RADON TESTING FOR LOW-INCOME MONTANA FAMILIES

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Abstract

In this study, survey data from rural, low-income families were analyzed for the demographic and cognitive predictors of indoor radon testing. Participants (*n* = 224) lived in Zone 1 designated Montana counties. Logistic regression analyses were used to test a theoretically supported model in predicting radon testing. Half of the participants had never heard of the health effects of radon. The overall radon testing rate was 13.8% (*n* = 31) with rate of testing higher among home-owners ($\chi^2_{(1, 224)} = 8.4$, $p = .004$, OR = 3.2; 95% CI 1.4 – 7.4). A model of five demographic and three cognitive variables were significant in predicting whether participants who had not tested their homes had ever heard of the health effects of radon ($\chi^2_{(8, 193)} = 20.6$, $p < .01$) and home-radon testing in the full sample ($\chi^2_{(8, 224)} = 22.4$, $p < .01$). Members of the scientific and medical community should not assume that low-income families understand radon risks. Interventions are needed to include this important group in ethical and comprehensive radon risk reduction efforts.

Key Words: radon, social determinants, rural health, environmental health, householder status
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Introduction

Background

Research and discussion of residential radon exposure is timely as national efforts are underway to emphasize prevention, reduce health disparities (U.S. Department of Health and Human Services, 2011a, 2011c), and help families make the connection between housing and health (Environmental Protection Agency & U.S. Department of Health and Human Services, 2011). The elimination of toxic, residential exposures—particularly for poor and minority families who are at increased risk for differential health outcomes—is an important focus of the National Prevention Strategy (U.S. Department of Health and Human Services, 2011b) and the World Health Organization (2009). Radon gas is an example of such an exposure. The Environmental Protection Agency (EPA) estimated that 21,000 annual lung cancer deaths in the U.S. are attributable to radon (Pawel & Puskin, 2003) and radon is the leading environmental cause of cancer death in North America (Environmental Protection Agency & U.S. Department of Health and Human Services, 2011). Unfortunately, the risks associated with radon exposure have failed to receive widespread attention (President's Cancer Panel, 2009).

Because naturally occurring radon in the soil is very common in many areas of the West, rural communities are at particular risk for radon exposure (Environmental Protection Agency, 2011). Compounding the problem, rural communities in the western U.S. may be influenced by economic segregation, community gentrification, and displacement of lower-income families to unincorporated parts of the county (Butterfield & Postma, 2009). These and other social and economic factors influence the extent to which many low-income families come to live in areas beyond the reach of many public health and municipal services making evidence-based case finding an important tool for the public health practitioner (Larsson, Hill, Odom-Maryon, & Yu, 2009). Therefore, research exploring salient predictors of radon exposure awareness and testing behavior in rural communities is needed.

Research Questions

The goals of this research study were to explore the sociodemographic and cognitive predictors of radon exposure awareness and prevalence of residential testing for rural, low-income families. Specific Aim 1 was to investigate the prevalence of home-radon testing by home ownership status. Specific Aim 2 was to assess the influence of sociodemographic and cognitive variables in predicting pre-testing awareness. Specific Aim 3 was to assess the influence of sociodemographic and cognitive variables in predicting home-radon testing.

Methods

Design and Sample

Data for this research were collected by survey questionnaire from health department clients who lived in three Montana counties designated by the EPA as Zone 1 (Environmental Protection Agency, 2011). This cross-sectional study was nested within a larger randomized, controlled trial for a household nursing intervention. For a detailed description of the design of the intervention study, see Butterfield, Hill, Postma, Butterfield, & Odom-Maryon (in-press). Study participants were referred by public health nurses, screened for eligibility (< 250% of poverty level), and consented to participate (n = 127, 60.0%). Additional study participants were recruited through the Women Infant and Children (WIC) Clinics (n = 97, 40.0%) to meet sample size requirements within the study timeframe. WIC survey participants had an income of < 185% of the poverty level. Participants received a $10 gift card for completing the survey.

