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# Changes to the Behavioral Risk Factor Surveillance System Methodology: Rationale and Application in Alaska

Contributed by: Erin Peterson, MPH, Kathy Pickle, MPH, Matt Bobo, MPH, Rebecca Topol, SM, Charles J. Utermohle, PhD, Clint Farr, MS, and Gail Stolz, MPH

## Abstract

The Behavioral Risk Factor Surveillance System (BRFSS) is a telephone survey that monitors state-level prevalence of the major behaviors associated with premature morbidity and mortality among adults. The BRFSS was developed by the National Centers for Disease Control and Prevention (CDC) and has been implemented by the State of Alaska since 1991 (referred to as the Alaska Standard BRFSS). In 2004, the State of Alaska developed a second survey, the Alaska Supplemental BRFSS, in order to collect additional population-based health data and to increase the sample size for certain questions. The Supplemental BRFSS has been conducted annually since 2004 and uses the same sample design and data collection methods as the Standard BRFSS.

The BRFSS survey estimates the prevalence of behavioral risk factors in the general (i.e., non-institutional) adult population. Historically, the BRFSS sample has been drawn from adults with landline telephones and survey data have been weighted using a method known as post-stratification. Beginning with the 2011 BRFSS, the CDC is using a new weighting method known as iterative proportional fitting, or raking, to weight the survey data to the adult population. Raking allows for the inclusion of additional demographic factors in the weighting process, including markers of socioeconomic status. In addition, the sampling frame for the BRFSS was expanded in 2011 to include cell phones. The methodology changes were made to ensure that the BRFSS continues to produce accurate population-level estimates for health risk behaviors. Changes in methods may also change the prevalence estimates reported by the BRFSS.

This report examines the 2011 Alaska BRFSS prevalence estimates for a variety of health indicators using the traditional landline sample and post-stratification weighting method compared to the new methods which include cell phones and utilize the raking method to weight the data. Although point estimates produced when cell phones are included in the sample and weighting is done by raking differ from those produced when the sample includes only landlines and weighting is done by post-stratification, the differences are often minimal. The changes to the BRFSS methods will ensure that the survey remains a valuable tool for monitoring behavioral risk factors and certain health conditions.

