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Risk-Reduction Strategies to Expand Radon Care Planning with Vulnerable Groups

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Abstract

Objectives—Radon is the second leading cause of lung cancer in the United States and the leading cause of lung cancer among nonsmokers. Residential radon is the cause of approximately 21,000 U.S. lung cancer deaths each year. Dangerous levels of radon are just as likely to be found in low-rise apartments and townhomes as single-family homes in the same area. The preferred radon mitigation strategy can be expensive and requires structural modifications to the home. The public health nurse (PHN) needs a collection of low-cost alternatives when working with low-income families or families who rent their homes.

Method—A review of the literature was performed to identify evidence-based methods to reduce radon risk with vulnerable populations.

Results—Fourteen recommendations for radon risk reduction were categorized into four strategies. Nine additional activities for raising awareness and increasing testing were also included.

Discussion—The results pair the PHN with practical interventions and the underlying rationale to develop radon careplans with vulnerable families across housing types. The PHN has both the competence and the access to help families reduce their exposure to this potent carcinogen.

Keywords

housing; lung cancer; radon; risk reduction; vulnerable populations

The World Health Organization (2009), the Environmental Protection Agency (EPA) (Pawel & Puskin, 2003), and the President's Cancer Panel's (2009) have all identified radon as a dangerous carcinogen. Radon gas is the largest source of radiation exposure to the general public (Darby et al., 2005), and exposure to radon is the second leading cause of lung cancer death among smokers and nonsmokers. Lung cancer has the lowest 5-year survivability rate of all the cancers and 21,000 lives per year are lost in the U.S. due to lung cancers attributed to radon exposure. This estimate represents approximately 10% of all lung cancer deaths (Darby et al., 2005). Radon-related lung cancers are entirely preventable making the topic of reducing exposure an important public health concern.

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Unfortunately, most radon policy, research, and education has focused primarily on homeowners and overlooked low-income families and families who rent, rather than own, their homes. The current emphasis in health disparities research is to move beyond the documentation of health inequalities to addressing questions of how differential socioeconomic status exerts its influence on health (Dunn & Hayes, 2000). As renting is often a function of being low income, indoor radon exposure serves as an exemplar case for how differential socioeconomic status may contribute to health disparities in the U.S. The imperative to reduce preventable deaths from radon-related lung cancers and the national drive to address health disparities provide the rationale for advancing a radon-action agenda tailored to the barriers of low-income families who rent their homes.

Radon is a naturally occurring gas that comes from the soil and rock and enters into homes through cracks in the foundation, crawl spaces, and structural openings. Radon gas is colorless, tasteless, and odorless. As radon gas decays, it gives off small, radon decay products (RDP) that increase the risk of lung cancer when inhaled. The particles are referred to in the literature as alpha particles, radon progeny, or radon daughters. Even though it is the RDP that cause cancer, the measurement of “radon” in the home is typically based on radon gas concentration rather than RDP. Using a conversion factor to relate RDP to radon gas, the EPA cautions that any home with an indoor radon gas concentration greater than 4 pCi/L has a dangerous level of RDP and should be fixed (EPA, 2010). Radon gas can be understood as a proxy measure for RDP.

Active soil depressurization (ASD) is the predominant method for reducing indoor radon gas. Using this method, radon-rich air is evacuated from the soil directly beneath the home with the installation of a fan and suction system (EPA, 2010). While mitigation using ASD is the radon-industry standard and the preferred way to reduce lung cancer risk in nonsmoking households (Mendez, Warner, & Courant, 1998; World Health Organization [WHO], 2009), there are several other techniques to apply in cases where ASD is either not feasible or cost prohibitive. The PHN is uniquely poised to broaden the environmental health discussion to include these lower cost strategies for families who either cannot afford to mitigate or those who rent their homes (Larsson & Butterfield, 2002). The PHN is fluent in the language of risk reduction and well suited to working with families to reduce a host of environmental and nonenvironmental exposures (e.g., lead-based paint, infectious disease, injury). A review of the literature supporting a set of alternative risk-reduction strategies is outlined in this paper.