Data collection began July 10, 2006 and ended June 30, 2009. Human subjects' approval was obtained from the Montana State University Institutional Review Board for the Protection of Human Subjects.

A power analysis was conducted using the *Statistics in Medicine* software (Hsieh, Block, & Larsen, 1998). The number of respondents necessary to protect against committing a type two error in completing Specific Aim 3 (to test eight variables in predicting home radon testing) was 161 (final sample of 224). Item responses were entered into Statistical Package for the Social Sciences (2009) version 18.0 for data analysis. Minimal missing values were treated by imputation (Missing Values Analysis Statistical Package for the Social Sciences, 2009) with the expectation maximization algorithm after assumptions of the procedure were satisfied.

Measures

To achieve the aims of the study, measures for five sociodemographic and three cognitive variables were used. The sociodemographic variables chosen for testing were related to factors hypothesized in the literature to be important to the adoption of health-protective behaviors and are described as follows.

Socioeconomic status (SES) variables

SES was defined as an ecologic, multi-level factor that constrains access to resources and influences how families shape their health behaviors (Evans & Kantrowitz, 2002; Institute of Medicine Committee on Environmental Justice, 1999; Kneipp & Drevdahl, 2003; Leight, 2003; Stewart & Napoles-Springer, 2003). Although the measurement of SES varies broadly, householder ownership status is a critical SES variable in this study, as an estimated 6.4 million rural families rented their homes in 2009 (Housing Assistance Council, 2010; United States Department of Housing and Urban Development, 2011). Compared to families who owned their homes, rural renters were more likely to live in overcrowded, substandard housing and were twice as likely to live on incomes below the federal poverty level. Home ownership rates in the West were the lowest of all the regions in the U.S. for the first quarter of 2011 at 60.9% compared to 66.4% nationally (U.S. Census Bureau, 2011). Homeowner net worth was estimated by the Federal Reserve Board (Bucks, Kennickell, Mach, & Moore, 2009) to be 46 times that of the typical renter. This statistic supports the statement from The Institute of Medicine (2009) that, like racial and ethnic minorities, individuals of low SES have not enjoyed the same advances in health status as other Americans. SES in the reported study was operationalized as five variables: annual household income, householder status (rent/own), partner status (married, widowed, divorced/separated, living with partner, never married, and other), years of education, and number of children younger than 18 living in the home. Annual household income categories were in $10,000 increments (e.g., $20,000 – 29,999) between $10,000 and 59,999 with the first category capturing income less than $10,000 annually and the final category capturing income of $60,000 or more. Years of education were reported in yearly increments with less than six years as the lowest education option and greater than 18 years as the highest.

Cognitive variables

The cognitive variables chosen for testing were derived from theoretical and contributions to the study of health behavior (Bandura, 1977; Weinstein & Sandman, 2002). The variables were radon knowledge, risk-perception, and self-efficacy. These constructs are defined here based on a comprehensive review of the literature in order to establish their operational definitions for radon research. Radon knowledge has been conceptualized in past studies as a cognitive process (Alsop & Watts, 1997), where evidence about radon exposure is evaluated (Garvin, 2001) and from which factual awareness results (Wang, Ju, Stark, & Teresi, 2000). Radon knowledge has been recognized by "change theorists" for its importance in advancing people from never having thought about radon testing to the next stage of precaution adoption (Weinstein & Sandman, 2002). Radon knowledge in this study was defined as knowledge of agent-level information (four questions), health effects from exposure (six true-false questions), and appropriate activities to reduce exposure (nine questions). The radon knowledge items, in a multiple-choice format, originated with project investigators and were reviewed by experts for validity. The knowledge items were scored on a basis of 19 points with a higher score indicating greater knowledge and then standardized on a percent scale ($\bar{x}$ = 70.8%, *sd* = 24.7%, range 0-100%).

