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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. It has no color, odor or taste, and is chemically inert. It comes from the breakdown of uranium. As a uranium molecule decays to form stable lead, a process taking many years, it changes from one radioactive element to another in a sequence known as the uranium decay cycle. Part of the way through this cycle, the element radium becomes radon gas, which moves up through the soil into the atmosphere. Radon is estimated to cause about 21,000 lung cancer deaths nationwide per year. The Surgeon General has warned that 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.

During calendar year 2009, a series of questions was added to the Colorado Behavioral Risk Factor Surveillance System (BRFSS) to determine residents' awareness and response to the presence of radon gas in household air. The survey participants were asked if they knew what radon was and if their household air had been tested for it. If the house had been tested for radon the survey further asked if the test result was above the remediation action limit of 4 picocuries per liter (pCi/L) and what their response to a high radon test result was. The 4 pCi/L action limit was set by the United States Environmental Protection Agency (EPA). The EPA recommends that at, or above, this level a radon mitigation system be installed.

The Colorado Department of Public Health and Environment Hazardous Materials and Waste Management Division provides support to residents, counties and local public health departments for radon awareness outreach and testing. The results of the BRFSS survey provided insight to where the programs were most effective and, where they may require additional resources.

Methodology

The Colorado BRFSS is an ongoing health survey of Colorado adults ages 18 years and older. A total of 11,956 adults were interviewed in 2009. All households with landline telephones

had a chance of being selected to participate in the survey, with individual survey respondents being randomly selected from each successfully contacted household.

The 2009 Colorado BRFSS asked four questions designed to measure residents' awareness of household radon, radon testing, radon levels and mitigation techniques. The participants were asked, "Do you know what radon is?" and, "Has your household air been tested for the presence of radon gas?" Answering "no" to the second question concluded the survey. A "yes" answer, however, prompted a third question: "Were the radon levels in your household above 4 pCi/L?" If the participant answered "yes" to this question, then a final question was asked: "In response to a high radon test result did you... retest, do a long-term test, have a mitigation system installed, no longer go in the basement or other." The radon questions were asked of approximately one-half of the total sample.

Variables were tested to determine if significant differences existed between various groups. Ninety-five percent confidence intervals (CIs) were calculated and statistical significance was determined by examining overlap of the CIs between the prevalence estimates. Data were analyzed using SAS version 9.2. When reviewing the output both the "no" and "unknown/not sure" responses were counted as a "no" response.

Results

Demographics: Do You Know What Radon Is?

Respondents ages 18-29 were less likely to know what radon is than all other age groups. The 30-49 year-old age group was also less likely to know about radon than the two older age groups. There was no difference in radon knowledge observed between the 50-69 year-old age group and the 70+ age group (Table 1).

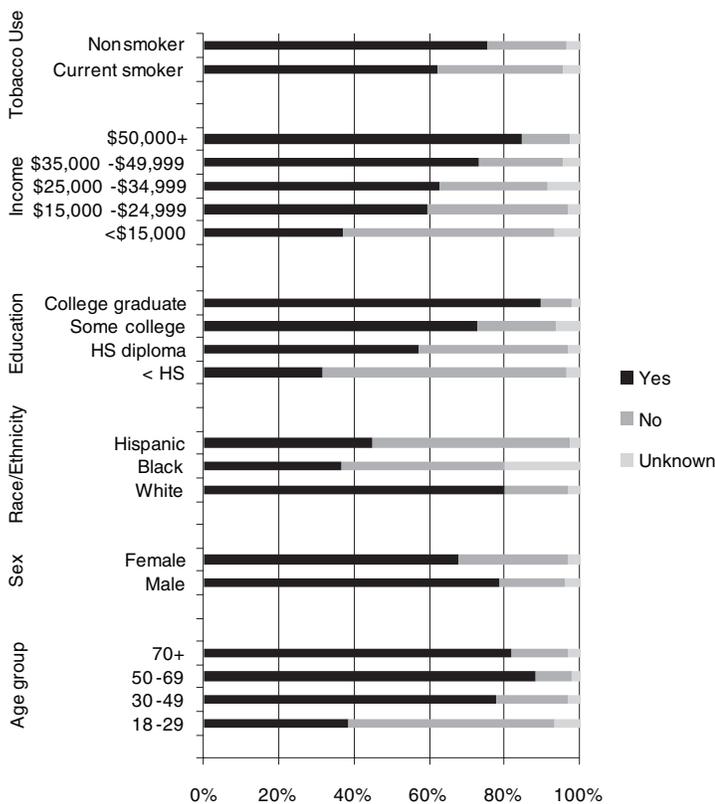
Table 1. Reported radon knowledge by selected sociodemographic characteristics, Colorado adults, BRFSS, 2009

| | Yes | | | | No | | | | Unknown/not sure | | | |
|--------------------|------------------------------|---------|----------------------------------|------|------------------------------|---------|----------------------------------|------|------------------------------|---------|----------------------------------|------|
| | Weighted population estimate | Percent | Confidence Intervals Low High | | Weighted population estimate | Percent | Confidence Intervals Low High | | Weighted population estimate | Percent | Confidence Intervals Low High | |
| All adults | 2,486,506 | 73.1 | 70.4 | 75.7 | 793,251 | 23.3 | 20.7 | 25.9 | 121,997 | 3.6 | 2.5 | 4.7 |
| Age group | | | | | | | | | | | | |
| 18-29 | 263,925 | 38.3 | 30.4 | 46.2 | 1,058,511 | 54.9 | 46.4 | 63.5 | 47,024 | 6.8 | 2.1 | 11.6 |
| 30-49 | 1,058,511 | 77.9 | 75.3 | 80.4 | 898,835 | 18.9 | 16.5 | 21.4 | 43,225 | 3.2 | 2.1 | 4.3 |
| 50-69 | 898,835 | 88.2 | 86.4 | 89.9 | 32,811 | 9.7 | 8.1 | 11.2 | 22,260 | 2.2 | 1.4 | 2.9 |
| 70+ | 32,811 | 82.0 | 74.3 | 89.8 | 6,014 | 15.0 | 7.9 | 22.1 | 1,172 | 2.9 | 6.0 | 6.5 |
| Sex | | | | | | | | | | | | |
| Male | 1,308,024 | 78.9 | 75.4 | 82.5 | 282,886 | 17.1 | 13.9 | 20.3 | 65,960 | 4.0 | 2.0 | 6.0 |
| Female | 1,178,481 | 67.5 | 63.7 | 71.3 | 510,365 | 29.2 | 25.4 | 33.1 | 56,036 | 3.2 | 2.3 | 4.1 |
| Race and Ethnicity | | | | | | | | | | | | |
| White | 2,129,822 | 80.1 | 77.3 | 82.3 | 443,147 | 16.7 | 13.9 | 19.4 | 83,303 | 3.2 | 2.5 | 4.0 |
| Black | 37,226 | 36.7 | 21.8 | 51.7 | 44,056 | 43.5 | 26.7 | 60.3 | 20,075 | 19.8 | 43.0 | 43.9 |
| Hispanic | 222,990 | 44.9 | 37.6 | 52.1 | 260,970 | 52.5 | 45.1 | 59.9 | 13,051 | 2.6 | 0.6 | 4.6 |
| Education | | | | | | | | | | | | |
| < HS | 76,405 | 31.6 | 23.4 | 39.7 | 157,645 | 65.1 | 56.5 | 73.7 | 8,112 | 3.3 | 1.1 | 5.9 |
| HS diploma | 464,471 | 57.2 | 51.2 | 63.2 | 321,755 | 39.6 | 33.4 | 45.8 | 25,620 | 3.2 | 1.7 | 4.6 |
| Some college | 677,847 | 72.7 | 67.1 | 78.3 | 196,208 | 21.0 | 15.8 | 26.3 | 58,076 | 6.2 | 2.8 | 9.7 |
| College graduate | 1,263,718 | 89.7 | 87.8 | 91.6 | 116,042 | 8.2 | 6.5 | 10.0 | 29,505 | 2.1 | 1.3 | 2.9 |
| Income | | | | | | | | | | | | |
| <\$15,000 | 73,976 | 37.1 | 28.1 | 46.1 | 112,490 | 56.4 | 46.3 | 66.5 | 12,921 | 6.5 | 1.6 | 11.3 |
| \$15,000-\$24,999 | 212,475 | 59.4 | 50.6 | 68.3 | 134,598 | 37.6 | 28.7 | 46.6 | 10,538 | 2.9 | 0.8 | 5.0 |
| \$25,000-\$34,999 | 156,589 | 62.7 | 53.0 | 72.4 | 71,826 | 28.8 | 21.6 | 36.0 | 21,326 | 8.5 | 19.0 | 19.6 |
| \$35,000-\$49,999 | 303,007 | 73.2 | 67.0 | 79.4 | 92,742 | 22.4 | 16.3 | 28.5 | 18,399 | 4.4 | 2.0 | 6.9 |
| \$50,000+ | 1,512,857 | 84.9 | 81.8 | 87.9 | 227,364 | 12.8 | 9.7 | 15.8 | 42,406 | 2.4 | 1.6 | 3.2 |
| Tobacco Use | | | | | | | | | | | | |
| Current smoker | 348,941 | 62.0 | 54.3 | 69.6 | 188,056 | 33.4 | 25.5 | 41.3 | 26,133 | 4.6 | 2.5 | 6.7 |
| Nonsmoker | 2,132,318 | 75.3 | 72.6 | 78.1 | 602,685 | 21.3 | 18.6 | 23.9 | 95,692 | 3.4 | 2.1 | 4.6 |

Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Approximately 55 percent of respondents ages 18-29 did not know what radon was. This number declined as age increased. Approximately 19 percent of the respondents ages 30-49 did not know what radon was, but approximately 10 percent of respondents ages 50-69 did not know what radon was (Figure 1).

Figure 1: Proportion of reported radon knowledge by selected sociodemographic characteristics, Colorado adults, BRFSS, 2009



Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Approximately 64 percent of black respondents indicated that they did not know what radon was. When answering the same question approximately 58 percent of Hispanic respondents indicated that they did not know what radon was.

Slightly less than 20% of White respondents did not know what radon was (Figure 1). Blacks and Hispanics were less likely to know what radon is than white respondents.

When the educational level of participants was assessed the results showed that approximately 68 percent of respondents with less than a high school diploma did not know what radon is. Examination of the survey results further identified that approximately 43 percent of those with a high school diploma did not know what radon is. Approximately 22 percent of those with some college did not know what radon is and approximately 10 percent of those that graduated from college did not know what radon is (Figure 1). The results show that the less education a respondent had the less likely they were to know what radon is.

Radon knowledge increased with annual income (Figure 1). An exception existed between \$25,000-\$34,999, and \$35,000-\$49,999 where there was no difference between the groups (Table 1). However, the general trend is that lower income respondents were less likely to know what radon is.

An additional question was asked that identified the respondent as a smoker or nonsmoker. Current smokers were less likely to know what radon is than both nonsmokers and the statewide value. It was also observed that men were more likely to know what radon is than women (Table 1).

Has Your Household Air Been Tested For The Presence of Radon Gas?

The responses to the question, “Do you know what radon is?” indicated that approximately 900,000 Coloradans did not know what radon is. However, it was also observed in the results that approximately 2.5 million Coloradans did know what radon is. Respondents were then asked a second question: “Has your household air been tested for the presence of radon gas?”

A weighted estimate of 1,170,971 Coloradans have had their household air tested for the presence of radon gas. The BRFSS further concluded that a weighted estimate of 1,770,876 adults have not had their home tested for radon gas, and a weighted estimate of 454,877 adults did not know or were unsure (Table 2).

Table 2. Reported radon testing by selected demographic characteristics, Colorado adults, BRFSS, 2009

| | Yes | | | | No | | | | Unknown/not sure | | | |
|--------------------|------------------------------|---------|----------------------|------|------------------------------|---------|----------------------|------|------------------------------|---------|----------------------|------|
| | Weighted population estimate | Percent | Confidence Intervals | | Weighted population estimate | Percent | Confidence Intervals | | Weighted population estimate | Percent | Confidence Intervals | |
| | | | Low | High | | | Low | High | | | Low | High |
| All adults | 1,170,971 | 34.5 | 32.4 | 36.5 | 1,770,876 | 52.1 | 49.8 | 54.5 | 454,877 | 13.4 | 11.2 | 15.6 |
| Age group | | | | | | | | | | | | |
| 18-29 | 129,458 | 18.8 | 12.7 | 24.9 | 361,729 | 52.4 | 43.5 | 61.3 | 198,954 | 28.8 | 19.9 | 37.7 |
| 30-49 | 541,201 | 39.9 | 37.0 | 42.7 | 681,338 | 50.2 | 47.2 | 53.1 | 135,441 | 10.0 | 8.2 | 11.7 |
| 50-69 | 403,042 | 39.6 | 37.0 | 42.1 | 535,487 | 52.6 | 50.0 | 55.1 | 80,059 | 7.9 | 6.5 | 9.2 |
| 70+ | 15,952 | 40.0 | 29.0 | 50.7 | 19,473 | 48.7 | 37.8 | 59.6 | 4,574 | 11.4 | 5.1 | 17.8 |
| Sex | | | | | | | | | | | | |
| Male | 610,431 | 36.9 | 33.9 | 40.0 | 872,843 | 52.8 | 49.5 | 56.1 | 169,607 | 10.3 | 7.7 | 12.8 |
| Female | 560,540 | 32.1 | 29.5 | 34.8 | 898,033 | 51.5 | 48.2 | 54.8 | 285,270 | 16.4 | 12.9 | 19.8 |
| Race and Ethnicity | | | | | | | | | | | | |
| White | 990,730 | 37.3 | 35.1 | 39.5 | 1,353,736 | 51.0 | 48.6 | 53.4 | 310,634 | 11.7 | 9.6 | 13.8 |
| Black | 25,718 | 25.4 | 13.2 | 37.5 | 44,208 | 43.6 | 27.0 | 60.2 | 31,432 | 31.0 | 8.7 | 53.3 |
| Hispanic | 110,955 | 22.4 | 16.0 | 28.7 | 293,619 | 59.2 | 51.2 | 67.1 | 91,723 | 18.5 | 10.6 | 26.3 |
| Education | | | | | | | | | | | | |
| < HS | 37,171 | 15.4 | 9.4 | 21.3 | 149,123 | 61.7 | 50.9 | 72.5 | 55,558 | 23.0 | 11.7 | 34.3 |
| HS diploma | 189,795 | 23.4 | 19.6 | 27.2 | 487,658 | 60.1 | 54.7 | 65.5 | 133,883 | 16.5 | 11.6 | 21.4 |
| Some college | 303,620 | 32.6 | 28.3 | 37.0 | 491,616 | 52.9 | 47.9 | 57.8 | 134,914 | 14.5 | 9.2 | 19.8 |
| College graduate | 638,168 | 45.4 | 42.7 | 48.0 | 639,171 | 45.4 | 42.8 | 48.1 | 129,699 | 9.2 | 7.6 | 10.9 |
| Income | | | | | | | | | | | | |
| <\$15,000 | 32,561 | 16.4 | 10.5 | 22.4 | 113,204 | 57.2 | 45.6 | 68.7 | 52,255 | 26.4 | 13.5 | 39.3 |
| \$15,000-\$24,999 | 83,805 | 23.4 | 15.7 | 31.2 | 199,592 | 55.8 | 46.8 | 64.8 | 74,374 | 20.8 | 11.3 | 30.3 |
| \$25,000-\$34,999 | 57,201 | 22.9 | 17.2 | 28.7 | 141,898 | 56.9 | 47.9 | 66.0 | 50,145 | 20.1 | 9.6 | 30.7 |
| \$35,000-\$49,999 | 113,821 | 27.5 | 22.6 | 32.5 | 260,806 | 63.1 | 57.7 | 68.5 | 38,792 | 9.4 | 6.3 | 12.4 |
| \$50,000+ | 791,595 | 44.5 | 41.7 | 47.2 | 810,654 | 45.5 | 42.7 | 48.3 | 178,539 | 10.0 | 7.5 | 12.5 |
| Children in home | | | | | | | | | | | | |
| Yes | 538,866 | 36.9 | 33.8 | 40.0 | 721,040 | 49.3 | 46.0 | 52.7 | 201,412 | 13.8 | 10.8 | 16.8 |
| No | 629,123 | 32.6 | 29.8 | 35.3 | 1,049,304 | 54.3 | 51.1 | 57.5 | 253,466 | 13.1 | 10.0 | 16.2 |
| Tobacco Use | | | | | | | | | | | | |
| Current smoker | 165,538 | 29.4 | 23.3 | 35.5 | 289,228 | 51.4 | 44.2 | 58.5 | 108,304 | 19.2 | 11.7 | 26.8 |
| Nonsmoker | 1,003,285 | 35.5 | 33.4 | 37.6 | 1,476,334 | 52.2 | 50.0 | 54.6 | 346,048 | 12.2 | 10.2 | 14.3 |

Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Respondents ages 18-29 were less likely than all other age groups to report that they lived in a house that had been tested for radon (Figure 2). There was no difference between responses from the other age groups.

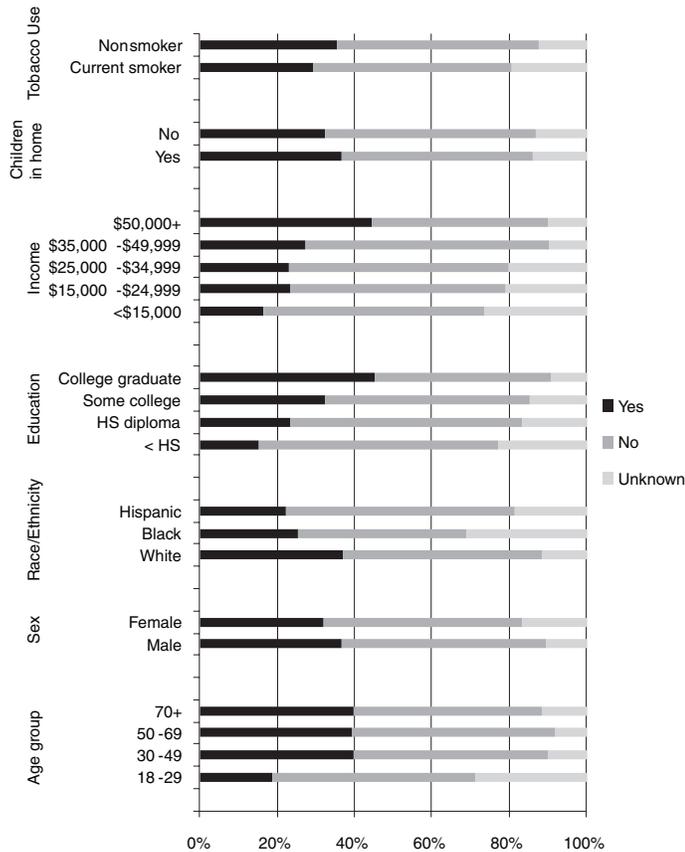
Hispanics were less likely to have tested their house than whites, and those represented by the statewide value. Although Figure 2 shows a difference in the responses between blacks and Hispanics, this difference was not statistically significant.

As education level increased, from less than high school

through college graduate, so too did the proportion of respondents who reported that their home had been tested for the presence of radon gas (Figure 2). Those with some college and college graduates were significantly more likely than those with less education to report having their homes tested (Table 2).

Respondents making \$50,000 and more per year were significantly more likely to test their house than all other income groups (Figure 2, Table 2).

Figure 2. Proportion of reported radon testing by demographic characteristics, Colorado adults, BRFSS, 2009



Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Were the Radon Levels in Your Household Above 4 pCi/L?

If respondents had tested their house for radon, they were then asked what the result was. The action limit set by the EPA is 4 picocuries per liter (pCi/L). At or above this level, the risk of lung cancer from exposure increases. Respondents were asked, “Were the radon levels in your household above 4 pCi/L?”

Approximately 12 percent of the respondents who reported they had tested their homes for radon had a test result that had exceeded 4 pCi/L.

Responses of 18-29 year-olds for radon tests above 4 pCi/L were not statistically significant. The 70+ age group did not have enough data collected to appropriately assess the results for that demographic (Table 3).

Table 3. Reported elevated home radon test results (over 4 pCi/L) by demographic characteristics, Colorado adults, BRFSS, 2009

