIE study are: "never heard of radon", "never thought about testing", "undecided about testing", "decided not to test", "decided to test", and "testing". Thus, stages used in the present analysis were matched so

that findings from a national sample and presented here can be compared with ERRNIE findings in the future.

In order to investigate the relationship between householder status and testing for radon, three theoretically framed research questions are addressed: 1) does radon awareness differ by householder status, 2) does radon testing differ by householder status, and 3) does the relationship between householder status and awareness and testing appear to change over time?

Methods

Design and Sample

The experimental design was a cross-sectional prevalence study with time trends. We examined responses from persons 18 years and older who identified their residence type as either “apartment/condominium” or “single family home/townhome” to the 1994 National Health Interview Survey (NHIS) ($n=18138$) and the 1998 NHIS ($n = 27919$) conducted by the National Center for Health Statistics (NCHS). The NHIS method involved face-to-face household interviews of a nationally representative sample of adult, non-institutionalized, civilian US residents. The response rate for the 1994 NHIS Year 2000 supplement was 84.5% (United States Department of Health and Human Services National Center for Health Statistics, 1994). The adult response rate for the 1998 NHIS household data was 73.9% (United States Department of Health and Human Services National Center for Health Statistics, 2001). Interviewers obtained proxy responses for adults who were absent from home or unable to answer for themselves. Although all participating households received the 1994 NHIS questionnaires, the Year 2000 supplement questions were asked of only one randomly selected adult in half of the participating households. Information about the design, sampling techniques, and the raw data are available on the NCHS Web site at <http://www.cdc.gov/nchs/nhis.htm>

The sampling protocol for the NHIS uses a complex, multi-stage, clustering approach to achieve the required diversity in the sample within a manageable level of complexity and cost. The sample for the NHIS is chosen so that each person in the sampled population has a known non-zero probability of being included. Selection probabilities, in addition to adjustments for non-response and post-stratification, are reflected in the reported data by the application of sample weights provided by NHIS. In obtaining the results presented here for the 1994 data, the Year 2000 Final Basic Weight was used to account for non-response and the selection of only one adult per family; therefore, these results provide nationally representative population estimates. Likewise, the 1998 data were obtained using the Final Weight for Adult Prevention and Sample Adults. All complex survey data analysis was performed using SAS version 9.1. The survey logistic procedure was used to obtain odds ratios and confidence intervals. This procedure was necessary to obtain valid standard errors and statistical tests when applying sampling weights drawn from complex survey samples.

Measures

Special to the 1994 NHIS (United States Department of Health and Human Services National Center for Health Statistics, 1994) were questions related to achieving a subset of the Healthy People 2000 objectives. This supplemental data collection, titled the Year 2000 Objectives Supplement was administered in 1994 and included questions on the respondent's type of residence as well as three questions related to environmental risk reduction for radon. This supplemental data is referred to here as the 1994 NHIS. The first question was *had the participant ever heard of radon*. The response choices were *yes*, *no*, *not ascertained*, and *don't know/refused*. Radon awareness for this analysis was defined as those who responded they had heard of radon versus all other response categories. If the response to the first question was *yes*, the respondent was then asked if their air had been tested for radon. Again, the response categories were *yes*, *no*, *not ascertained*, and *don't know/refused*. Radon testing was defined for this analysis as those who responded *yes* their household air had been tested versus all other responses. The same questions were asked in the 1998 NHIS with the additional expansion of the response categories to allow for separation of *don't know* from *refused*. To the best of the authors' knowledge, the association between residence type and radon knowledge and testing has not been previously analyzed or reported for either NHIS data set.

