HHS Public Access

Author manuscript

J Environ Health. Author manuscript; available in PMC 2015 September 02.

Published in final edited form as:

J Environ Health. 2015 June ; 77(10): 38–40.

Are Schools Safe From Indoor Radon?

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The U.S. Environmental Protection Agency (U.S. EPA) estimates approximately 21,000 lung cancer deaths are attributable to radon exposure (U.S. EPA, 2003). This number is approximately seven times greater than the number of lung cancer deaths due to secondhand smoke exposure and about twice as many deaths caused by drunk drivers (Centers for Disease Control and Prevention, 2015; Foundation for Advancing Alcohol Responsibility, 2013; National Cancer Institute, 2012). Despite these startling statistics, very few programs are in place to monitor or evaluate indoor radon levels in homes and public buildings in the U.S. Since radon gas is colorless, odorless, and tasteless, testing is the only way to determine its presence (Agency for Toxic Substances and Disease Registry [ATSDR], 2012; U.S. EPA, 2003; U.S. Geological Survey, 1993). When testing reveals levels greater than 4 picocuries per liter (pCi/L), mitigation is recommended by U.S. EPA and several effective strategies for reducing indoor radon levels exist (American Association of Radon Scientists and Technologists, 2014; U.S. EPA, 2010). Given the absence of a national program for radon surveillance and the ubiquitous nature of radon gas, we have undertaken a series of activities to understand the extent to which indoor radon may be a risk for Americans, specifically for children attending public schools, in hopes of increasing awareness about the importance of radon testing.

In 2013, we began a study of the scope and extent of regular and standard radon testing programs in schools across the nation. We learned that many states have active radon testing and mitigation programs. For example, in the last eight years New Jersey has tested 1,705 (51%) public schools (New Jersey Department of Environmental Protection, 2014). We also learned, however, that laws and regulations for reducing radon in schools were scarce (Bernstein, 2013). Additionally, we were surprised to uncover the variations in requirements among different laws. Since our original inquiries, some states have lost funding to support their legislation. Other states have added language in support of testing or radon-resistant new construction practices (Environmental Law Institute, 2014). Policies for radon testing in schools and radon-resistant new construction continue to be uncommon and moving targets.

As part of this effort we reached out to all state programs we believed to be engaged in radon testing in schools. As a result of our inquiries we were able to partner with many of these states. These partnerships provided us radon results from testing conducted in schools. Florida's comprehensive radon testing program provided both residential and school testing results. Therefore, we analyzed 13 years (1990–2012) of indoor radon test results from both

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residential homes and schools. In Florida no counties are designated U.S. EPA Radon Zone 1 ("predicted average indoor radon screening level greater than 4 pCi/L") and only nine counties are designated U.S. EPA Radon Zone 2 ("predicted average indoor radon screening level between 2 and 4 pCi/L") (U.S. EPA, 2012). Regardless, 10,780 (18.4%) residential radon tests and 335 (8.9%) schools had results greater than 4 pCi/L, U.S. EPA's action level. Additionally, we explored the spatial relationship between schools and residences with test results greater than 4 pCi/L. Using circular buffers of a quarter mile, half mile, one mile, and three miles we examined the number of schools with >4 pCi/L test results within each buffer distance category of a residence with >4 pCi/L results. For each of these distances a statistically significant and strong association exists between residential test results and school radon test results. For schools located within a quarter mile of residences with test results above U.S. EPA's action level an odds ratio (*OR*) of 2.8 (95% confidence interval [*CI*] 2.0, 4.0) exists; that is, if a school is located within a quarter mile of a residential radon test result above the U.S. EPA's action level, that school has almost a threefold increased odds of having an indoor radon level greater than 4 pCi/L. At a half mile, the *OR* = 2.3 (95% *CI* 1.8, 3.0); at one mile, the *OR* = 2.1 (95% *CI* 1.7, 2.5); and at three miles, the *OR* = 1.4 (95% *CI* 1.2, 1.6). We continue to acquire residential and school data to confirm the validity of this spatial relationship in other states.

To further our awareness efforts we are partnering with an elementary school in metropolitan Atlanta to pilot outreach activities. In Georgia, the four metropolitan counties of Cobb, DeKalb, Fulton, and Gwinnett are the only counties in the state designated U.S. EPA Radon Zone 1. For this project we are preparing an overview of radon, for third and fifth grade students, that includes information about radon and its effects, how radon enters buildings, testing for radon, and mitigation strategies to reduce indoor radon levels, if necessary. Additionally, we plan to provide test kits for all students participating in the lesson and kits to test for indoor radon in participating classrooms. The outreach will culminate with a follow-up lesson exploring the test result data through basic statistics, GIS visualization, and spatial analysis. Our hope is these outreach activities will result in a new generation cognizant of issues associated with radon exposure. Furthermore, we hope the children will share this information with their guardians to motivate voluntary residential radon testing.

We are also developing two products to supplement our research efforts: an activity/coloring book and a series of state-specific radon fact sheets. The activity/coloring book will share information about radon appropriate for young audiences. For a more comprehensive understanding of potential radon exposure, we are developing a series of state-specific radon fact sheets that will present demographic information describing the population potentially at risk for indoor radon exposure by county. Additionally, the state fact sheet will include an overview of schools, student and teacher populations, and number of occupied households located in U.S. EPA Radon Zone 1, as well as a map of each state reflecting the U.S. EPA Radon Zones. We anticipate both products being available online later this year.

Eliminating exposure to indoor radon can significantly reduce future lung cancer morbidity. By applying spatial analysis techniques, we anticipate gaining a greater understanding of the relationship between residential test results and indoor radon level in schools. We hope that

our research, outreach, and educational products will increase awareness of the importance of radon testing and radon-resistant new construction practices. Additionally, we anticipate these efforts will result in a new generation aware of the impact of radon exposure, empowered to protect their future health.

Acknowledgements

The authors would like to acknowledge Olivia Leach of the Geospatial Research, Analysis, and Services Program for her assistance reviewing state radon laws. We are also thankful for the data and support provided by Jorge Laguna and Clark Eldredge of the Radon and Indoor Air Program, Bureau of Epidemiology, Division of Disease Control and Health Protection, Florida Department of Health.

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