Radon risk-perception has been defined as attitude (Ferng & Lawson, 1996), beliefs (Halpern & Warner, 1994) and concerns (Birrer, 1990) about radon exposure and testing. Risk perception is the subjective counterpart to objective radon knowledge as risk characteristics act to either amplify or dampen public risk-perception (Johnson & Luken, 1987; Sandman & Weinstein, 1993; Weinstein, Klotz, & Sandman, 1988; Weinstein, Lyon, Sandman, & Cuite, 1998). Radon risk-perception was defined for this study as perceived vulnerability to the exposure and health effects from radon gas. Respondents ranked their perceptions on a 7-point scale (*strongly disagree* to *strongly agree*) to three risk statements. For example, participants were asked to rate their agreement with the statement, "My children are at risk for being exposed to radon." Lower numbers indicated a lower perception of risk from radon. Radon risk-perception scores ($\bar{x}$ = 4.3, *sd* = 1.0, *n* = 224) were reported in the full range.

Radon self-efficacy was defined as a cognitive mechanism based on expectations or beliefs about one's ability to perform actions necessary to reduce radon risk (Bandura, 1977). Items included identifying potential health effects to children, determining if the home is safe from radon, and taking steps to reduce exposure. Self-efficacy was measured using the three-item, radon-specific portions of the Self-efficacy for Environmental Risk Reduction (SEERR) instrument (*n* = 33, α = 0.89) (Butterfield, et al., in-press). Participants indicated their radon self-efficacy score on a 0-100 confidence scale ($\bar{x}$ = 62.5, *sd* = 25.0, *n* = 224), where a higher number represented a greater sense of confidence. For example, participants were asked to rate their confidence between 0-100 that they could "Identify potential hazards in your home that may affect the health of your child or children." In the reported study, the internal consistency reliability coefficient (*n* =224, α = 0.73) was not as strong as in the pilot study but may have been due to the larger size and variability of the sample.

Analytic Strategy

A backward stepwise logistic regression analysis was performed on pre-testing awareness as outcome and five sociodemographic and three cognitive predictors. Sociodemographic predictors were number of children in the home age 18 or younger, domestic partner (presence or absence), income (categorical), level of education (continuous), and householder status (rent, own). Cognitive predictors were composite scores for radon knowledge, risk-perception, and self-efficacy. Contingency table analyses were performed to yield odds ratios. A backward stepwise logistic regression was also performed on radon-testing as outcome and the same set of eight predictor variables. Backward stepwise (statistical) likelihood ratio regression was used as there was no theoretical rationale to support hierarchical variable entry. There are caveats for stepwise regression; however, the cross-sectional, hypothesis generating nature of this research justified its use in this application.

Results

Sample

The final sample was composed of 224 respondents living in rural, Zone 1 radon counties. Most respondents had domestic partners (80.4%, n = 180), rented their homes (53.1%, n = 119), and had two children younger than 18 living in the home (39.3%; n = 88, m = 2.0, $\bar{x}$ = 2.0, sd = 1.1, range 0-6). The average participant had completed one year of post-secondary education (12.1%, n = 27; m = 13 years, sd = 2.2 years) and earned between \$20,000 and \$29,999 (16.7%, n = 37).

Radon Testing Prevalence

Specific Aim 1 was to investigate the prevalence of home-radon testing by home ownership status. Testing the home for radon was a rare event (13.8%, n = 31). Ninety-two participants (41.1%) had never heard of the health effects of radon. Participants who owned their home (n = 105, 46.9%) were 1.9 times more likely to have heard of radon than those who did not own their home ($\chi^2_{(1,224)} = 5.2$, $p = .02$, 95% CI = 1.1 – 3.2). Participants who owned their home were 3.2 times more likely to have tested their home for radon than those who did not own their home ($\chi^2_{(1,224)} = 8.4$, $p < .01$, 95% CI = 1.4 – 7.4).