Analytic Strategy

The 1994 and 1998 NHIS data were available via the Inter-university Consortium for Political and Social Research (ICPSR) Database. Housing type categories for the 1994 NHIS were single-family homes/townhomes ($n = 12529$, 63.5%), apartments/condominiums ($n = 5609$, 28.4%), trailers/mobile homes ($n = 1116$, 5.6%), or something else ($n = 298$, 1.5%). Housing type data were not ascertained for less than one percent of the sample ($n = 186$, 0.9%). Housing type categories for 1998 were single-family homes/townhomes ($n = 20683$, 63.8%), apartments/condominiums ($n = 8949$, 27.6%), trailers/mobile homes ($n = 1979$, 6.1%), or something else ($n = 260$, 0.8%). Housing type data were not ascertained for less than two percent of the sample ($n = 558$, 1.7%). Due to the practice improvement aims of this research, the original 1994 ($n = 19738$) and 1998 ($n = 32440$) samples were narrowed to include occupants of the two most common housing types, representing 91.9% of the 1994 NHIS respondents ($n = 18138$) and 91.3% of the 1998 NHIS respondents ($n = 29632$). Chi Square and odds ratio analyses were performed on *yes* and *no* responses to the radon questions from 1994 and 1998. Sample weights were applied to prevalence estimates and weight-adjusted percentages are reported herein.

Results

1994 Data

In response to the first question, "Have you ever heard of radon?" more participants had heard of radon ($n = 12417$, 69.4%) than not ($n = 5444$, 29.1%). Responses of *don't know* or *refused* ($n = 210$, 1.1%) and *not ascertained* ($n = 67$, 0.4%) summed to less than two percent (1.6%) of the total sample ($n = 18138$). The participants who responded *yes* to the first question ($n = 12417$) were then asked the follow up question, "Has household air been tested for radon?" Affirmative responses ($n = 1138$, 9.7%) were less common than negative

responses ($n = 9679$, 78.7%) with 0.16% ($n = 16$) of data not ascertained and 11.4% ($n = 1584$) of participants who did not know or refused to answer. Table 1 provides a breakdown of responses to these questions by residence type and Table 2 summarizes the corresponding odds ratios. People who occupied single family homes/townhouses were two times more likely as people who occupied apartments/condominiums to have heard of radon. Similarly, people who occupied single family homes/townhouses were more than twice as likely as people who occupied apartments/condominiums to know if their household air had been tested for radon. To account for a large number ($n = 1584$, 11.4%) of participants who answered *don't know* or *refused* to the second question "Has your household air been tested for radon?" a follow-up analysis was performed combining *don't know* or *refused* responses with the *no* responses. This strategy is reasonable because it is likely that those that *don't know* if testing has been performed or who *refused* are more likely to not have tested based upon the relatively low percentage of U.S. homes tested annually. Both analyses resulted in similar point and interval estimates, suggesting that a conservative estimate of effect is about double.

1998 Data

In response to the first question, "Have you ever heard of radon?" overall more participants had heard of radon ($n = 19546$, 70.7%) than not ($n = 9327$, 27.2%). Responses of *don't know* ($n = 743$, 1.97%), and *refused* ($n = 16$, 0.04%) summed to 2.01% of the total sample ($n = 29632$). The participants who responded *yes* to the first question ($n = 19546$) were then asked the follow up question, "Has household air been tested for radon?" Affirmative responses ($n = 2765$, 15.5%) were less common than negative responses ($n = 14159$, 72.8%) with 11.7% ($n = 2618$) of participants who *didn't know* and 0.03% ($n = 4$) who *refused* to say if their air had been tested for radon. People who occupied single family homes/townhouses were more than twice as likely as people who occupied apartments/condominiums to have heard of radon. Compared to people who occupied apartments/condominiums, people who occupied single family homes/townhouses were more likely to know if their household air had been tested for radon. Including the respondents who answered *don't know* to the second question as a *no* response yielded even stronger associations ($n = 2618$, 11.7%).

Discussion

In answer to the first research question, the results for both 1994 and 1998 indicate that radon awareness did differ by residence type with occupants of single family homes/townhomes being twice more likely to have heard of radon than occupants of apartments/condominiums. Awareness may be higher among occupants of single family homes/townhomes because those types of residences are more often occupied by owners than renters. Estimates calculated from the American Housing Survey are that 87.9% of owner-occupied units are single family homes or townhouses while approximately 80.5 % of renter-occupied dwellings are apartments or condominiums (United States Department of Housing and Urban Development, 2008). Analyzed in this way, the findings by residence type are highly associated with householder status (i.e., rent or own). Legal requirements to test for and disclose radon concentrations as part of real-estate proceedings may provide one

explanation for the difference in radon awareness. Another explanation may be the age of the respondent as these results are not age-adjusted. It stands to reason that younger people are more often renters and may have had fewer years to learn about and understand radon as a threat to good health. Unfortunately, radon exposures are cumulative, suggesting the need for public health nurses to deliver educational messages to young adults and young families with children. The reported difference of awareness by residence type is a noteworthy finding because everyone needs to have “heard” about radon—a toxin that claims the lives of an estimated 21,000 Americans each year (Environmental Protection Agency, 2008). Public health nurses can use residence type as an indicator of individuals who may need educational messages about the threat of cumulative exposure to radon. Many of these families are likely to be mobile and may be able to take this information with them to their next home, daycare setting, or workplace.

