



Colorado Department
of Public Health
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Colorado Radon Awareness and Household Testing: Results from the Behavioral Risk Factor Surveillance System

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Introduction

Radon is a naturally occurring radioactive gas resulting from the decay of uranium. It has no color, odor or taste and is chemically inert. As uranium decays over millions of years, it changes from one radioactive element to another in a sequence known as the Uranium Decay Cycle. Partway through this cycle, radium becomes radon gas which moves up through the soil into the atmosphere. Radon is estimated to cause about 21,000 lung cancer deaths per year and is the leading cause of lung cancer among non-smokers. The US Surgeon General has warned radon is the second leading cause of lung cancer in the United States today. Only smoking causes more lung cancer deaths. Smoking has been found to have a synergistic effect with radon in causing lung cancer.

The Behavioral Risk Factor Surveillance System (BRFSS) is an ongoing health survey of adults ages 18 years and older. It is the longest running and largest ongoing collection of public health behavior data in the United States. The BRFSS is administered by the Centers for Disease Control and Prevention (CDC) and supported through grants to individual states. In Colorado, the BRFSS is conducted by the Center for Health and Environmental Information and Statistics (CHEIS), a division of the Colorado Department of Public Health and Environment (CDPHE).

In 2012, the Radon Outreach program again added a short series of four (4) radon awareness and testing questions to the Colorado BRFSS in an attempt to quantify radon related behaviors in Colorado. The same questions were asked on the BRFSS in 2009. The results of the 2009 questions intended to establish a baseline for radon awareness and testing prevalence that later survey results could be compared to.

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In 2010, however, a change was made in the sampling and analysis methodology that incorporated cell phones. This change was made to better include a broader demographic and to better represent the nation's health status in a time when an increasing number of households in the target population, adults over the age of 18 who do not live in institutional settings, exclusively use cell phones. The changes also required a new weighting practice known as *raking* to be incorporated in order to account for the demographic characteristics of the responses in the target population including phone type, and home ownership or rental status. Both of these changes took effect during the 2011 survey which was released in 2012. For this reason the 2012 results can not reliably be compared to the 2009 results.

In both 2009, and 2012 a number of disparities were identified relating to radon awareness, testing, and mitigation behavior. Although the prevalence of those disparities can not be compared annually it is important to understand that there is a large difference in awareness and testing behavior associated with underserved and underrepresented segments of the population.

In Colorado, radon is monitored by the CDPHE Radon Outreach Program. The program was designed to provide a resource for radon information to the public and provide guidance on testing and mitigation measures. Addition of the radon testing question to the BRFSS was intended to estimate radon testing trends.

Including high test result information was intended to help understand regional indoor radon variations. The question regarding participants response to high radon test results, question 4, was intended to estimate mitigation trends to see if Coloradans are mitigating, doing nothing, or some other behavior, in response to a high radon test. Collection and analysis of this information also allows the Radon Outreach Program to observe differences in program use and other related behaviors between different segments of the population or geographic location across the state.

Methodology

This report is based on the results from the Colorado added BRFSS questions for 2012. A total of 5,398 adults were asked the radon questions in 2012 on Version B of the BRFSS. The participants were asked the radon awareness question first, and then asked to select from a list of responses. Participants were then asked up to three additional questions on testing and mitigation depending on how they answered the previous questions. Responses were then tabulated, including open-ended responses.

Survey results were analyzed to determine if statistically significant differences existed between responses from different regions of the state or between demographic groups. Weighted population estimates, prevalence rates (percent of the population), and ninety-five percent confidence intervals (CI) were calculated. Statistical significance was determined by examining CI overlap for each response rate.

Data were grouped by two categories; Demographics and Regions. Demographic characteristics are those used by the CDC for the BRFSS.

Counties are aggregated into “Health Statistics Regions” (regions) that were developed by the Health Statistics Section of CDPHE. Aggregating populations across the state into these regions allows for consistent calculations of descriptive statistics in large areas of the state with small populations, for example rural counties.

Overlap of regional, or demographic CIs, with the Colorado CI indicates no significant difference between the prevalence of that behavior for a group or region and the entire state. No overlap in the CI, or essentially a gap between the CIs, between a group or region with the statewide CI indicates a statistical difference from the statewide rate. When the CI for a group or region was below the statewide CI that group or region is considered statistically less likely to behave a certain way.

When the CI for a group or region was above the statewide CI that group or region is considered statistically more likely to exhibit a certain behavior. The same comparison can be done within demographic groups as well, comparing for example the response levels between Hispanics and Whites, or those in a higher versus lower income brackets.