Prediction of Radon Awareness in Non-Testers

Specific Aim 2 was to assess the influence of sociodemographic and cognitive variables in predicting pre-testing awareness. The model was statistically reliable ($\chi^2_{(8,\ 193)} = 20.6$, $p < .01$) indicating that the set of predictors could distinguish between those who had never heard of the health effects of radon (n = 92, 47.6%) and those who had heard of the health effects of radon but never tested (n = 101, 52.3%). See Table 1 for the regression statistics summary and Table 2 for a comparison of the step changes. The most parsimonious model was the final model ($\chi^2_{(2,\ 193)} = 19.0$, $p < .01$, Nagelkerke $R^2 = 0.13$). The radon knowledge score (Wald statistic = 5.2, p = .02) and education (Wald statistic = 10.6, p = .00) were retained in the final model which correctly classified 63.7% of those who had never heard of the health effects of radon and 62.6% of those who had heard but never tested for an overall classification accuracy of 63.2%. The logistic regression equation was:

Probability of having heard = $\hat{Y}_i = e^{-2.98 + (0.015)\text{ (Radon Knowledge Score)} + (0.241)\text{ (Education)}} / 1 + e^{-2.98 + (0.015)\text{ (Radon Knowledge Score)} + (0.241)\text{ (Education)}}$.

The follow-up odds ratio (OR) analysis of radon knowledge on pre-testing awareness suggested the radon knowledge instrument was effective as a potential screening tool. Scores were divided into groups of 69% or less (*n* = 69, 35.8%) and 70% or more (*n* = 124, 64.2%) and analyzed by crosstabs. Participants who scored 70% or better were 2.1 times more likely to have heard of radon and not tested than their counterparts who scored 69% or less ($\chi^2_{(1, 193)} = 5.9$, $p = .01$, 95% CI = 1.1 – 3.8). The follow-up OR analysis of education on pre-testing awareness suggested that participants with any post-secondary education (*n* = 107, 61.7%) were 2.3 times more likely to have heard of radon's health effects than participants without (*n* = 86, 40.7%) ($\chi^2_{(193, 1)} = 8.4$, $p < .01$, 95% CI = 1.3 – 4.2).

Predictors of Home Radon Testing

Specific Aim 3 was to assess the influence of sociodemographic and cognitive variables in predicting home-radon testing using the same set of eight predictor variables and the full sample. A test of the full model against a constant-only model was statistically reliable ($\chi^2_{(8, 224)} = 22.4$, $p < .01$) indicating that the model could distinguish between those who had tested (*n* = 31, 13.8%) and those who had not (*n* = 193, 86.2%). The most parsimonious model was the final model ($\chi^2_{(3, 224)} = 22.1$, $p < .01$) where radon self-efficacy, income, and education were retained in a model that correctly classified 86.4% of participants on radon testing. The logistic regression equation was:

Probability of having tested = $\hat{Y}_i = e^{-6.38 + (0.020)\text{ (Radon Self Efficacy)} + (0.220)\text{ (Income)} + (.252)\text{ (Education)}} / 1 + e^{-6.38 + (0.020)\text{ (Radon Self Efficacy)} + (0.220)\text{ (Income)} + (.252)\text{ (Education)}}$.

The follow-up OR analysis of the independent variables on radon testing revealed that participants with any post-secondary education were 5.4 times more likely to have tested their home for radon than those without ($\chi^2_{(1, 224)} = 11.1$, $p < .01$, 95% CI = 1.8 – 16.1). Participants who reported radon self-efficacy scores of 70 or higher (*n* = 100, 44.6%) were 3.6 times more likely than those who reported lower scores to have tested their homes ($\chi^2_{(1, 224)} = 10.1$, $p < .01$, 95% CI = 1.6 – 8.2). Participants who reported annual household incomes greater than $30,000 (*n* = 105, 47.5%) were 2.6 times more likely to have tested their homes for radon than those earning less ($\chi^2_{(1, 224)} = 5.9$, $p = .015$, 95% CI = 1.1 – 5.9).