The second research question was “Does radon testing differ by residence type?” Occupants of single family homes/townhomes were twice as likely to live in a home tested for radon as occupants of apartments/condominiums in 1994 with the gap decreasing to 1.38 times the as likely in 1998. A complicating factor in this analysis was how to handle the respondents who answered that they *didn’t know* if their home had been tested for radon. Using a conservative approach, we performed each analysis again including respondents who *didn’t know* with those who responded *no* in the chi-square analysis. The point estimates increased for both study years (see Table 2), and the upward trend for testing by occupants of apartments/condominiums persisted. Interpreted through the lens of the PAPM, these descriptive findings suggest that improvements are indeed occurring along the continuum from awareness to action. Unfortunately, important differences in testing behavior persist by residence type, suggesting an important case-finding strategy for public health professionals.

The third aim of this study was to examine how radon awareness and testing behavior had changed over time. Awareness remained qualitatively stable over the two measurements with occupants of apartments/condominiums decreasing from 56.6% to 55.7% and occupants of single family homes/townhomes increasing from 74.0 to 75.3% from 1994 to 1998 respectively. Overall, radon awareness improved only from 69.4% in 1994 to 70.7% in 1998, suggesting that the effectiveness of current outreach strategies may have reached a plateau. Resources may need to be allocated for innovative strategies including outreach to property managers and real-estate professionals, outreach in collaboration with ancillary health professionals and through the formation of new partnerships.

The analysis of the change in testing behavior over time revealed that overall home testing increased from 9.7% to 15.5% over the four-year period. When examined by residence type, occupants of apartments/condominiums increased their testing from 4.4% to 9.4% while occupants of single family homes/townhomes increased their testing from 11.2% to 16.8% over the same period. It must be mentioned that these rates only apply to respondents who had heard of radon. This practice, employed by Healthy People 2010 (United States Department of Health and Human Services, 2009b), provides an overly-optimistic estimate of testing prevalence in the general population by excluding from the denominator all those who had never heard of radon. However, an increase in testing does provide evidence that more people are advancing along the PAPM from “thinking about testing” to “testing”. If

this trend continues with increased radon abatement, increased practices to reduce radon exposure, and the standardization of radon-resistant construction practices, the health-care community can look forward to fewer radon-related lung cancer deaths.

Limitations

While the age of the 1994 and 1998 NHIS data sets is a limitation to this exploratory study, it is important to note that the 1998 data set is the current data source for the Healthy People 2010 objective of increasing to 20% the proportion of persons who live in homes tested for radon (United States Department of Health and Human Services, 2009a). Another limitation to the reported findings is the lack of precision in using residence type as a proxy for householder status. The advantage to the public health nurse is that he or she can use both residence type and householder status to refine the environmental health intervention. Related to the experience of conducting SDA and using national data for secondary purposes, the authors of national data sets should consider decoupling residence type categories. In this instance, separating apartments from condominiums and single family homes from townhouses would have expanded the utility of the database in supporting SDA projects without any obvious disadvantage for the NCHS.

Conclusion

Promoting risk reduction activities in the home is a fundamental focus of public health nursing. The goals of this research were to explore the utility of housing variables to understand risk factors for conditions that may lead to differential radon exposure. Residence type was significantly associated with radon awareness and knowing if household air had been tested in both the 1994 and 1998 NHIS studies. Over the four-year study period, living in a single family home/townhome continued to be a stable indicator of increased awareness and testing. These findings add to other reports that have also found radon protective behaviors to largely be the domain of homeowners (Cohen, 1991; Hill et al., 2006). A likely explanation for this distinction could be state-mandated testing and disclosure of radon concentrations in real-estate transactions.