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## Introduction

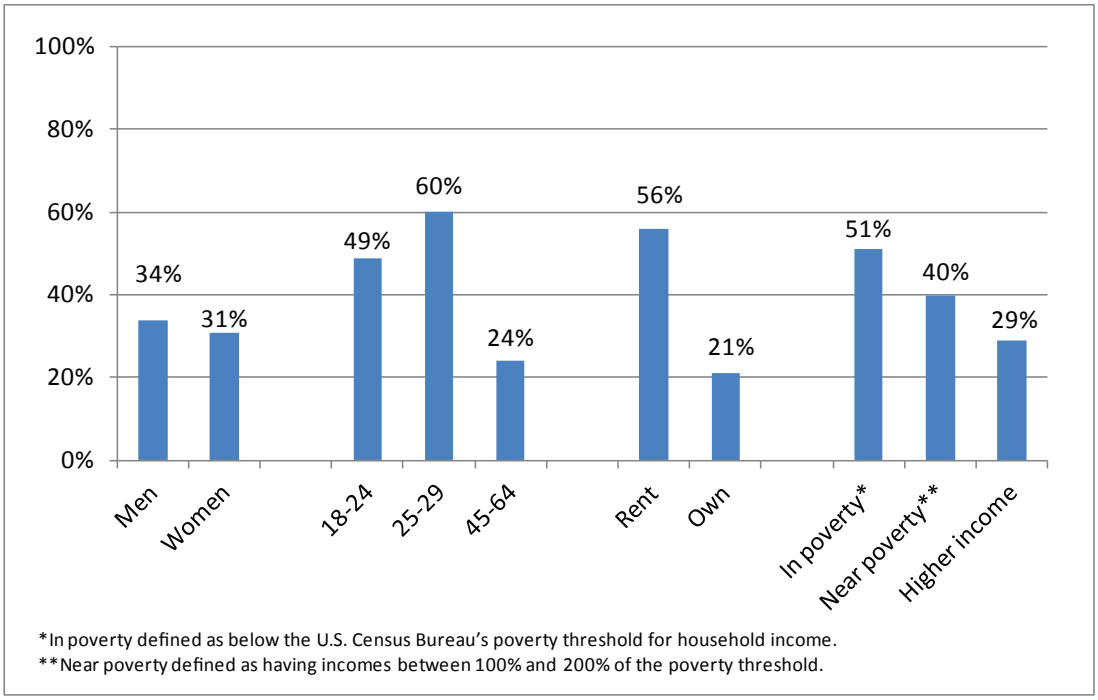
Sampling

The BRFSS was designed using random-digit dial landline telephone sampling, a survey method that has been widely used for several decades. Since 2003, however, the proportion of households in the United States with only cellular telephone service has increased dramatically. Data from the National Health Interview Survey (NHIS) indicate that more than a quarter (27%) of households in the United States had only cellular telephone service by the first half of 2010, and the upward trend is increasing.[1] Although direct estimates of state-level cell coverage are not available through the NHIS survey, the National Center for Health Statistics (NCHS) has provided modeled estimates of the types of household telephone coverage in each state. Based on the modeled estimates, by June 2010 approximately 20% of Alaska households were served only by cellular telephones.[2]

The increase in the number of cell-only households is an important consideration in telephone-based surveys, especially given emerging differences in the characteristics of people living in households with and without landline telephones.[3] One of the most notable patterns in telephone use involves age, with national data showing that younger adults (ages 18-29) are increasingly using cell phones as their only telephone. As a result, younger adults may not be adequately represented in telephone-based surveys that use only landline sampling. National data also show high rates of cell-only phone service among economically disadvantaged adults (Figure 1).

The decrease in the proportion of adults who can be reached by a landline phone, as well as the emerging demographic differences between adults with only cell phones and those with landlines, has raised concerns about whether a truly representative sample of the population can be obtained through surveys conducted only on landline telephones. For example, Alaska BRFSS data indicate that there has been a decrease in our ability to reach younger

**Figure 1. Proportion of adults who have switched to cell-only telephone service, United States, July-December 2011**



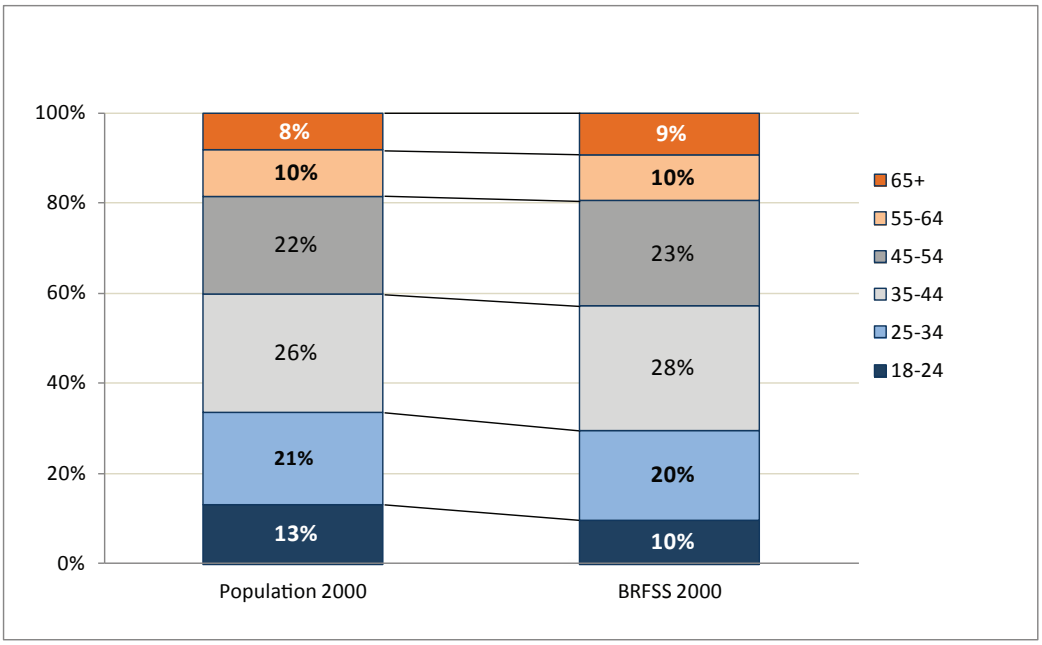

*In poverty defined as below the U.S. Census Bureau's poverty threshold for household income.
**Near poverty defined as having incomes between 100% and 200% of the poverty threshold.