| | Yes | | | | No | | | | Unknown/not sure | | | |
|--------------------|------------------------------|---------|----------------------|------|------------------------------|---------|----------------------|------|------------------------------|---------|----------------------|------|
| | Weighted population estimate | Percent | Confidence Intervals | | Weighted population estimate | Percent | Confidence Intervals | | Weighted population estimate | Percent | Confidence Intervals | |
| | | | Low | High | | | Low | High | | | Low | High |
| All adults | 135,593 | 11.7 | 9.8 | 13.6 | 606,213 | 52.2 | 9.8 | 13.6 | 419,364 | 36.1 | 32.9 | 39.3 |
| Age group | | | | | | | | | | | | |
| 18-29 | 9,423 | 7.3 | 1.0 | 13.5 | 65,081 | 50.3 | 33.0 | 67.5 | 54,953 | 42.4 | 25.7 | 59.2 |
| 30-49 | 70,318 | 13.1 | 10.0 | 16.2 | 274,170 | 51.0 | 46.3 | 55.7 | 193,106 | 35.9 | 31.4 | 40.5 |
| 50-69 | 49,867 | 12.5 | 9.7 | 15.4 | 221,751 | 55.7 | 51.4 | 60.0 | 126,689 | 31.8 | 27.9 | 35.7 |
| 70+ | * | * | * | * | * | * | * | * | * | * | * | * |
| Sex | | | | | | | | | | | | |
| Male | 80,392 | 13.3 | 10.3 | 16.3 | 330,620 | 54.8 | 49.8 | 59.8 | 192,633 | 31.9 | 27.3 | 36.6 |
| Female | 55,200 | 10 | 7.6 | 12.2 | 275,593 | 49.4 | 45.2 | 53.6 | 226,732 | 40.7 | 36.5 | 44.9 |
| Race and Ethnicity | | | | | | | | | | | | |
| White | 121,702 | 12.4 | 10.3 | 15.4 | 503,923 | 51.3 | 47.9 | 54.7 | 356,684 | 36.3 | 33.0 | 39.6 |
| Black | * | * | * | * | * | * | * | * | * | * | * | * |
| Hispanic | 5,541 | 5.0 | 10.0 | 10.2 | 61,881 | 56.0 | 40.9 | 71.2 | 42,989 | 38.9 | 24.9 | 53.0 |
| Education | | | | | | | | | | | | |
| < HS | 175 | 0.5 | 1.0 | 1.4 | 16,846 | 45.3 | 25.3 | 65.4 | 20,150 | 54.2 | 34.2 | 74.2 |
| HS diploma | 10,266 | 5.4 | 2.4 | 8.4 | 89,925 | 47.6 | 39.6 | 55.7 | 88,599 | 46.9 | 38.7 | 55.1 |
| Some college | 27,521 | 9.2 | 5.8 | 12.5 | 154,385 | 51.3 | 43.6 | 59.0 | 118,830 | 39.5 | 32.2 | 46.8 |
| College graduate | 97,630 | 15.4 | 12.5 | 18.4 | 345,056 | 54.6 | 50.6 | 58.6 | 189,568 | 30.0 | 26.3 | 33.7 |
| Income | | | | | | | | | | | | |
| <\$15,000 | 1,022 | 3.2 | 6.0 | 6.5 | 12,279 | 37.8 | 20.8 | 54.9 | 19,143 | 59.0 | 41.9 | 76.1 |
| \$15,000-\$24,999 | 3,589 | 4.3 | 0.8 | 7.8 | 52,570 | 63.1 | 47.3 | 79.0 | 27,094 | 32.5 | 17.9 | 47.2 |
| \$25,000-\$34,999 | 5,088 | 8.9 | 1.6 | 16.3 | 27,186 | 47.8 | 35.1 | 60.5 | 24,633 | 43.3 | 30.6 | 56.0 |
| \$35,000-\$49,999 | 8,223 | 7.4 | 3.5 | 11.3 | 49,937 | 45.1 | 35.1 | 55.2 | 52,510 | 47.4 | 36.9 | 58.0 |
| \$50,000+ | 108,558 | 13.8 | 11.3 | 16.3 | 428,321 | 54.5 | 50.8 | 58.2 | 249,478 | 31.7 | 28.2 | 35.2 |
| Children in home | | | | | | | | | | | | |
| Yes | 72,142 | 13.5 | 10.4 | 16.5 | 266,727 | 49.7 | 45.0 | 54.5 | 197,312 | 37.0 | 32.0 | 41.6 |
| No | 63,451 | 10.2 | 7.9 | 12.5 | 337,962 | 54.3 | 49.8 | 58.8 | 220,594 | 35.5 | 31.3 | 39.7 |
| Tobacco Use | | | | | | | | | | | | |
| Current smoker | 11,331 | 6.9 | 2.0 | 11.7 | 89,214 | 54.2 | 42.7 | 65.7 | 64,157 | 39.0 | 28.2 | 49.7 |
| Nonsmoker | 124,262 | 12.5 | 10.4 | 14.6 | 515,230 | 51.8 | 48.5 | 55.1 | 354,829 | 35.7 | 32.4 | 39.0 |

Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

The results for race and ethnicity indicated that approximately 12 percent of the white respondents had a radon test result above 4 pCi/L. Approximately 5 percent of Hispanic respondents stated that they had a test result above 4 pCi/L. The data to support the same assessment of black respondents were insufficient (Figure 3).

The proportion of responses for a radon test above 4 pCi/L increases with education. Those with some college and college graduates were significantly more likely than those with less than a high school diploma to have had test results above 4 pCi/L (Table 3).

Those making \$50,000 and more per year were more likely to report a result over the action limit than those in the two lowest income groups (Table 3, Figure 3).

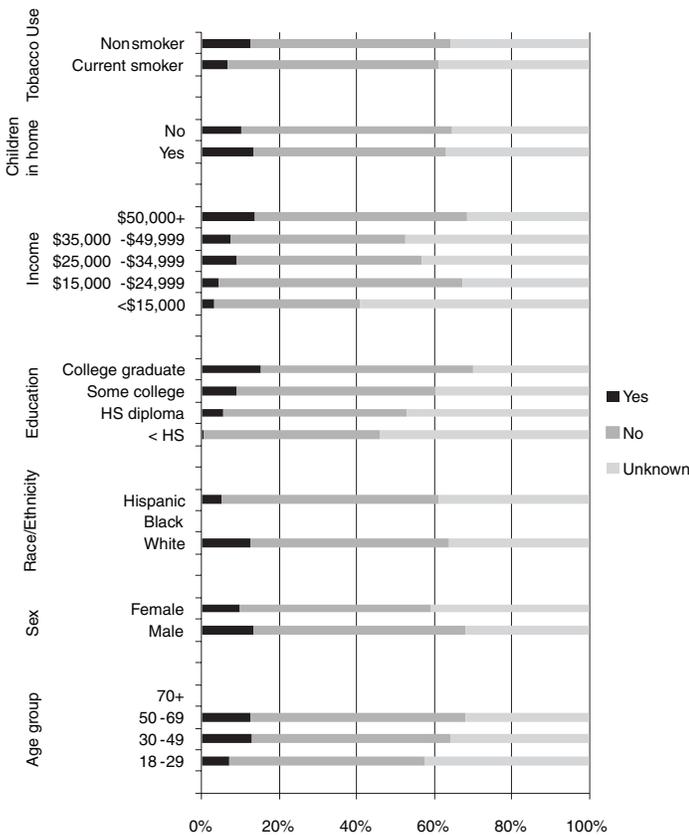
Questions regarding children in the home and tobacco use were asked. There were no differences within these segments regarding radon test results (Table 3).

What Did You Do in Response to a High Test Result Above 4 Pci/L?

The final question in the radon survey asked respondents what they did in response to having a radon test result above 4 pCi/L. The number of respondents decreased with each level of questioning in the radon survey. The survey sample size was not adequate to accurately assess the demographic profile or regional trends for a specific remediation method.

Statewide, approximately 75 percent of survey respondents who reported having a radon home test above 4 pCi/L responded by having a radon mitigation system installed.

Figure 3. Reported elevated home radon test results (over 4 pCi/L) by demographic characteristics, Colorado adults, BRFSS, 2009



Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Other outcomes observed included doing nothing, some other remediation or avoidance behavior, and no longer going into the basement (Table 4). Figure 4 shows the survey results tabulated by weighted population estimate.

Geography

Do You Know What Radon Is?