State and local ordinances requiring testing and disclosure of radon concentrations for rental properties would be a structural approach to narrowing the gap in protective behaviors. This hypothesis-generating work suggests that renters may be a new focus population appropriate for intervention studies aimed at increasing radon awareness and testing in order to reduce health disparities. Future public health research would benefit from qualitative study to understand differential health behaviors between renters and owners, an inventory of the landlord/tenant policies that govern the indoor air quality of the rented home and further study to validate householder status as a significant demographic variable.

Given the approximately double effect size of awareness and testing for occupants of single family homes/townhomes, public health nurses have an evidence-based screening tool to guide their education, advocacy, and intervention activities for families. Residence type and its correlate householder status, may be important ways to identify and allocate nursing interventions to the most vulnerable families especially as public health resources become

more limited (Geiger, 2006; Institute of Medicine Committee on Environmental Justice, 1999).

References

- Agency for Toxic Substances and Disease Registry. Toxfaqs for radon. 2008. Retrieved December 13, 2008, from <http://www.atsdr.cdc.gov/tfacts145.html>
- Brill AB, Becker DV, Donahoe K, Goldsmith SJ, Greenspan B, Kase K, et al. Radon update: Facts concerning environmental radon: Levels, mitigation strategies, dosimetry, effects and guidelines. Society of nuclear medicine committee on radiobiological effects of ionizing radiation. *Journal of Nuclear Medicine*. 1994; 35(2):368–385. [PubMed: 8295012]
- Cohen BL. Variation of radon levels in US homes correlated with house characteristics, location, and socioeconomic factors. *Health Physics*. 1991; 60(5):631–642. [PubMed: 2019494]
- Council on Scientific Affairs. Radon in homes. Council on scientific affairs. *Journal of the American Medical Association*. 1987; 258(5):668–672. [PubMed: 3612990]
- Environmental Protection Agency. Radon second only to cigarette smoking in causing lung cancer - home testing for radon is one way to fight it. 2008. Retrieved December 17, 2008, from <http://yosemite.epa.gov/opa/advpress.nsf/e51aa292bac25b0b85257359003d925f/503243c79c5bcf35852573c50065ae42!OpenDocument>
- Field RW, Smith BJ, Brus CP, Lynch CF, Neuberger JS, Steck DJ. Retrospective temporal and spatial mobility of adult Iowa women. *Risk Analysis*. 1998; 18(5):575–584. [PubMed: 9853393]
- Finkelstein MM. Clinical measures, smoking, radon exposure, and risk of lung cancer in uranium miners. *Occupational and Environmental Medicine*. 1996; 53(10):697–702. [PubMed: 8943835]
- Geiger, HJ. Health disparities: What do we know? What do we need to know? What should we do?. In: Schulz, AJ.; Mullings, L., editors. *Gender, race, class, & health: Intersectional approaches*. San Francisco: Jossey-Bass; 2006. p. 261–288.
- Hancock T. Indicators of environmental health in the urban setting. *Canadian Journal of Public Health*. 2002; 93(S1):S45–51. [PubMed: 12425175]
- Hill W, Butterfield P, Larsson LS. Rural parents' perceptions of risks associated with their children's exposure to radon. *Public Health Nursing*. 2006; 23(5):392–399. [PubMed: 16961559]
- Institute of Medicine Committee on Environmental Justice. *Toward environmental justice: Research, education, and health policy needs*. Washington, D.C: National Academy Press; 1999.
- National Academy of Sciences. *Health risks from exposures to low levels of ionizing radiation: Biological effects of ionizing radiation (beir) vii*. Washington D.C: National Academies Press; 2005.
- National Research Council. *Dangers of radon exposure and smoking compound each other*. *Journal of Environmental Health*. 1998; 60(10):39.
- Sargent JD, Brown MJ, Freeman JL, Bailey A, Goodman D, Freeman DH. Childhood lead poisoning in Massachusetts communities: Its association with sociodemographic and housing characteristics. *American Journal of Public Health*. 1995; 85(4):528–534. [PubMed: 7702117]
- Sesana L, Beghini S. Hourly indoor radon measurements in a research house. *Radiation Protection Dosimetry*. 2004; 112(2):277–286. [PubMed: 15353606]
- Severtson DJ, Baumann LC, Brown RL. Applying a health behavior theory to explore the influence of information and experience on arsenic risk representations, policy beliefs, and protective behavior. *Risk Analysis*. 2006; 226(2):353–368. [PubMed: 16573626]
- Sundal AV, Henriksen H, Soldal O, Strand T. The influence of geological factors on indoor radon concentrations in Norway. *Science of the Total Environment*. 2004; 328(1–3):41–53. [PubMed: 15207572]
- United States Department of Health and Human Services. Healthy people 2010 objective 8–18: Increase the proportion of persons who live in homes tested for radon concentrations. 2009a. Retrieved February 24, 2009, from <http://www.healthypeople.gov/document/html/objectives/08-18.htm>