Background and significance

National housing data figures show that 98 million Americans rent their homes and that rental units account for 31.6% of all occupied housing units in the United States. (U.S. Department of Housing and Urban Development, 2011). Testing of rental units is rarely required of landlords, but some states have begun to address this gap. Maine will begin requiring landlords to test and disclose the residential air for radon in March 2014 (Radon Testing, 2013). In Maine, the required radon-testing interval will be every 10 years. Further, Maine is offering a tax credit for developers who create low-income housing that is radon resistant. This is similar to a new law in New York where a green building tax credit will be

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issued for radon-resistnat tenant space. Illinois requires the disclosure of known radon to renters, but does not require testing (Nuclear Safety Illinois Radon Awareness Act, 2012). There are currently no other states requiring landlords to test and disclose indoor radon concentrations to their tenants. Until the warranty of habitability is amended to address this shortcoming in the regulatory framework, PHNs may be the professionals in the best position to educate the 33% of American families who rent their homes about the risks from radon (Maring, Singer, & Shenassa, 2011).

The disparities in radon knowledge and testing between renters and homeowners has been well documented (Hill, Butterfield, & Larsson, 2006; Larsson et al., 2011). In a secondary analysis of a national dataset, an odds ratio (OR) estimate was used to confirm that occupants of single-family homes/townhomes were twice as likely to have ever heard of radon (OR = 2.26; 95% CI = 2.09–2.44) and also more likely to know if their household air had been tested for radon (OR = 1.38; 95% CI = 1.19–1.59) as occupants of apartments/condominiums (Larsson, Hill, Odom-Maryon, & Yu, 2009). Despite results that have shown renters demonstrate less radon awareness and testing behavior (Larsson et al., 2011; Poortinga, Bronstering, & Lannon, 2011) solutions to the radon issue have nearly always been framed as a “homeowner” issue (Johnson & Luken, 1987; U.S. Department of Health and Human Services [USDHHS], 2013; Weinstein, Lyon, Sandman, & Cuite, 1998).

When teams studying indoor air quality have included renters, they have mostly been underrepresented relative to their numbers in the general population. Chi and Laquatra (1990), in their investigation of the relationship between the degree of weatherization and indoor radon level in New York, reported radon levels for 17 renters (8%) of 211 total participants. Cohen (1991) reported that 3.2% (n = 1100) of first-time radon testers were renters. In a study of radon abatement, Wang, Ju, Stark, and Teresi (2000) 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. Scarcely represented in published research, renters are a subgroup in need of interventions tailored to their particular barriers to radon testing and risk reduction.

Some investigators, perhaps deciding that it was unethical to make renters aware of an exposure they were powerless to fix, deliberately excluded renters from their research designs. Johnson and Luken (1987) excluded nonhomeowners from their study of radon risk perception in Maine households. Sandman and Weinstein (1993) only included New Jersey single-family homeowners who had heard of radon in their analysis. Nissen, Leach, Nissen, Swenson, and Kehn (2012) tested a radon intervention in a primary care setting for families who owned their home. Field, Kross, and Vust (1993) collected householder status, but did not analyze it as an independent variable, and the USDHHS (1999) investigated residence type, but not householder status. In studies of radon awareness and testing where householder status was a dependent variable, renters were much less likely to be aware of radon, to have tested for radon, or to know if their household air had been tested for radon, compared to homeowners (Larsson et al., 2009, 2011; Poortinga et al., 2011).

Results of housing studies have shown that renting is a risk factor for several other negative health outcomes such as adolescent substance abuse (Williams, Scheier, Botvin, Baker, &

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Miller, 1997), low birth weight (Shiono, Rauh, Park, Lederman, & Zuskar, 1997), and HIV risk behaviors (Sikkema et al., 1996). Similarly, residential segregation has been associated with increases in a variety of important health indicators including infant mortality (Commission to Build a Healthier America, 2008), exposure to tobacco and alcohol advertising (USDHHS, 1998), and increased exposure to air pollution (Lopez, 2002). Papadimitriou et al. (2005) found a nine-fold increase in smoking among mothers of newborns who occupied rental housing, lacked higher education, and were single parents.