Another piece of information the confidence interval provides is an indicator of how certain we can be in a value. If the CI is very large then the value may not be very precise, possibly because of a small number of responses. However, a small, or tight, confidence interval shows that the value it represents is likely more precise. Weighted population estimates, prevalence, and CIs were calculated from the raw BRFSS survey results data using the statistical software SAS (v 9.3).

Results: Regional Distribution of Survey Results

Results from the survey identified a number of statistically significant differences in regions which are discussed in the following pages. Each region is comprised of one or more counties and may include one or more types of geology, naturally occurring radiation, construction types, or age of construction. All are variables contributing to indoor radon levels. Results showed differences based on geography for radon awareness, testing, and results above the action level. In 2012, 71.6% of Coloradans reported that they knew what radon gas was. Of those, 41.7% had their homes tested for radon gas, and 15.7% had a radon level above the Environmental Protection Agency’s (EPA) action level of 4 pCi/L .

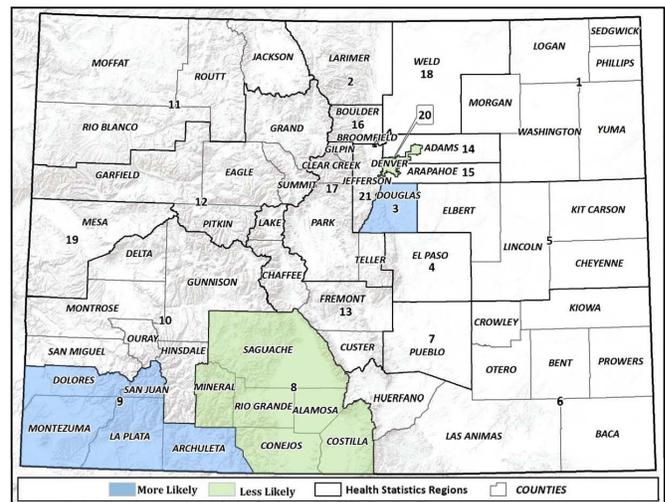


Figure 1: Do you know what radon is? Variation in radon awareness across Colorado.

Radon Awareness

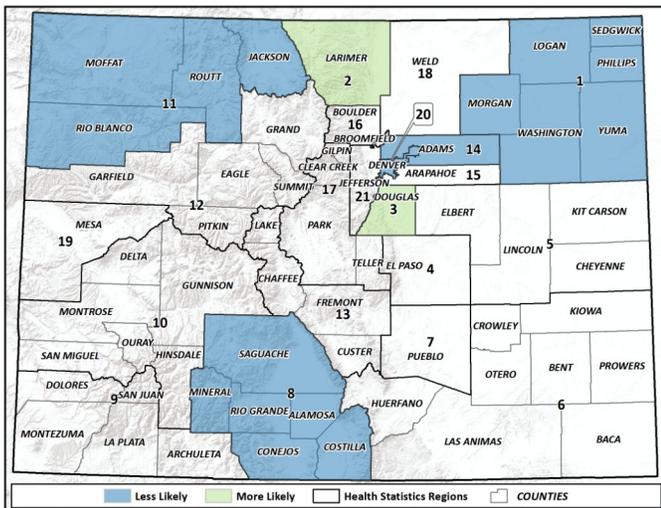
Survey results from several regions indicate variations in prevalence of radon awareness compared to the statewide average.

Residents of counties in Health Statistics Region 8, and 20 reported they are less likely to know what radon is. Counties in Health Statistics Regions 3, and 9 reported they are more likely to know what radon is than the Colorado as a whole (Figure 1).

Radon Testing

Survey results from several regions indicate variation in rates of radon testing compared to the statewide average. Residents in regions 2, and 3 were more likely to test their homes for radon. Residents in regions 1, 8, 11, 14, and 20 were less likely to test their homes for radon than the state as a whole (Figure 2).

Figure 2: Has your household been tested for the presence of radon gas? Variation in radon testing across Colorado.