Discussion

Prevalence of Home Radon Testing as Influenced by Sociodemographic Factors

Perhaps the most striking finding of this study was that rural, low-income families in three Zone 1 radon counties rarely tested their homes and, of those who had not tested, nearly half had never heard of the health effects of radon gas (*n* = 92, 47.6%). This is an alarming finding given that 49 of Montana's 56 counties are estimated to have average indoor radon gas levels greater than the recommended 4 pCi/L (Environmental Protection Agency, 2011). Moreover, because the bulk of lung cancer deaths associated with household radon exposure are attributable to the combination of radon exposure and tobacco smoking (Krewski et al., 2006), low-income populations that are represented by a greater percentage of smokers are likely to be at much greater risk for terminal outcomes. In Montana, 2008 Behavioral Risk Factor Surveillance data suggested that among respondents earning greater than $50,000 annually only 8% smoked every day compared with about 25% for those earning less than $25,000 a year (Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance System, 2010).

Findings presented here contributed to our understanding of vulnerability to radon exposure risk for rural, low-income families. Our research suggested that families who rented their homes may not be receiving important public health messages about the dangers of indoor radon exposure, or, alternatively, are unable to act on information received related to radon exposure due to financial constraints. In the recently published Federal Radon Action Plan (Environmental Protection Agency & U.S. Department of Health and Human Services, 2011) the federal agencies acknowledged the financial barriers low-income families face for mitigating a radon problem that may explain an unwillingness to test for radon in the first place. Similarly, there are no known regulations requiring landlords to test or mitigate a dwelling to demonstrate habitability making the radon problem for renters one of particular significance (Environmental Protection Agency & U.S. Department of Health and Human Services, 2011).

Increasing Radon Awareness in Non-Testers

Radon knowledge and education level of the participant were significant variables in the model that correctly classified nearly three-fourths of those who had never heard of the health effects of radon and over half of those who had heard but never tested. Follow-up study should focus on increasing radon knowledge, particularly among families where the parents have not attained any post-secondary education or where clients score less than 70% on the radon knowledge screening tool. These findings support “stage of change” theory for adopting health behaviors in sequential steps as individuals overcome common barriers relevant to each stage (Weinstein & Sandman, 2002). First, public health and radon experts should implement knowledge interventions to share information on the health effects of radon gas exposure. Next, interventions should focus on helping individuals with practical steps of where to buy test kits, how to perform a radon test, and perhaps in some cases how to access financial assistance for mitigation in the event of a high result (Environmental Protection Agency & U.S. Department of Health and Human Services, 2011).

Utilizing Predictors of Home Radon Testing in Community Education

Radon self-efficacy, household income, and education level of the participant were significant variables in the model that correctly classified 86.4% of participants on radon testing. While household income and education level are not attributes for intervention, they do provide the rationale for public health professionals working with families with fewer years of education or lower income levels to spend the time to share knowledge about radon risks and practical information on completing home-radon testing. Home visitation programs and WIC counseling are two programs where an emphasis on radon knowledge and testing could make an important difference for vulnerable families. Improving self-efficacy for radon testing is another opportunity for public health professionals to be creative. For example, efforts to increase visibility of radon test kits and demonstrate their use at health fairs, home shows, and community events could help demystify the testing process. In addition, displays, posters, pod-casts or digital signage with diagrams of radon test-kits and simplified illustrations/demonstrations of how to conduct the tests could be useful. The goal would be to increase consumer confidence in performing home radon testing as well as to educate families about low or no-cost steps to reduce their family's exposure. The Federal Radon Action Plan (Environmental Protection Agency & U.S. Department of Health and Human Services, 2011) has outlined an ambitious, multi-agency plan to greatly increase the public's understanding of cancer risks from radon. The interventions discussed here would supplement those large-scale plans at the local level.