The approach to addressing an environmental health concern with renters may be more than a simple matter of including them as a priority population. According to Dunn and Hayes (2000), housing status was crucial in social identity as homeowners reported higher health status than homerenters (Relative Risk 2.42, 95% CI: 2.30–2.51). Authors of subsequent studies have confirmed that the psychological dimensions of householder status including self-worth, self-esteem, power, and social standing are important explanatory variables in differential health outcomes and more than just proxies for the physical attributes of housing or correlations between renting and lower educational or socioeconomic status (Gee & Payne-Sturges, 2004; Kneipp & Drevdahl, 2003). To the degree that renting is more than a proxy measure of socioeconomic status and in consideration of the significant comorbidities and higher smoking rates among renters, intervention with this subpopulation to reduce radon exposure is justified (Larsson et al., 2009).

A further rationale for working with renters on radon testing and knowledge is that renters tend to be younger people. In the United States, 72% of people aged 30 years or younger rented their home in 2011 (National Multi-Housing Council, 2011). Poortinga et al. (2011) reported a significant age effect where people aged 55–64 years were 20 times more likely to have heard of radon than the 16–24 year old reference group. When housing tenure by age of householder is considered, the argument for early intervention with individuals and families who rent their home is clear. As radon exposure is a lifetime cumulative risk it makes sense to intervene with a younger cohort of people who can benefit longer from the knowledge and skills acquired. Early intervention with families of childbearing age also has the most potential for preventing pediatric exposure to radon—considered by the EPA to be the most potent carcinogen in homes (EPA, 2008).

Method

The author began by conducting a review of the literature for evidence-based and low-cost alternatives to radon mitigation when a home has a radon concentration greater than 4 pCi/L. Web of Science, the Cumulative Index of Nursing and Allied Health Literature and PubMed searches were conducted using the major search headings, “radon —adverse effects,” “environmental health,” “air pollution indoor,” “residential radon,” and “healthy homes.” Articles that focused on alternatives to radon mitigation and were evidence based were retained. Reference pages of those articles were inspected for additional, relevant citations. Next, a query of statutory, administrative, or constitutional statutes was performed using LexisNexis Academic; for any legal document that contained the term “radon” at least five times. Several government agency web sites such as the Environmental Health Agency (EPA), the Centers for Disease Control and Prevention, and the WHO were also important

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data sources for this literature review. The American Association of Radon Scientists and Technicians annual conference proceedings were searched by hand. Finally, experts were consulted for access to industry papers not published in the health sciences literature.

Analytic strategy

The results of the literature review were categorized using two approaches. First, the recommendations were sorted into four strategies: (1) changes in the occupancy pattern, (2) changes in indoor air quality, (3) reductions in source exposure, and (4) overall risk reduction. Second, the recommendations were organized by level of intervention (see Table 1) as this may be an organizational approach useful to the PHN and her clients.

As with any care planning by the PHN, interpretation of an indoor radon result should be done within the context of an initial overall assessment. Housing characteristics, householder status (e.g., rent or own), comorbidities (e.g., asthma, allergies), and a comprehensive risk assessment including smoking status, heating source, and presence of a heating, air-conditioning, or ventilation (HVAC) system should be included to tailor the plan to the family's situation. For example, a tenant should explore the possibility of mitigation with their landlord first as ASD is the preferred approach for reducing exposure (Steck, 2012). Of course, the strategies suggested here should only be considered as short-term solutions until renters are able to move into a healthier environment or homeowners can accumulate enough savings to use ASD to mitigate their residence.

Results

Changes in the occupancy pattern

Until a biomarker for host lung injury is available clinically (Hanash & Taguchi, 2011; Taguchi et al., 2011) health care providers must rely on indoor radon measurements to estimate risk. Radon measurements should be taken in the lowest living area as concentrations are higher in basements and first floor living areas than in the upper levels of the home. The number of hours of exposure for any individual resident of a home changes based on their occupancy pattern. Additional individual factors in radon exposure like uptake, clearance, and susceptibility cannot be estimated. The low-cost interventions the PHN should employ under this strategy include encouraging families to place sleeping quarters in the highest levels of the home (Barnes et al., 2010), limit basement recreation time, and spend more time outdoors (Hancock, 2002). Families who rent their homes or who have a young adult preparing to rent their first home should be reminded to rent a second-story unit if available and only a basement or first-story unit if the landlord can provide documentation of safe radon levels.