Source: Blumberg SJ, Luke JV. Wireless substitution: Early release of estimates from the National Health Interview Survey, July–December 2011. National Center for Health Statistics. June 2012. Available from: http://www.cdc.gov/nchs/nhis.htm.

adults over time. In 2000, the Alaska BRFSS landline phone sampling methods provided a reasonably good distribution of respondents from across all age groups (Figure 2). By 2010, however, younger (age 18 to 34) adults were under-represented in the BRFSS compared to the population, while older (age 55 and older) adults were over-represented (Figure 3).

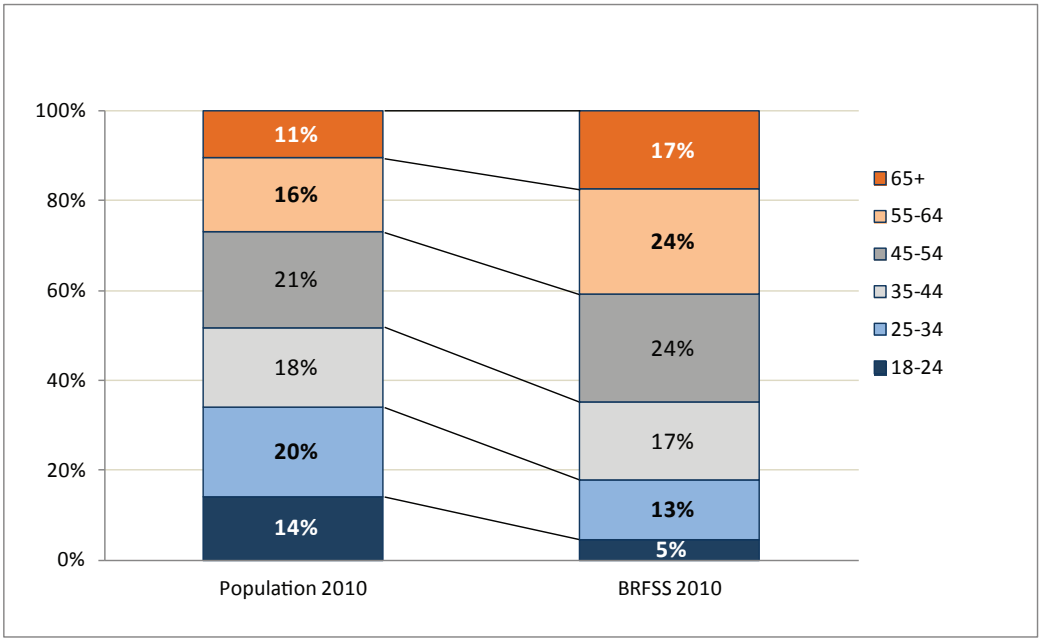
To address concerns about survey representation, many companies and agencies that run telephone-based

**Figure 2: Age distribution of Alaska BRFSS respondents compared to adult population by age group, 2000**




Source: US Census Bureau (Population 2000); Alaska Behavioral Risk Factor Surveillance System (BRFSS 2000)

**Figure 3: Age distribution of Alaska BRFSS respondents compared to adult population by age group, 2010**




Source: US Census Bureau (Population 2010); Alaska Behavioral Risk Factor Surveillance System (BRFSS 2010)

surveys have begun to modify their sampling procedures to include cell phones. During 2009 and 2010, the CDC worked with all states in piloting the inclusion of cell phone sampling for the BRFSS. Due to the small number of cell phone surveys during the pilot period, Alaska survey results include landline-only respondents through 2010. In 2011, Alaska's cell phone sample was large enough to allow reporting of the combined cell phone and landline data.