Future Research

Several variables may improve our ability to account for radon testing behavior aside from those tested in this study. First, the extent to which information about the health benefits of ionizing radiation for curing arthritis and respiratory disease influences thinking about radon risk and testing is not known and should be explored (Luckey, 2008; Woodbury, 2000). Second, those living in rural poverty are exposed to a greater array of adverse physical and psychosocial conditions than those living in middle class homes (Evans & English, 2002), and these stressors may preempt or postpone attention to preventative health behaviors associated with the home environment such as radon testing. A full exploration of radon testing with populations experiencing poverty should take into account the extent to which daily stressors interfere with prospective health behaviors.

Limitations

This study had several limitations. First, because cross-sectional data was used, the cautions about implying causative relationships with either radon testing or awareness are warranted. Second, the convenience sample of only rural, low-income, health-department clients limited external validity. Third, traditional variables in SES research such as age, race, and ethnicity were intentionally excluded for WIC Clinic collaboration. Future research should include these potentially important variables in an examination of radon testing behavior.

Conclusions

The findings from this study have a number of important implications for public health efforts aimed at improving environmental health in rural U.S. communities. In terms of vulnerable populations, targeted messages to landlords and families who rent their homes should be implemented to address the paucity of testing by families who rent their homes. The President's Cancer Panel (2009) stated in their recent report that the cancer risk attributable to residential radon exposure has been clearly demonstrated and must be better addressed. They recommended the broad dissemination of information to raise awareness of radon-related cancer risk. They proposed tax incentives for property owners to mitigate for high radon levels and legislation to mandate testing of public buildings and daycares. Legislative efforts to expand landlord-tenant law to include disclosure of indoor radon concentrations to tenants would be another important goal in alignment with these and other public health efforts aimed at reducing health disparities for the most vulnerable members of our communities.

The Federal Radon Action Plan (Environmental Protection Agency & U.S. Department of Health and Human Services, 2011) is a hallmark document created by multiple federal agencies focused on addressing radon exposure across the population. While the authoring agencies have outlined an ambitious agenda for increasing radon knowledge, testing, and mitigation, the results reported here on low-income families in rural areas would indicate that interventions for *reducing* exposures should also be emphasized. As examples, if a family cannot afford to mitigate a high-radon home, they should be counseled to limit sleep and play time in basements, increase ventilation of fresh air, increase activities outside of the home in order to reduce hours of occupancy, seal cracks in foundations, create a vapor barrier in dirt foundations, eliminate exposure to second hand smoke and other particulate matter in the home (i.e., dust, wood smoke), and work with their landlord on a plan for mitigation or cost-sharing on increased energy bills to support increased ventilation.

While the "warranty of habitability" that governs a landlord's requirement to provide safe housing to the tenant is perhaps the appropriate legal argument for requiring radon testing and mitigation in rented housing, this is a case for the justice system that has not yet been addressed. In the absence of a strong regulatory framework to protect renters from radon and until the goals of Healthy People 2020 (U.S. Department of Health and Human Services, 2010) and the Federal Radon Action Plan (Environmental Protection Agency & U.S. Department of Health and Human Services, 2011) are realized, sociodemographic correlates are among the best tools we have for identifying families at high risk. The public health community is obligated to discuss low-cost alternatives to reduce radon exposure for clients and families who cannot afford standard mitigation. The failure to do so is a systematic exclusion of the low-income community from the scientific and engineering gains made in reducing preventable lung cancer in recent years.

Table 1—Results from Multivariable Modeling for Predictors of Indoor Radon Risk Reduction Aim 2: What Variables Predict if Non-testers Have Ever Heard of Health Effects of Radon (*n* = 193)?

Aim 2: What Variables Predict if Non-testers Have Ever Heard of Health Effects of Radon?