Changes in indoor air quality

It is important to note that working with families to improve indoor air quality is a comprehensive environmental health strategy that includes reducing exposures to asthma and allergy triggers, secondhand smoke, combustion products, and RDP. The mechanism for host injury occurs when the RDP are inhaled and travel to the lungs. Most commonly, the RDP are attached to fine particles in the air such as tobacco smoke, combustion by-products,

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dusts, and aerosols. Therefore, actions to reduce indoor particulate matter can reduce exposure to ionizing radiation in the lungs and bronchial tree even if the radon gas levels in the home cannot be significantly reduced. There are five recommendations to reduce exposure to radiation: two to reduce particles emitted within the home, two to filter particles in the homes, and one to increase air exchange.

The first recommendation is to counsel families who smoke tobacco to enroll in a cessation program or to smoke outside the home (Lichtenstein et al., 2008; Mendez et al., 1998). The second recommendation is to ask the family if they are able to reduce their reliance on wood heat or confirm that they are using an EPA-certified wood stove (Noonan et al., 2011).

The third recommendation is to remove fine particulates from the air (Hinds, Rudnick, Maher, & First, 1983; Hopke, 1996). Air cleaners were shown to reduce RDP by 72–89% (Hinds et al., 1983). Air cleaners with filtration and with filtration plus carbon filter showed significant ($p < .01$) reductions in RDP (Yasuoka et al., 2009). Air-to-air heat exchangers have also been shown to reduce indoor radon gas (Hellevang & Pedersen, 2009). Mechanical filtration using portable or console air cleaning is an option that may work particularly well for renters as they can be used without consulting the landlord or property manager. Wang, Meisenber, Chen, Karg, and Tschiersch (2011) demonstrated a 45% reduction in RDP by placing a surgical mask over a household fan to clean the air. Hinds et al. (1983) used a console fan to achieve a 64% reduction in RDP and a ceiling fan to achieve a 54% reduction in RDP. Mechanical filtration of home air has the added health benefits of reducing allergens, asthma triggers, and dust as well. The PHN should refer clients to the EPA document on residential air cleaners (EPA, 2009).

The fourth recommendation involves collaboration with a heating and air-conditioning technician if a home has a central HVAC unit. There are two alternative approaches to radon mitigation to consider if this is the case. The first is related to the size and type of filter. Minimum-efficiency reporting value (MERV 10–13) and electrostatic filters are the types to consider.

Minimum-efficiency reporting value (MERV-13) filters mechanically filter fine particulates (i.e., bacteria, lead dust, and attached radon particles) from the air without necessarily requiring alterations to the ducting or the fan motors that would be required for true HEPA filtration (EPA, 2009; Kladder, 2011). Issues to consider in this approach are the technical specifications of the HVAC system. For example, whether the furnace is designed to accommodate a one or four inch filter is determined by the age and cost of the HVAC system with newer and more expensive systems using the thicker, more expensive filters. The rating of the blower motor and the sizing of the furnace ducting are also important to consider when changing the dimensions or density of the furnace filter. Tenants should be advised to communicate with their landlords to understand the compatibility of a central system with High-MERV filters. Even advising families to create a simple reminder system to be sure that one-inch filters are changed monthly and four-inch filters are changed yearly is an action toward helping improve indoor air quality.

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The utility of electronic filters for radon reduction was demonstrated in both published (Hinds et al., 1983) and unpublished reports (Kladder, 2011). Hinds et al. reported a 72% reduction in RDP using an electronic filter. An electronic filter is equipped with a constant mechanism for imparting a surface charge. See Hinds et al. for a discussion of the three ways in which these filters achieve reductions in RDP. In Kladder's experiment, the electronic filter was used to replace an existing one-inch filter without duct revisions in the home (approximate cost $100). While typically used just to reduce allergens, the electronic filters combined with increased air circulation removed the RDP to well below the EPA action level. Simultaneous measurements of radon gas and RDP demonstrated that the RDP were abated even though the radon gas level in the room was still above 4 pCi/L. Kladder noted that the objective was to reduce the health risks associated with RDP rather than simply reducing the radon gas concentration.