Weighting

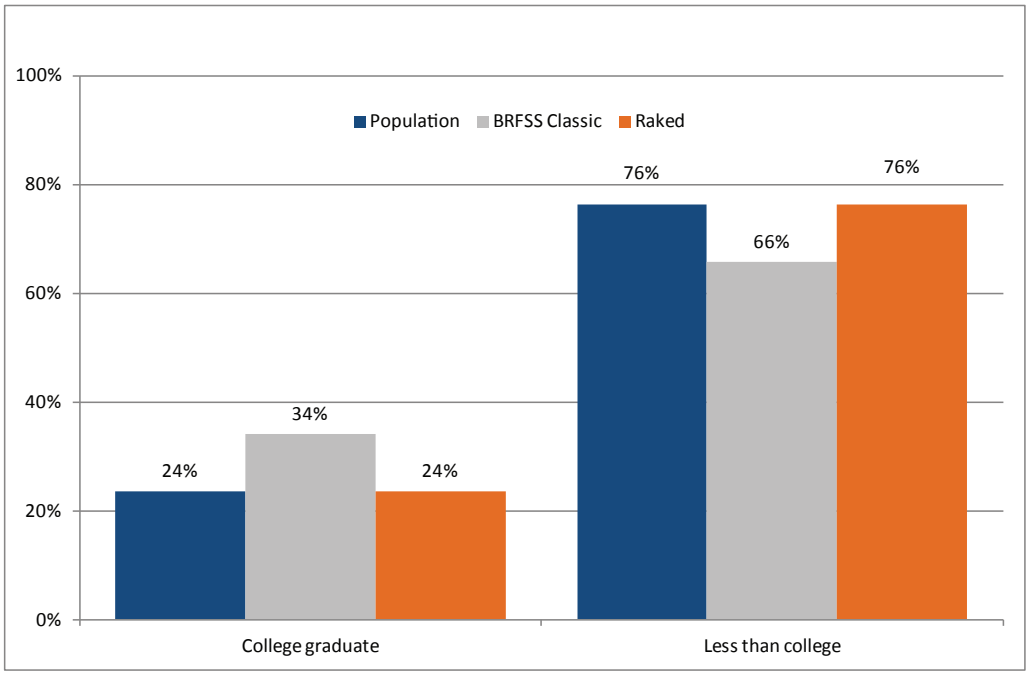
In the BRFSS, data have historically been weighted to account for differences between the survey sample and the population that the sample should represent—that is, adults age 18 and older who do not live in institutional settings. The BRFSS weighting methodology includes two parts: a) an adjustment due to the survey design, which accounts for the probability that the respondent would be selected, based on factors related to the sampling process, and b) adjustment based on demographic factors.

Between 1991 and 2010, the CDC used a method called post-stratification to adjust for demographic factors. In Alaska, post-stratification was used to adjust BRFSS data for sex and age groups by region. More recently, however, significant advances in ultra-fast microprocessors for desktop computing and networks made it possible for the CDC and its partner states to adopt the more sophisticated data weighting method known as raking, also called iterative proportional fitting. Raking is important because it allows the consideration of other demographic variables besides age and sex to make sure that data from surveys is comparable to that of the overall population. In the BRFSS, raking allows for the inclusion of education, marital status, and home-owner or renter status, in addition to sex, age and region. Taken together, these variables provide a proxy for socio-economic status (SES). The CDC has been testing and reviewing the raking method since 2007, and raked weight estimates are available for Alaska's landline-sample BRFSS from 2007 to 2010.

Unlike post-stratification, raking also allows adjustment for phone type—landline or cell phone, so that these groups are represented in the data in proportion to how they occur in the population. In 2011, Alaska data for key indicators now include respondents who only have cell phones.

Including these additional variables in the weighting process means that the overall estimates will now better reflect more demographic characteristics of the population. The figure below (Figure 4) shows the education level of BRFSS respondents using the post-stratified and raked methods, as compared to the population. As the figure shows, when data were

**Figure 4. Education level of Alaska BRFSS respondents, post-stratified and raked data compared to the population, 2010**




Source: American Community Survey, US Census Bureau (Population); Alaska BRFSS (Post-Stratified and Raked)

weighted using post-stratification, which did not adjust for education, adults with a college degree were slightly over-represented and adults with less than a high school education were slightly under-represented. Using raked weighting, survey data match levels of education in the population.