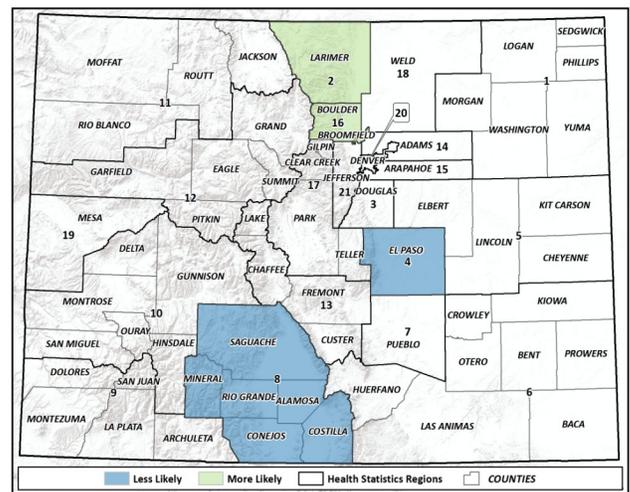


Radon Test Results

Survey responses from several regions indicated higher, or lower, rates of radon levels above the EPA's action level compared to the statewide average.

Residents of counties in regions 2, and 16 were more likely to have radon levels above the action level than the rest of the state. Residents of counties in regions 4, and 8 were less likely to have radon above action levels than the rest of state (Figure 3).

Figure 3: Were the radon levels in your household above of 4 PCi/L? Variation in radon test results across Colorado.



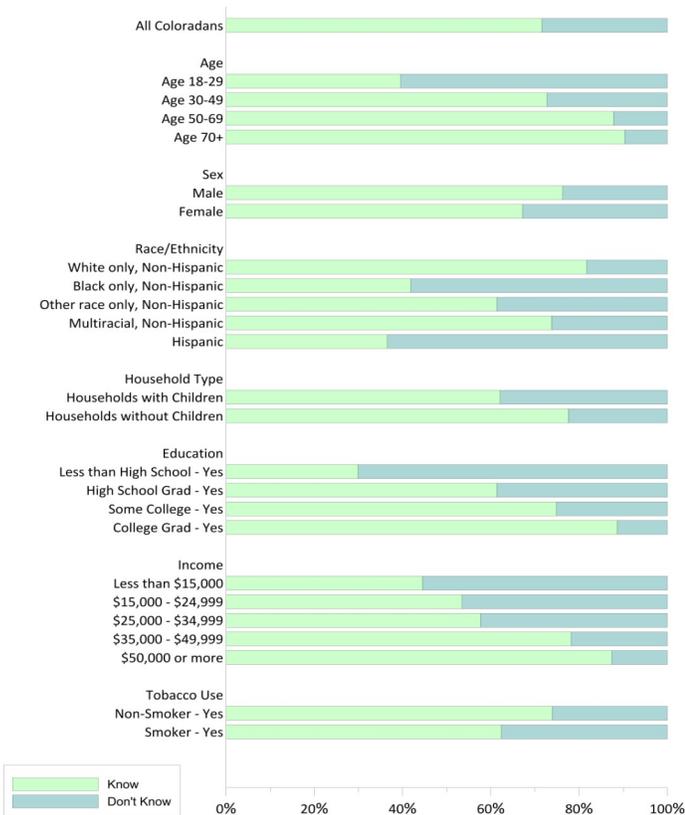
Results: Demographic Distribution of Survey Results

Survey results identified a number of statistically significant differences in the responses to each radon question relating to age, education, income, race/ethnicity, sex, and smoking. Results showed differences, or disparities, based on a number of demographic variables. Statistical analysis for the demographic groups was not performed on the final question; *what did you do in response to a high radon test*, question 4, due to small sample size.

Radon Awareness

Results from question 1, *do you know what radon is*, show differences in response by demographics (Figure 4). Coloradans 50 to 69, and 70+ were more likely to know what radon is. Younger Coloradans age 18 to 29 were less likely to know what radon is. Males were more likely than females to know what radon is. Females were less likely than the Colorado average to know what radon is.

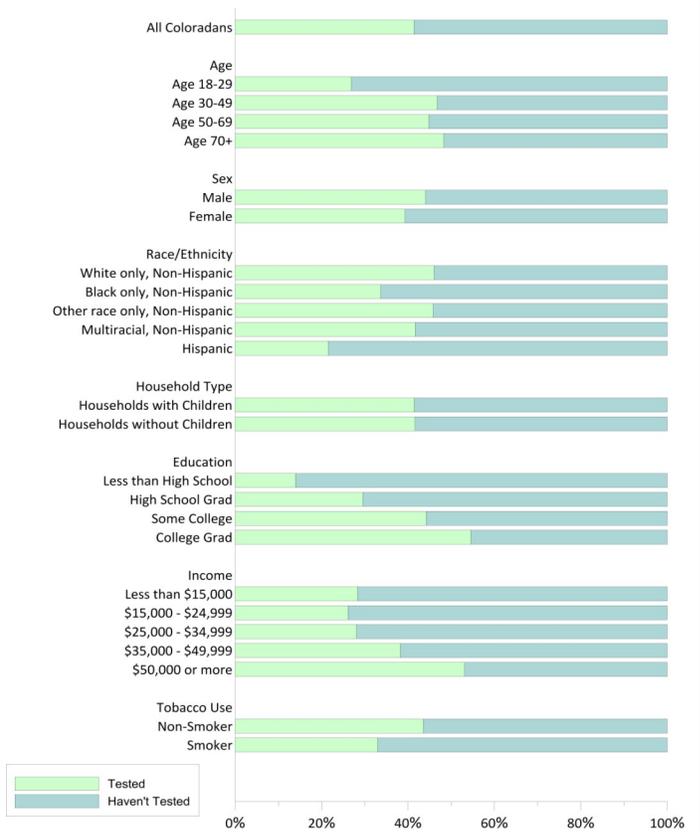
Figure 4: Demographic responses to; Do you know what radon gas is?