The second alternative approach involving the HVAC system is to see if the unit has an electronically controlled motor that can be set to run all the time at a lower speed. When the thermostat calls for heat the speed increases. Ideally, it would provide 1.5–2.0 exchanges of room hair per hour (Kladder, 2011). This approach produces filtration and air movement and can dilute the radon gas in household air (WHO, 2009). Keep in mind that this approach may increase radon levels in cases where there are upper levels of the home, so should only be used with modest elevations in radon concentration.

Fifth, the PHN should encourage families to ventilate the home by opening windows and doors. The average radon concentration in outdoor air is very small and radon trapped inside can be released while household air is refreshed from the outside. Yasuoka et al. (2009) demonstrated that opening doors and windows achieved similar results to air cleaning, but they did not report the magnitude of the effect. While the obvious concern is loss of heated or cooled air and it is not a permanent mitigation strategy, it certainly is a simple practice to improve indoor air quality when the weather allows (World Health Organization, 2009).

The PHN should explain to clients considering these five recommendations for improving indoor air quality that increasing the use of exhaust fans, oscillating fans, air exchangers, and using continuous rather than intermittent flow on the HVAC are strategies that may help improve indoor air quality (EPA, 2009; Hellevang & Pedersen, 2009) without reducing the source of radon into the home. It is important to explain to clients that the harmful dose in radon exposure comes from the inhalation of RDP rather than the radon gas itself. Importantly, reducing RDP will not reduce radon gas measurements, but will reduce inhalation of harmful particles (Wang et al., 2011). Explain to clients that the fans push the radioactive particles against interior walls or onto filter media in the HVAC system allowing the radon to "plate out" of the air. This means that the RDP—the alpha particles—are stuck to the walls and not in the breathing zone. It is important to remind clients of two things if they use these strategies. One is to expect an increase in energy usage on their power bill. While the watts used will probably be approximately equivalent to running the fan on an ASD system, it is still important to prepare families for the increased electrical costs. The second is that follow-up measurement to evaluate the effectiveness of the strategy will need to use a direct measurement of RDP rather than the proxy measurement of radon gas. Remind them that RDP can be very low even when the radon gas level can be very high.

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Federal statutes cite a level of 0.02 Working Levels as the clean-up implementation standard for RDP (Code of Federal Regulations, 2012).

Reductions in source exposure

For nonsmokers, there are no reduction strategies that work as well as eliminating radon before it enters the living space of the home. Strategies in this domain depend a lot on the structural characteristics of the home. In homes with bare soil or graveled crawl spaces, one approach is to line the crawl space with visqueen to retard entry of radon gas (World Health Organization, 2009). It is critical that the barrier be airtight or the visqueen will not confer any benefit. This is a good approach in unfinished basements as well. With a poured concrete foundation, modest reductions in radon entry can be achieved by sealing cracks, and caulking around pipes, drains, and other openings (EPA, 2010; World Health Organization, 2009). Where foundation vents are used, keeping them open to increase ventilation under the home is another temporary strategy (Hellevang & Pedersen, 2009; World Health Organization, 2009).

A nursing intervention from Colorado is particularly innovative. PHNs in Pueblo offer weekend Do-it-Yourself (DIY) workshops in cooperation with local radon mitigation specialists for homeowners unable to afford hiring a professional. The combination of learning about radon and how to “fix it” allowed the homeowner to take action at a fraction of the expense (Barber, 2010; Kladder, Burkhart, & Jelinek, 1995). Library and online resources (Center for Environmental Research and Technology Incorporated (Producer), 2012) make the DIY intervention one that can be duplicated in other high-radon areas. This is a powerful example of nurses working creatively and collaboratively with mitigation professionals to address health disparities at the community level.