## Methods

In 2011, BRFSS data were collected using the new sampling procedure (including cell phone as well as landline phone numbers) and the data were weighted using iterative proportional fitting, or raking. The 2011 landline data were also weighted using the historically applied post-stratification method for the purposes of comparison.

Raked and post-stratified estimates for a variety of risk factors, health conditions, and healthcare access variables were produced for 2011 using statistical software that accounted for the complex sampling design employed by the BRFSS.

The post-stratified estimates for 2011 included only landline telephone respondents and were weighted for sex and age groups by region.

The raked estimates included cell phone respondents in the survey sample and data were weighted to match the overall population using the following variables, or margins:

- Age group by sex
- Race
- Education level
- Marital Status
- Home owner or renter
- Sex by race
- Age group by race
- Telephone source/type (respondent has cell-only, landline-only, or both cell and landline)
- Region
- Region by age group
- Region by sex
- Ethnicity

In raking, each margin is adjusted one at a time, with the process repeating until all of the margins are within 0.025% of the population estimates.

## Results

Figure 5 (on page 6) shows differences in 2011 prevalence estimates for a variety of risk factors, health conditions, and healthcare access variables when cell phones are included in the sample and data are weighted by raking as opposed to using the landline sample and weighting by post-stratification.

Of the variables examined, the estimates produced using raking to weight cell phone and landline data were between 0.2 to 4.4 percentage points different than the estimates produced using post-stratification to weight landline data. For most variables, the confidence intervals around the different estimates overlapped, indicating that the estimates produced using raking to weight cell phone and landline data are not significantly different from those produced using post-stratification to weight landline data. For two variables, the percentage of adults age 18-64 with no health care insurance, and the percentage of adults who reported not being able to see a doctor due to cost, the confidence intervals around the estimates did not overlap, indicating significant differences between the raked and post-stratified estimates (Table 1, Table 2, Table 3, on pages 7-8).