The data were further tabulated by health statistic region. Colorado is divided into 21 health statistics regions. These 21 regions are aggregations of counties developed by the Health Statistics Section of the Colorado Department of

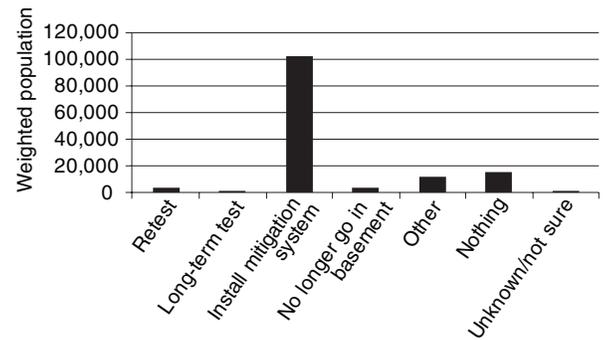
Table 4. Reported responses to a radon test above 4 pCi/L, Colorado adults, BRFSS, 2009

In response to a high radon test result did you...

| | Weighted population estimate | Percent | Confidence Intervals | |
|---------------------------|------------------------------|---------|----------------------|------|
| | | | Low | High |
| Retest | 3,433 | 2.5 | 0.5 | 4.6 |
| Long-term test | 970 | 0.7 | 0.0 | 1.6 |
| Install mitigation system | 101,414 | 74.9 | 67.9 | 81.8 |
| No longer go in basement | 2,807 | 2.1 | 0.0 | 4.2 |
| Other | 11,104 | 8.2 | 3.0 | 13.4 |
| Nothing | 14,983 | 11.1 | 6.2 | 16.0 |
| Unknown/not sure | 710 | 0.5 | 0.0 | 1.3 |

Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Figure 4. Proportion of reported responses to a radon test above 4 pCi/L, Colorado adults, BRFSS, 2009



Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Public Health and Environment in partnership with state and local public health professionals. These regions were developed using statistics and demographic criteria. Regions along the Front Range, where large concentrations of Colorado's population exist, may be made up of a single county. Regions elsewhere may consist of multiple counties.

Statewide, respondents who stated they knew what radon is totalled 73.1 percent. Respondents in Health Statistics Regions 16 and 17 were more likely to report that they knew what radon is. Regions 8 and 14 were less likely to know what radon is. No differences were observed in the remaining regions (Table 5).

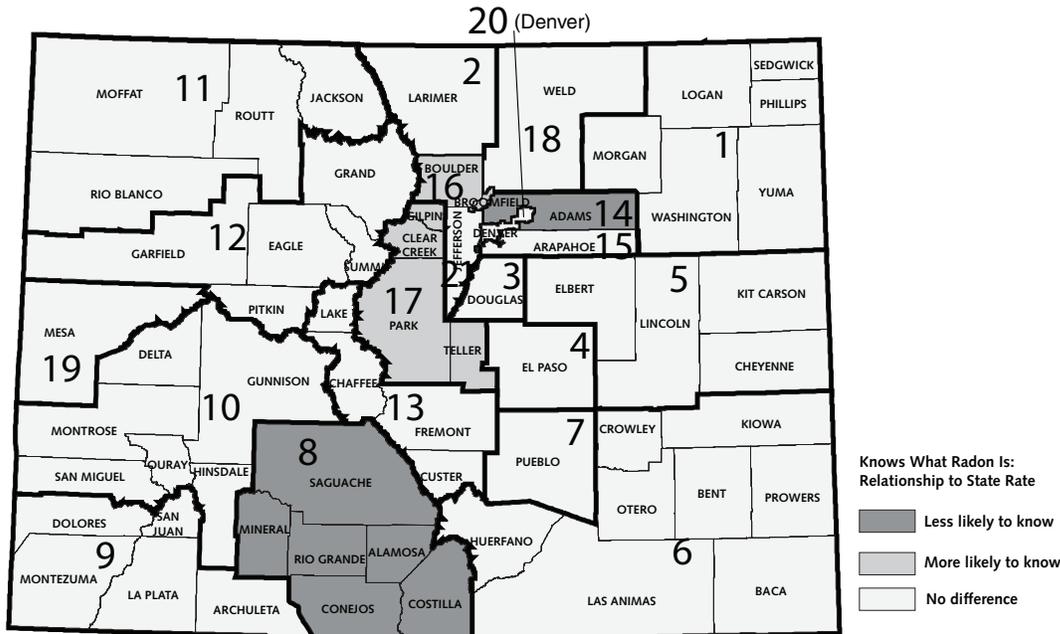
Table 5. Reported radon knowledge by Health Statistics Region, Colorado adults, BRFSS, 2009

| | Yes | | | | No | | | | Unknown/not sure | | | |
|-----------|------------------------------|---------|----------------------------------|------|------------------------------|---------|----------------------------------|------|------------------------------|---------|----------------------------------|------|
| | Weighted population estimate | Percent | Confidence Intervals Low High | | Weighted population estimate | Percent | Confidence Intervals Low High | | Weighted population estimate | Percent | Confidence Intervals Low High | |
| Colorado | 2,486,506 | 73.1 | 70.4 | 75.7 | 793,251 | 23.3 | 20.7 | 25.9 | 121,997 | 3.6 | 2.5 | 4.7 |
| Region 1 | 33,184 | 68.3 | 59.7 | 76.9 | 14,539 | 30.0 | 21.3 | 38.5 | 886 | 1.8 | 0.1 | 3.5 |
| Region 2 | 158,579 | 73.6 | 54.2 | 92.9 | 54,936 | 25.5 | 5.9 | 45.0 | 2,062 | 1.0 | 2.0 | 2.0 |
| Region 3 | 149,499 | 79.5 | 64.9 | 94.1 | 32,109 | 17.1 | 2.1 | 32.1 | 6,361 | 3.4 | 0.8 | 5.9 |
| Region 4 | 294,893 | 73.9 | 67.9 | 79.8 | 82,662 | 20.7 | 15.1 | 26.3 | 21,704 | 5.4 | 2.3 | 8.6 |
| Region 5 | 20,429 | 73.3 | 62.6 | 84.0 | 6,037 | 21.7 | 11.0 | 32.3 | 1,415 | 5.1 | 1.0 | 9.1 |
| Region 6 | 40,132 | 79.9 | 71.8 | 88.0 | 9,192 | 18.3 | 10.4 | 26.2 | 893 | 1.8 | 3.0 | 3.5 |
| Region 7 | 67,198 | 64.5 | 52.2 | 76.7 | 26,791 | 25.7 | 14.6 | 36.8 | 10,271 | 9.9 | 0.3 | 19.4 |
| Region 8 | 18,341 | 60.2 | 50.6 | 69.8 | 9,881 | 32.4 | 23.5 | 41.3 | 2,242 | 7.4 | 0.7 | 14.0 |
| Region 9 | 49,724 | 75.2 | 63.9 | 86.5 | 13,827 | 20.9 | 9.5 | 32.3 | 2,570 | 3.9 | 0.6 | 7.2 |
| Region 10 | 53,725 | 77.8 | 68.8 | 86.8 | 14,341 | 20.8 | 11.9 | 29.7 | 990 | 1.4 | 3.0 | 3.1 |
| Region 11 | 24,413 | 72.8 | 63.4 | 82.1 | 8,028 | 24.0 | 14.6 | 33.3 | 1,100 | 3.3 | 0.8 | 5.8 |
| Region 12 | 92,345 | 77.2 | 68.4 | 86.0 | 23,174 | 19.4 | 10.9 | 27.8 | 4,136 | 3.5 | 7.0 | 7.2 |
| Region 13 | 41,752 | 77.0 | 64.0 | 90.1 | 11,691 | 21.6 | 8.3 | 34.8 | 797 | 1.5 | 3.0 | 3.3 |
| Region 14 | 172,924 | 62.4 | 56.2 | 69.0 | 94,881 | 34.2 | 28.0 | 40.4 | 9,452 | 3.4 | 1.5 | 5.3 |
| Region 15 | 275,885 | 71.0 | 62.4 | 79.6 | 85,271 | 22.0 | 15.0 | 28.9 | 27,373 | 7.0 | 14.0 | 14.5 |
| Region 16 | 194,869 | 85.9 | 78.6 | 93.2 | 30,733 | 13.6 | 6.3 | 20.9 | 1,160 | 0.5 | 1.0 | 1.2 |
| Region 17 | 32,867 | 88.4 | 81.5 | 95.4 | 3,793 | 10.2 | 3.4 | 17.0 | 502 | 1.4 | 3.0 | 3.2 |
| Region 18 | 127,291 | 75.3 | 66.9 | 83.8 | 38,581 | 22.8 | 14.5 | 31.2 | 3,069 | 1.8 | 3.0 | 3.6 |
| Region 19 | 83,683 | 82.2 | 73.8 | 90.6 | 14,430 | 14.2 | 6.6 | 21.7 | 3,661 | 3.6 | 8.0 | 8.1 |
| Region 20 | 264,640 | 64.1 | 55.7 | 72.6 | 134,055 | 32.5 | 23.9 | 41.1 | 13,873 | 3.4 | 1.4 | 5.3 |
| Region 21 | 290,134 | 76.0 | 66.4 | 85.6 | 84,302 | 22.1 | 12.3 | 31.8 | 7,479 | 2.0 | 0.8 | 3.1 |