Predictor	χ^2	β	SE β	Wald	Sig	*e*β	95% CI for β
Step 0	21.02**	-0.01	.16	0.00	.94	0.99	
Step 1	22.62**						
Partner Status		-0.03	.46	0.00	.95	0.97	0.39 - 2.41
Self-Efficacy		-0.002	.008	0.08	.78	1.00	0.98 - 1.01
Risk Perception		0.10	.17	0.36	.55	1.10	0.80 - 1.53
Radon Knowledge		0.09	.04	4.72*	.03	1.10	1.00 - 1.20
Annual Income		0.06	.08	0.50	.48	1.06	0.91 - 1.23
Education		0.29	.11	6.78**	.00	1.33	1.07 - 1.65
Number of Children		-0.08	.17	0.21	.65	0.93	0.67 - 1.28
Householder Status		-0.07	.42	0.03	.87	0.93	0.41 - 2.14

Aim 3: What Variables Predict Home Radon Testing among Rural, Low-Income Families (*n* = 224)?

Predictor	χ^2	β	SE β	Wald	Sig	*e*β	95% CI for β
Step 0	12.35 (.14) (.17)	-2.20	.26	73.86*	.00	0.11	
Step 1	13.31 (.10)						
Partner Status		-0.34	.92	0.13	.72	0.72	0.12 - 4.31
Self-Efficacy		0.03	.02	4.26*	.04	1.03	1.00 - 1.06
Risk Perception		-0.19	.25	0.60	.44	0.83	0.51 - 1.34
Radon Knowledge		-0.03	.07	0.22	.64	0.97	0.85 - 1.10

Annual Income	-0.03	.11	0.07	.79	0.97	0.78 - 1.21
Education	0.26	.16	2.80	.10	1.30	0.96 - 1.77
Number of Children	-0.25	.27	0.87	.35	0.78	0.46 - 1.32
Householder Status	-0.44	.66	0.45	.50	0.64	0.18 - 2.33

*p < .05

**p < 0.01

Table 2—Model Summary Statistics of Backward Stepwise Logistic Regression for Sociodemographic and Mental Model Variables Predicting Home Radon Pre-Testing Awareness (n = 193) and Testing (n = 224)

Pre-Testing Awareness

Step	χ^2	*df*	-2 LL	Nagelkerke R^2	Cox & Snell R^2
0	20.6*	8	263.0		
1: PS, SE, RP, KN, IN, ED, CH, HH	21.7*	8	241.4	.14	0.11
2: SE, RP, KN, IN, ED, CH, HH	21.7*	7	241.4	.14	0.11
3: SE, RP, KN, IN, ED, CH	21.7*	6	241.4	.14	0.11
4: SE, RP, KN, IN, ED	21.6*	5	241.5	.14	0.11
5: SE, KN, IN, ED	21.2*	4	241.8	.14	0.11
6: SE, KN, ED	20.4*	3	242.6	.14	0.10
7: KN, ED	19.0*	2	244.0	.13	0.10

Radon-Testing

Step	χ^2	*df*	-2 LL	Nagelkerke R^2	Cox & Snell R2
0	22.4*	8	179.2		
1: PS, SE, RP, KN, IN, ED, CH, HH	24.4*	8	154.8	.19	.10
2: PS, SE, KN, IN, ED, CH, HH	24.4*	7	154.8	.19	.10
3: SE, KN, IN, ED, CH, HH	24.4*	6	154.8	.19	.10
4: SE, IN, ED, CH, HH	24.2*	5	155.0	.19	.10
5: SE, IN, ED, CH	23.2*	4	156.0	.18	.10
6: SE, IN, ED	22.1*	3	157.1	.17	.10

Note. PS = partner status, SE = self-efficacy, RP = risk perception, KN = knowledge, IN = income, ED = education, CH = children, and HH = householder status. Nagelkerke R2 and Cox & Snell R2 are both measures of effect size. -2LL = -2 Log Liklihood and is the difference in model improvement over the null. Model 7 for Pre-Testing Awareness: Hosmer & Lemeshow test = 13.0, p =.11. Model 6 for Radon Testing: Hosmer & Lemeshow test = 7.51, p = .48. Hosmer & Lemeshow is a goodness-of-fit test where a finding of non-significance indicates adequate fit.

*p < .01

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