Non-Hispanic, White Coloradans are more likely to know what radon is while Black, Other race, Non-Hispanic, and Hispanic Coloradans are less likely to know what radon is. Households with children are less likely to know what radon is, and households without children are more likely to know what radon is.

Those with less than a High School diploma, or with only a High School diploma were less likely to know what radon is. Those earning less than \$15,000 per year were less likely to know what radon is, those earning \$15,000 to \$24,999 per year were less likely to know what radon is, those earning \$25,000 to \$34,999 were less likely to know what radon is, compared to the rest of the state. Conversely, those earning \$35,000 to \$49,999 or over \$50,000 per year were more likely to know what radon is compared to the rest of the state. Smokers were less likely to know what radon is compared to the rest of the state.

Figure 5: Demographic responses to; Has your household been tested for the presence of radon gas?



Radon Testing

Results from question 2, *has your household been tested for the presence of radon gas*, show differences in response by demographics (Figure 5). Coloradans 18 to 29 years old were less likely to have their homes tested compared to the rest of the state. Coloradans 30 to 49 years old were more likely to have their homes tested for radon. Non-Hispanic Whites are more likely to have their homes tested for radon. Black, and Hispanic Coloradans are less likely to have their homes tested for radon. Coloradans with less than, or with only a High School diploma were less likely to have their homes tested for radon than the Colorado average for radon testing. Those with a college degree were more likely to have their homes tested for radon compared to the rest of the state.

Coloradans earning \$15,000 to \$24,999, and \$25,000 to \$34,999 per year were less likely to have their homes tested for radon. Those earning \$50,000 per year and more were more likely to have their homes tested for radon. Smokers were less likely to have their homes tested for radon.

Radon Test Results

Results from question 3, *Were the radon levels in your household above EPA recommended action level of 4 pCi/L?*, show differences in response for only two demographics (Figure 6). There were no differences in responses based on age, sex, household type, education, or income. Multiracial, non-Hispanic Coloradans were less likely to have household radon levels above EPA action level. Smokers were less likely to have household radon levels above the EPA action level.

Figure 6: Demographic responses to; *Were the radon levels in your household above EPA recommended action level of 4 pCi/L?*