Region 1: Logan, Morgan, Phillips, Sedgwick, Washington, Yuma Region 2: Larimer Region 3: Douglas Region 4: El Paso Region 5: Cheyenne, Elbert, Kit Carson, Lincoln Region 6: Baca, Bent, Crowley, Huerfano, Kiowa, Las Animas, Otero, Prowers Region 7: Pueblo Region 8: Alamosa, Conejos, Costilla, Mineral, Rio Grande, Saguache Region 9: Archuleta, Dolores, La Plata, Montezuma, and San Juan Region 10: Delta, Gunnison, Hinsdale, Montrose, Ouray, San Miguel Region 11: Jackson, Moffat, Rio Blanco, Routt Region 12: Eagle, Garfield, Grand, Pitkin, Summit Region 13: Chaffee, Custer, Fremont, Lake Region 14: Adams Region 15: Arapahoe Region 16: Boulder, Broomfield Region 17: Clear Creek, Gilpin, Park, Teller Region 18: Weld Region 19: Mesa Region 20: Denver Region 21: Jefferson

Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Figure 5. Reported radon knowledge by Health Statistics Region, Colorado adults, BRFSS, 2009



Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Has Your Household Been Tested for the Presence of Radon Gas?

Respondents from all the Health Statistics Regions reported an average 34.5 percent of them had tested their home for radon. Responses observed from Health Statistics Region 16 indicated a higher testing rate than the statewide rate. Responses from Regions 1, 8, 9, 10, and 11 all indicated lower rates for home radon testing (Table 6).

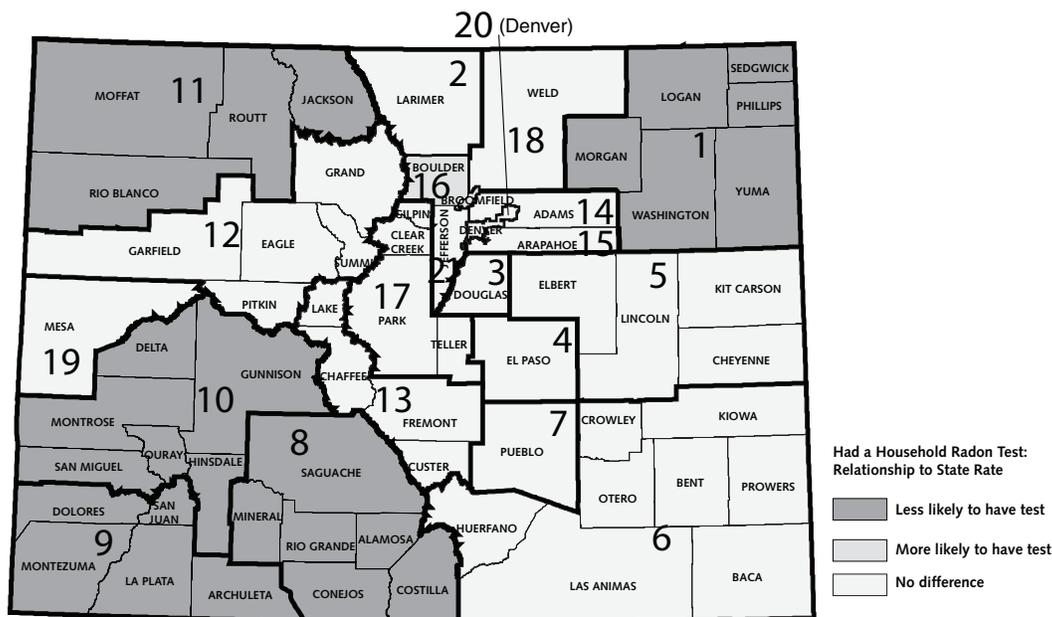
Table 6. Reported Radon Testing by Health Statistics Region, Colorado adults, BRFSS, 2009