Overall risk reduction

The relationship between radon exposure and smoked tobacco use is synergistic meaning that the cumulative effects are more than additive (Health Canada, 2010; Mendez et al., 1998; USDHHS, 1999). The PHN has the opportunity to discuss comprehensive risk to the lungs and explain that smoking cigarettes or inhaling environmental tobacco smoke makes radon even more dangerous (Darby et al., 2005). Household members who smoke and are amenable to quitting should be encouraged to enroll in a tobacco cessation program as smoking cessation is their best risk-reduction strategy. During a discussion of lung health, the PHN has the further opportunity to discuss pneumonia and influenza vaccination, and exposure to mold and asthma triggers as well (Butterfield, Hill, Postma, Butterfield, & Odom-Maryon, 2011). Lichtenstein et al. (2008) used indoor radon concentrations as a way to start conversations with participating families about tobacco cessation. Testing both telephone and video interventions, the team found that the combined interventions resulted in more new smoking bans than no intervention. Health Canada (2010) also reasoned that radon is an inexpensive and useful way to engage smokers in risk-reducing behaviors when they launched their, “Radon, Another Reason to Quit” campaign.

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Discussion

Four overall strategies including fourteen recommendations are proposed in this paper for reducing the risk of radon in residential environments where mitigation by ASD is not affordable or feasible. A concern of some scientists (Maher, Rudnick, & Moeller, 1987; Tschiersch, Meisenberg, & Wang, 2012) regarding alternative strategies to ASD for radon risk reduction is the comparative dose of radioactivity to the bronchial tree in the absence of particulate matter or aerosol in room air. Put simply, the idea is that RDP travel into the bronchial tree attached to particulate suspended in air, but most get trapped in the lining of the sinuses and trachea. As the particulate, or aerosol, is removed through the methods proposed in this paper, the RDP have nothing to attach to and are more dangerous because they can travel further into the bronchial tree and lungs. The controversy over this "unattached fraction" is whether it increases to a dangerous level as the large room particles are removed thus offsetting any health benefit. Contemporary research teams have addressed the dosimetry concerns from the unattached fraction (Hopke, 1996; James, Birchall, & Akabani, 2004; Joshi, Sapra, Khan, Kothalkar, & Mayya, 2010; Tokonami, Furukawa, Shicchi, Sanada, & Yamada, 2003). Experiments using better electronic instrumentation and better replication of the living environment supported the benefits of removing particulate matter from the air. After demonstrating a significant drop in RDP using an air cleaner, Hopke concluded, "There is no reasonable likelihood that the use of an air cleaner will increase the hazards from indoor radon" (p. 57). Therefore, risk-reduction activities are proposed based on the evidence that in homes with stoves, appliances, pets, and people, there is little reason to worry over air that is too clean of particulate matter.

A discussion of the relationship between the recommendations made in this article and the Healthy People framework is also important. The Healthy People 2020 overarching goal is to achieve health equity, eliminate disparities, and improve the health of all groups. While those goals are consistent with the interventions recommended here, it is important to note that the radon-related goals of Healthy People 2020 have evolved from Healthy People 2010 radon goals in a way that may perpetuate radon exposure as solely a home-owner issue. Healthy People 2010 Objective 8–18 was to, "Increase the proportion of persons who live in homes tested for radon concentrations (USDHHS, 2010)." This was a goal that crossed socioeconomic and housing tenure lines creating a uniform metric for all Americans. The Healthy People 2020 radon objectives are EH-14 "Increase the number of homes with an operating radon mitigation system for persons living in homes at risk for radon exposure" (USDHHS, 2011a) and EH-15 "Increase the percentage of new single-family homes constructed with radon-reducing features, especially in high-radon potential areas" (USDHHS, 2011b). The new goals are focused on ASD in high-radon geographic regions and provide stronger rationale for legislating radon-resistant building codes than the Healthy People 2010 goals. They do not include strategies for helping low-income families or those who rent their homes. The absence of renters and low-income families from the radon-related goals of Healthy People 2020 makes it even more important for the PHN to advocate for these groups at the local level and integrate the recommendations in this paper into their practice.

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This review of the literature was conducted for collecting a suite of alternative strategies to support the work of PHNs as they assist vulnerable families who either rent their homes or are unable to afford ASD. The recommendations in this paper have been further organized into primary, secondary, and tertiary prevention strategies a resident can take to prevent or reduce risk from radon (Table 1). When the PHN is helping an individual or family to understand their radon risk, this menu of actions should serve as a one-page reference list for the nurse or as a take-away sheet for the client. In non-English speaking communities, Table 1 can be translated to create a more accessible reference sheet.