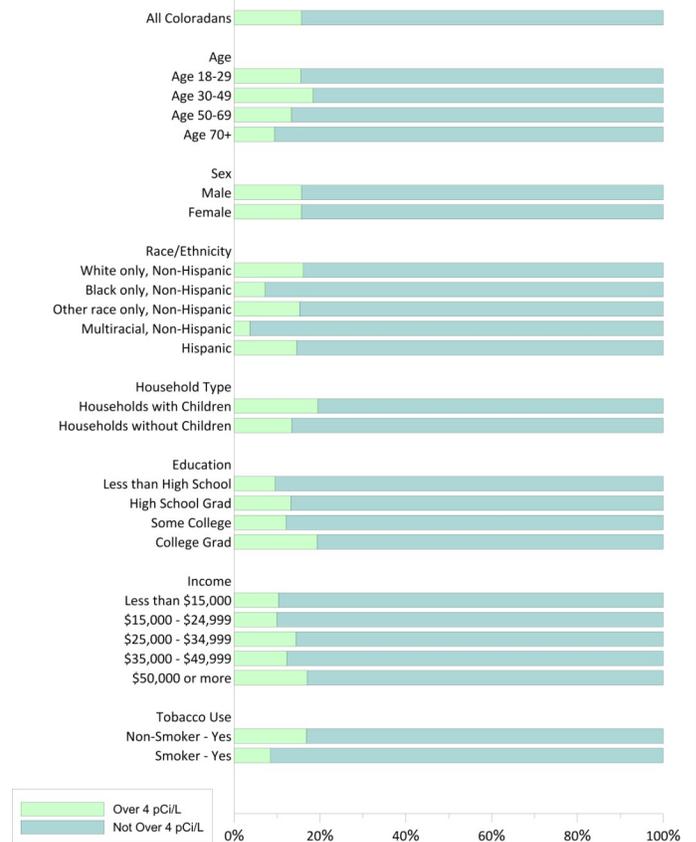
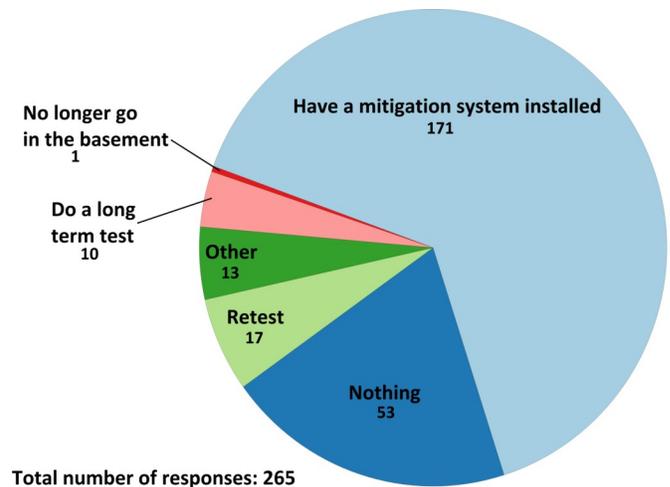


Figure 7: Results to question #4; *In response to a high radon result did you...*



Radon Mitigation

Statistical analysis was not performed on question 4 due to small sample size. However, raw responses are presented in Figure 7. These results should not be used for analysis, and should be interpreted with caution.

Conclusion

A variety of health disparities surround radon awareness, testing, and response in Colorado. Seventy percent of Colorado adults know what radon gas is. More than 40% of Coloradans that know what radon is had their home tested for radon. Nearly 16% of Coloradans who tested their home for radon had levels above the EPA action level.

Racial and Ethnic minority groups were significantly less likely to know what radon is. Black only, non-Hispanic, and Hispanic Coloradans were less likely to know what radon is. The responses evaluated by education showed that, typically, the more education one had the more likely they were to know what radon was. Coloradans with the least amount of education, those with less than, or with only a High School diploma were less likely to know what radon is. College graduates had the highest prevalence of radon awareness. Response rates by income show a pattern of increased radon awareness with increased income. The lowest income earners, those earning less than \$15,000 had the lowest radon awareness. Those earning \$50,000 and more were more likely to know what radon is. Radon awareness among households with children could be cause for concern.

Coloradans in the youngest age group, 18 to 29 years, were less likely to know what radon is.

Colorado males are statistically more likely to know what radon is than females. White only, non-Hispanic Coloradans were more likely to know what radon is.

Children have been reported to have greater risk than adults of certain types of cancer from radiation, but there are currently no conclusive data on whether children are at greater risk than adults from radon. Households with children were less likely to know what radon is while households without children were more likely to know what radon is. Disparities seemed to be fairly consistent in similar groups across all strata.

Douglas, Archuleta, Dolores, La Plata, Montezuma, and San Juan counties (regions 3, and 9) had a higher prevalence of radon awareness. Alamosa, Costilla, Conejos, Mineral, Rio Grande, and Saguache counties (region 8) had a lower prevalence of radon awareness. Larimer, and Douglas counties (regions 2, and 3) had a higher prevalence of radon testing. Moffat, Rio Blanco, Routt, Jackson, Denver, Adams, Morgan, Logan, Washington, Sedgwick, Phillips, Yuma, Mineral, Saguache, Rio Grande, Mineral, Conejos, and Costilla counties (regions 1, 8, 11, and 14) all had a lower prevalence of radon testing. Larimer, Boulder, and Broomfield counties (regions 2, and 16) were more likely to have radon levels below the EPA action level, while El Paso, Saguache, Rio Grande, Mineral, Conejos, and Costilla counties (regions 4, and 8) were less likely to have radon levels above action level.

Because of the uncertainty in predicting radon occurrence and the known contributing factors of geology, type of construction, and location in the house (lowest level) it may be worth adding a piece to the question in the future that considers housing type, construction, or renter/owner status to further understand this complex issue. Having identified these areas, the BRFSS is a valuable tool for identifying opportunities to improve public health and promote radon awareness. It is recommended that all homes be tested for radon in Colorado.