| | Yes | | | | No | | | | Unknown/not sure | | | |
|-----------|------------------------------|---------|----------------------|------|------------------------------|---------|----------------------|------|------------------------------|---------|----------------------|------|
| | Weighted population estimate | Percent | Confidence Intervals | | Weighted population estimate | Percent | Confidence Intervals | | Weighted population estimate | Percent | Confidence Intervals | |
| | | | Low | High | | | Low | High | | | Low | High |
| Colorado | 1,170,971 | 34.5 | 32.4 | 36.5 | 1,770,876 | 52.1 | 49.8 | 54.5 | 454,877 | 13.4 | 11.2 | 15.6 |
| Region 1 | 9,230 | 19.0 | 12.6 | 25.4 | 33,423 | 68.8 | 60.7 | 76.8 | 5,956 | 12.3 | 6.2 | 18.4 |
| Region 2 | 89,434 | 41.5 | 29.4 | 53.7 | 88,348 | 41.0 | 26.7 | 55.3 | 37,640 | 17.5 | 2.1 | 32.9 |
| Region 3 | 85,997 | 45.8 | 34.9 | 56.6 | 72,293 | 38.5 | 26.7 | 50.3 | 29,679 | 15.8 | 5.4 | 26.2 |
| Region 4 | 143,860 | 36.0 | 30.5 | 41.6 | 194,289 | 48.7 | 42.7 | 54.6 | 61,109 | 15.3 | 10.7 | 20.0 |
| Region 5 | 7,141 | 26.0 | 18.2 | 33.8 | 16,941 | 61.7 | 51.7 | 71.6 | 3,394 | 12.4 | 3.9 | 20.8 |
| Region 6 | 15,572 | 31.0 | 21.0 | 41.0 | 28,141 | 56.0 | 44.0 | 68.1 | 6,504 | 13.0 | 0.4 | 25.5 |
| Region 7 | 31,068 | 29.8 | 20.0 | 40.0 | 67,507 | 64.8 | 54.5 | 75.2 | 5,545 | 5.3 | 1.5 | 9.2 |
| Region 8 | 3,613 | 11.9 | 6.5 | 17.3 | 22,164 | 72.8 | 63.8 | 81.7 | 4,687 | 15.4 | 7.1 | 23.7 |
| Region 9 | 15,385 | 23.3 | 15.3 | 31.2 | 45,117 | 68.2 | 58.9 | 77.6 | 5,620 | 8.5 | 2.1 | 14.9 |
| Region 10 | 14,397 | 20.8 | 13.1 | 28.6 | 49,759 | 72.1 | 63.1 | 81.1 | 4,900 | 7.1 | 2.2 | 12.0 |
| Region 11 | 8,420 | 24.8 | 17.6 | 32.1 | 21,393 | 63.1 | 54.6 | 71.6 | 4,108 | 12.1 | 6.0 | 18.2 |
| Region 12 | 43,555 | 36.4 | 27.7 | 45.1 | 62,505 | 52.2 | 43.1 | 61.4 | 13,594 | 11.4 | 5.1 | 17.6 |
| Region 13 | 18,991 | 35.3 | 25.2 | 45.4 | 29,949 | 55.6 | 44.4 | 66.9 | 4,913 | 9.1 | 1.6 | 16.6 |
| Region 14 | 75,552 | 27.3 | 22.1 | 32.6 | 162,408 | 58.7 | 52.7 | 64.7 | 38,546 | 13.9 | 9.4 | 18.4 |
| Region 15 | 133,404 | 34.4 | 27.8 | 41.0 | 201,649 | 52.0 | 44.5 | 59.5 | 52,410 | 13.5 | 5.9 | 21.2 |
| Region 16 | 117,367 | 51.9 | 43.2 | 60.6 | 96,094 | 42.5 | 33.8 | 51.2 | 12,648 | 5.6 | 2.5 | 8.7 |
| Region 17 | 14,622 | 39.3 | 30.8 | 47.9 | 18,332 | 49.3 | 40.3 | 58.4 | 4,207 | 11.3 | 5.7 | 17.0 |
| Region 18 | 56,021 | 33.2 | 25.1 | 41.2 | 82,130 | 48.6 | 39.6 | 57.6 | 30,790 | 18.2 | 9.3 | 27.1 |
| Region 19 | 28,306 | 27.8 | 19.5 | 36.2 | 57,398 | 56.4 | 46.3 | 66.5 | 16,071 | 15.8 | 8.6 | 23.0 |
| Region 20 | 121,284 | 29.5 | 22.0 | 37.0 | 240,708 | 58.6 | 50.6 | 66.6 | 48,720 | 11.9 | 6.5 | 17.2 |
| Region 21 | 137,752 | 36.1 | 29.9 | 42.3 | 180,328 | 47.2 | 40.0 | 54.5 | 63,835 | 16.7 | 7.0 | 26.5 |

Region 1: Logan, Morgan, Phillips, Sedgwick, Washington, Yuma Region 2: Larimer Region 3: Douglas Region 4: El Paso Region 5: Cheyenne, Elbert, Kit Carson, Lincoln Region 6: Baca, Bent, Crowley, Huerfano, Kiowa, Las Animas, Otero, Prowers Region 7: Pueblo Region 8: Alamosa, Conejos, Costilla, Mineral, Rio Grande, Saguache Region 9: Archuleta, Dolores, La Plata, Montezuma, and San Juan Region 10: Delta, Gunnison, Hinsdale, Montrose, Ouray, San Miguel Region 11: Jackson, Moffat, Rio Blanco, Routt Region 12: Eagle, Garfield, Grand, Pitkin, Summit Region 13: Chaffee, Custer, Fremont, Lake Region 14: Adams Region 15: Arapahoe Region 16: Boulder, Broomfield Region 17: Clear Creek, Gilpin, Park, Teller Region 18: Weld Region 19: Mesa Region 20: Denver Region 21: Jefferson

Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Figure 6. Reported radon testing by Health Statistics Region, Colorado adults, BRFSS, 2009



Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Were the Radon Levels in Your Household Above 4 pCi/L?

When a respondent reported that they had their house tested for radon, they were asked the follow up question, “Were the radon levels in your household above 4 pCi/L?” Observations from the regional responses to this question were useful for comparison to existing radon data. Maps and datasets available from agencies including the Environmental Protection Agency and the United States Geologic Survey provide models of radon potential, or the likelihood that a household has an elevated radon measurement. Radon potential takes into account an array of variables including short-term test results, long-

term test results, location of the test in a house, and geology. Most of the available data and models indicate that the likelihood of any location in Colorado having a test result above 4 pCi/L is high (<http://www.epa.gov/radon/states/colorado.html#zone%20map>). The data collected through interviewing adults in Colorado indicated only 11.7 percent of the houses had a test result above 4 pCi/L. The statewide proportion of respondents who reported a radon test result below the action limit was 52.2 percent. Respondents who did not know the outcome of their radon test totaled 36.1 percent (Table 7).

Table 7. Reported elevated home radon test results (over 4 pCi/L) by Health Statistics Region, Colorado adults, BRFSS, 2009