As it is with many other concerns of the PHN, the entire cadre of radon-risk interventions cannot be handled by the nurse alone. The PHN and her clients should form a collaborative relationship with an HVAC technician who can advise on ducting, filters, fans, and fan motors for the inexperienced family or nurse. This is similar to forming a collaborative relationship with a nutritionist or social worker and as “healthy housing” gains increasing attention it is likely to be just as valuable a partnership.

In communities with landlord associations or tenant rights’ groups, the PHN may want to initiate outreach and education activities with these groups to promote radon awareness and risk-reduction behaviors. Forming collaborative relationships with these groups may provide opportunities for the PHN to facilitate conversations about radon awareness and risk reduction before a family finds they have a high-radon level in their home. In communities without these groups, the PHN may initiate direct outreach to an individual landlord to address a high-radon situation.

Strategic partnerships with policymakers and environmental health advocacy groups are other important collaborations. Working to pass laws requiring landlords in Zone 1 areas to test and disclose radon concentrations to their tenants would be a public health accomplishment. Working to pass ordinances requiring schools and day cares to test and report radon concentrations to families would be another public health victory. Finally, the PHN needs to collaborate with environmental nurse advocacy groups to assess homes in high-radon geographic areas for radon. For example, working through the Alliance of Nurses for Healthy Environments to add indoor radon to a comprehensive home assessment checklist would be a way to increase awareness and reduce a preventable, residential exposure.

Public health nurses have the environmental education and communication skills to advocate for and intervene with families with a residential radon problem (Larsson & Butterfield, 2002). Nurses have valuable experience helping families address housing-related health concerns including asthma triggers, lead poisoning from paint, fall hazards, household chemicals, and carbon monoxide poisoning (Barnes et al., 2010; Butterfield et al., 2011; Maring et al., 2011). Reducing a family’s exposure to RDP should be another such example. Tailored care planning with families about the low-cost strategies for reducing exposure to ionizing radiation in the home is an evidence-based, low-cost approach to addressing a preventable health risk.

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TABLE 1

Primary, Secondary, and Tertiary Level Interventions for the Public Health Nurse to use in Radon Care Planning with Clients

Primary Prevention: Education and prevention activities
Learn what it means to live in a county designated “Zone 1 for Radon.”
Discuss the health consequences of radon exposure.
Party! Give radon test kits for baby showers and housewarming gifts.
Zone 1? Move Up! Avoid basement and first-story apartments if you can.
Secondary Prevention: Screening for and early detection of radon exposure.
If you rent your home, talk with your landlord or property manager about measuring indoor radon gas levels.
Test your home for radon or have it tested by a radon professional every 2 years.
Ask to see results of radon measurements for your children’s schools and day-care facilities.
Tertiary Prevention: If you have a radon concentration greater than 4 pCi/L
One more reason to quit! Smoking cigarettes indoors or inhaling second-hand smoke makes indoor radon even more dangerous.
Take it higher—radon concentrations are higher in lower levels of the home. Move kids’ bedrooms and play areas out of the basement.
Weigh the risks and rewards of having home-gym equipment in a high-radon basement.
If you have high radon and cannot afford to mitigate right away, make a savings goal—your lungs are worth it!
Clean your air. Place a surgical mask over a desktop fan or upgrade your furnace filter.
Meet MERV—HEPA’s little brother. MERV filters sizes 10+ remove bacteria, lead dust, and attached radon particles.
If you rent your home or heat using wood consider purchasing a portable air cleaner. You do not want your lungs to be the only filters in the house.
Open the doors and windows when the weather allows. The average radon concentration outdoors is very low.
Let your furnace do the dusting for you! Replace 1″ filters every month and 4″ filters every year.
Supersize it! Make your next furnace one with a 4″ media tray.
Find out if your furnace has an electronic motor with a low-speed setting. Using the fan full time can provide your family with clean, well-circulated air.
Consider spending less time indoors—Americans spend about 90% of their time inside.
Increase ventilation under the house by opening foundation vents.
Decrease indoor radon by sealing cracks and openings in the basement or foundation.
Decrease radon by placing a plastic membrane over bare soil under the home.
Consider Doing-it-Yourself—Books and YouTube Videos are available.