- United States Department of Health and Human Services. Healthy people 2010. Tracking healthy people 2010. 2009b
- United States Department of Health and Human Services National Center for Health Statistics. National health interview survey, 1994: Year 2000 objectives supplement. Inter-university Consortium for Political and Social Research (ICPSR Database); 1994.
- United States Department of Health and Human Services National Center for Health Statistics. National health interview survey 1998. Inter-university Consortium for Political and Social Research (ICPSR Database); 2001.
- United States Department of Housing and Urban Development. American housing survey for the United States: 2007. 2008. Retrieved March 11, 2009, from <http://www.huduser.org/datasets/ahs/ahsdata07.html>
- Wang Y, Ju C, Stark AD, Teresi N. Radon mitigation survey among New York state residents living in high radon homes. *Health Physics*. 1999; 77(4):403–409. [PubMed: 10492346]
- Weinstein ND, Lyon JE, Sandman PM, Cuite CL. Experimental evidence for stages of health behavior change: The precaution adoption process model applied to home radon testing. *Health Psychology*. 1998; 17(5):445–453. [PubMed: 9776003]
- Weinstein ND, Sandman PM. A model of the precaution adoption process: Evidence from home radon testing. *Health Psychology*. 1992; 11(3):170–180. [PubMed: 1618171]

Table 1

Comparison of 1994 (*N* = 18138) and 1998 (*N* = 29632) National Health Interview Survey Data on Indoor Radon Risk Reduction Behaviors by Residence Type

NHIS Item	Response	Residence Type					
		1994			1998		
		Apartments or Condos	Single Family Homes or Townhomes	Single Family Homes or Townhomes	Apartments or Condos	Single Family Homes or Townhomes	Single Family Homes or Townhomes
		N	% ^a	N	% ^a	N	% ^a
1. Heard of radon?	Yes	3214	56.65	9203	73.98	4671	55.69
	No	2268	41.28	3176	24.73	3802	39.41
	DK	108	1.71	102	0.84	476	4.90
	NA	19	0.36	48	0.45		
	Total	5609	100	12529	100	8949	100
2. Home tested for radon?	Yes	135	4.44	1003	11.18	431	9.36
	No	2094	66.43	7585	82.07	2692	58.22
	DK	980	28.82	604	6.63	1548	32.43
	NA	5	0.31	11	0.11		
	Total	3214	100	9203	100	4671	100

NA = Not Ascertained; DK = "Don't Know or Refused"; N = raw numbers;

^a weighted % to correct for complex sampling.

Table 2

Results of Odds Ratio Analyses of 1994 and 1998 NHIS Data Exploring the Association between Residence Type and Radon Awareness and Testing

1994 NHIS					
	OR	χ^2	CI	p	N
1. Heard of Radon	2.18	362.84	2.01 – 2.36	< .0001	17861
2. Home tested for radon	2.04	28.42	1.57 – 2.65	< .0001	10817
2.1 Home tested for radon including <i>don't know</i> and <i>refused</i> responses with <i>no</i> responses	2.70	56.57	2.09 – 3.51	< .0001	12401
1998 NHIS					
1. Heard of Radon	2.26	435.28	2.09 – 2.44	< .0001	28873
2. Home tested for radon	1.38	18.21	1.19 – 1.59	< .0001	16924
2.1 Home tested for radon including <i>don't know</i> responses with <i>no</i> responses	1.96	81.45	1.69 – 2.27	< .0001	19542

N = raw numbers; a=weighted % to correct for complex sampling.