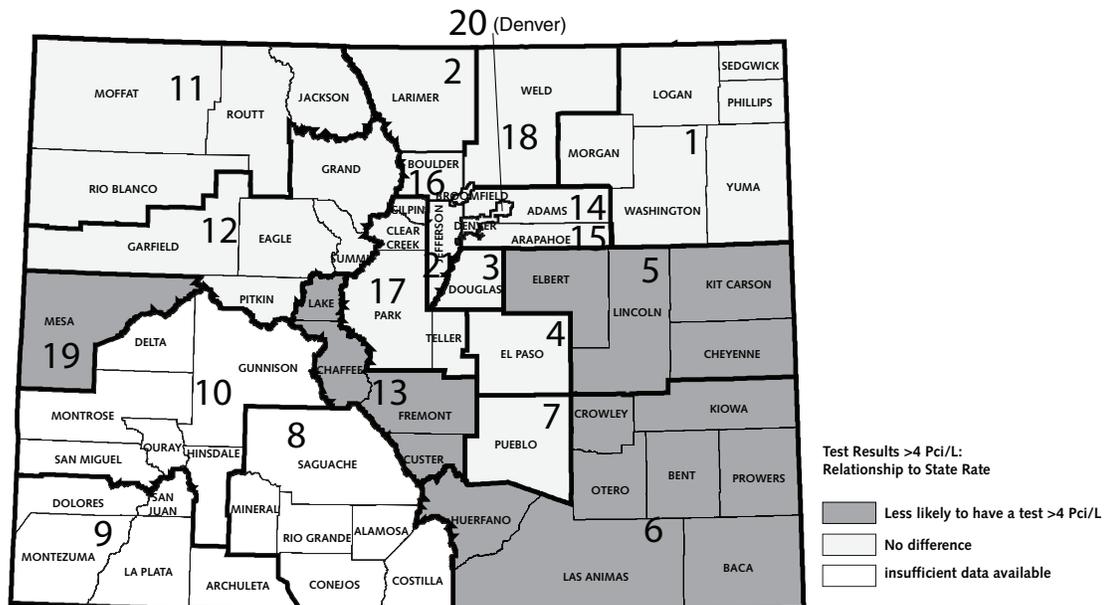
| | Yes | | | | No | | | | Unknown/not sure | | | |
|-----------|------------------------------|---------|----------------------|------|------------------------------|---------|----------------------|------|------------------------------|---------|----------------------|------|
| | Weighted population estimate | Percent | Confidence Intervals | | Weighted population estimate | Percent | Confidence Intervals | | Weighted population estimate | Percent | Confidence Intervals | |
| | | | Low | High | | | Low | High | | | Low | High |
| Colorado | 135,593 | 11.7 | 9.8 | 13.6 | 606,213 | 52.5 | 48.9 | 55.5 | 419,364 | 36.1 | 32.9 | 39.3 |
| Region 1 | * | * | * | * | * | * | * | * | * | * | * | * |
| Region 2 | 13,898 | 15.5 | 8.9 | 22.2 | 46,714 | 52.2 | 42.4 | 62.1 | 28,822 | 32.2 | 22.7 | 41.7 |
| Region 3 | 6,087 | 7.1 | 2.5 | 11.6 | 45,084 | 52.4 | 41.2 | 63.7 | 34,827 | 40.5 | 28.9 | 52.1 |
| Region 4 | 12,301 | 8.7 | 4.0 | 13.4 | 66,078 | 46.7 | 37.6 | 55.8 | 63,098 | 44.6 | 35.1 | 54.1 |
| Region 5 | 117 | 1.7 | 0.0 | 5.0 | 4,136 | 58.5 | 42.8 | 74.3 | 2,815 | 39.8 | 24.1 | 55.5 |
| Region 6 | 671 | 4.3 | 0.0 | 9.3 | 8,797 | 57.0 | 40.2 | 73.7 | 5,970 | 38.7 | 22.7 | 54.6 |
| Region 7 | 3,845 | 12.4 | 0.0 | 21.4 | 16,297 | 52.5 | 34.1 | 70.8 | 10,926 | 35.2 | 17.8 | 52.5 |
| Region 8 | * | * | * | * | * | * | * | * | * | * | * | * |
| Region 9 | 1,150 | 7.7 | 0.9 | 14.5 | 7,524 | 50.4 | 31.5 | 69.3 | 6,259 | 41.9 | 23.5 | 60.4 |
| Region 10 | * | * | * | * | * | * | * | * | * | * | * | * |
| Region 11 | 902 | 10.8 | 1.3 | 20.3 | 3,581 | 43.0 | 26.7 | 59.4 | 3,839 | 46.1 | 29.2 | 63.1 |
| Region 12 | 9,022 | 20.7 | 9.1 | 32.3 | 19,856 | 45.6 | 31.3 | 59.9 | 14,677 | 33.7 | 19.1 | 48.2 |
| Region 13 | 726 | 3.8 | 0.0 | 8.2 | 10,045 | 52.9 | 37.2 | 68.6 | 8,221 | 43.3 | 27.4 | 59.2 |
| Region 14 | 5,300 | 7.0 | 1.8 | 12.2 | 43,755 | 57.9 | 46.9 | 68.9 | 26,497 | 35.1 | 24.3 | 45.8 |
| Region 15 | 20,816 | 15.6 | 8.4 | 22.8 | 63,978 | 48.0 | 37.3 | 58.6 | 48,610 | 36.4 | 25.6 | 50.7 |
| Region 16 | 23,492 | 20.2 | 11.9 | 28.5 | 59,043 | 50.8 | 38.5 | 63.1 | 33,755 | 29.0 | 17.3 | 40.8 |
| Region 17 | 1,105 | 7.6 | 0.7 | 14.4 | 7,991 | 54.7 | 41.5 | 67.8 | 5,526 | 37.8 | 24.9 | 50.7 |
| Region 18 | 6,570 | 11.7 | 1.9 | 21.5 | 25,495 | 45.5 | 31.6 | 59.4 | 23,957 | 42.8 | 28.8 | 56.7 |
| Region 19 | 187 | 0.7 | 0.0 | 2.0 | 17,286 | 62.1 | 47.1 | 77.2 | 10,345 | 37.2 | 22.2 | 52.2 |
| Region 20 | 13,255 | 10.9 | 4.2 | 17.6 | 61,095 | 50.4 | 35.0 | 65.8 | 46,934 | 38.7 | 25.2 | 52.2 |
| Region 21 | 15,738 | 11.8 | 6.6 | 17.1 | 80,665 | 60.6 | 52.8 | 68.4 | 36,787 | 27.6 | 20.8 | 34.5 |

Region 1: Logan, Morgan, Phillips, Sedgwick, Washington, Yuma Region 2: Larimer Region 3: Douglas Region 4: El Paso Region 5: Cheyenne, Elbert, Kit Carson, Lincoln Region 6: Baca, Bent, Crowley, Huerfano, Kiowa, Las Animas, Otero, Prowers Region 7: Pueblo Region 8: Alamosa, Conejos, Costilla, Mineral, Rio Grande, Saguache Region 9: Archuleta, Dolores, La Plata, Montezuma, and San Juan Region 10: Delta, Gunnison, Hinsdale, Montrose, Ouray, San Miguel Region 11: Jackson, Moffat, Rio Blanco, Routt Region 12: Eagle, Garfield, Grand, Pitkin, Summit Region 13: Chaffee, Custer, Fremont, Lake Region 14: Adams Region 15: Arapahoe Region 16: Boulder, Broomfield Region 17: Clear Creek, Gilpin, Park, Teller Region 18: Weld Region 19: Mesa Region 20: Denver Region 21: Jefferson

* Insufficient data

Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Figure 7. Reported elevated home radon test results by Health Statistics Region, Colorado adults, BRFSS, 2009



Source: Colorado 2009 BRFSS, Health Statistics Section, Colorado Department of Public Health and Environment

Discussion

A variety of health disparities surround radon awareness and response in Colorado. The results of the first question in the survey, “Do you know what radon is?” indicates younger adults were less likely to know what radon is than older adults. Black and Hispanic respondents were less likely to know what radon is than white respondents. Lower income adults were less likely to have knowledge about radon than higher income adults, with the exception of those between \$25,000-\$34,999 and \$35,000-\$49,999. Those that had completed more education also had a higher rate of radon awareness. Females were identified as being less likely than males to know what radon is. The survey results indicated that smokers are statistically less likely to know what radon is than nonsmokers.

The results of the question, “Has your household air been tested for the presence of radon gas?” revealed further disparities. Hispanics were less likely to have reported that they lived in a tested home than whites. There was no statistical difference between blacks and the other two groups. Young people ages 18-29 were statistically the least likely to report that the household they lived in had been tested for radon. Education also seemed to be a factor in whether or not participants reported living in a household that had been tested. Although there was no significant difference between those with less than a high school diploma and with a high school diploma both groups were statistically less likely to report living in a home that had been tested for radon than those who had graduated from college.

Income results showed those earning \$50,000 and more annually were more likely to report they had tested a home than all other groups. The data did not show any difference in reported home testing between smokers and nonsmokers and those with or without children.

There were no differences reported by age for test results above 4 pCi/L. Hispanics were less likely to report an elevated test result as were those with lower educational levels. Of the respondents who stated that they had a test result above 4 pCi/L, approximately 75 percent reported installing a radon mitigation system.

There was an association between several demographic characteristics and knowing what radon is, and response to high test levels. Some of the disparities may be attributed to housing type. That is, individuals who live in rental properties may not have a basement and do not think they need to test; they may have had their landlord test and not know the results; they may simply not know that whether they have a basement or live in a ground floor structure in contact with the native geology. Relationships of homeownership, age, income and education should be examined further. Having identified these areas, the BRFSS is a valuable tool for identifying opportunities to improve public health and promote radon awareness. §