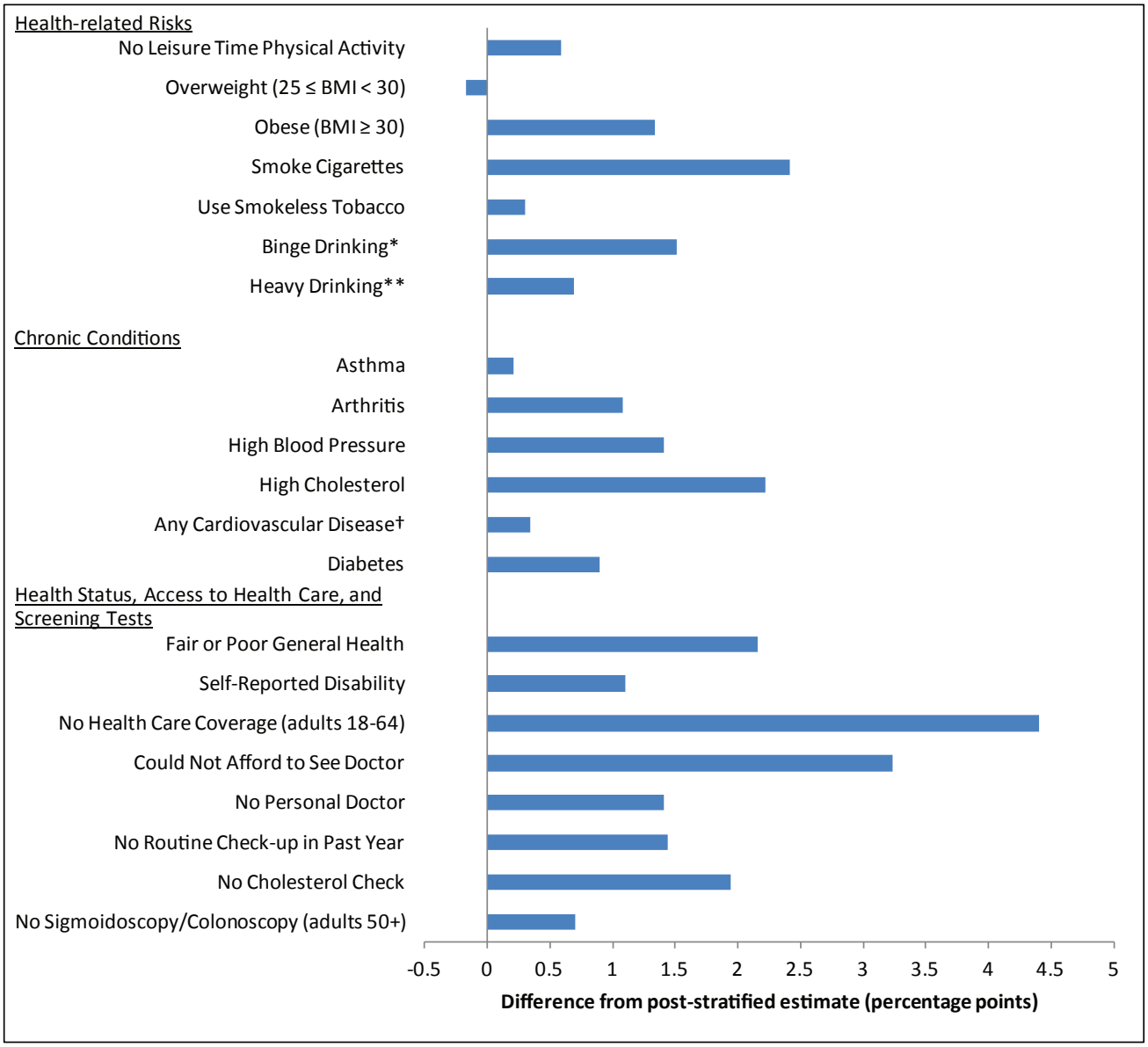
## Discussion

Changes to BRFSS sampling and weighting methods have been made to keep the survey data accurate and representative of the total population. Although these changes may make it difficult to compare estimates produced previously (using post-stratification) to estimates produced using raking, the changes have for the most part not resulted in significantly different estimates. The changes in methods may have a larger effect on health status indicators that are more closely associated with the "new" demographic factors included in raking, such as education and other measures of socioeconomic status. Similarly, the inclusion of cell phones in the BRFSS may influence prevalence estimates for some behaviors and risk factors, if those behaviors or risk factors are more or less common in population groups that exclusively use cell phones.

The changes in methods should be considered when comparing estimates produced previously using post-stratification and an exclusive landline sample to new estimates including cell phone users and using raking

(Continued on Page 8)

**Figure 5: Differences in prevalence estimates generated by a landline and cell phone sample weighted by raking compared to a landline sample weighted by post-stratification, Alaska BRFSS 2011**




*Consuming five or more alcoholic drinks for men or four or more drinks for women on one occasion in past 30 days.
**Consuming an average of more than two drinks for men or more than one drink for women per day in past 30 days.
†Any cardiovascular disease includes a diagnosis of one or more of the following conditions: heart attack or angina.

Source: Alaska Behavioral Risk Factor Surveillance System (2011)

**Table 1. Prevalence estimates of health-related risks, Alaska adults 2011**

| | Post-stratified Weights Landline Only | | | | Raked Weights Cell Phone & Landline | | | |
|---|---|---|---|---|---|---|---|---|
| | | 95% CI | | | | 95% CI | | |
| | Wt. % | LL | UL | UnWt. N | Wt. % | LL | UL | UnWt. N |
| No Leisure Time Physical Activity | 20.7 | 19.1 | 22.3 | 5,626 | 21.3 | 19.7 | 22.9 | 5,924 |
| Overweight (25 ≤ BMI < 30) | 37.7 | 35.8 | 39.7 | 5,487 | 37.5 | 35.6 | 39.5 | 5,804 |
| Obese (BMI ≥ 30) | 26.7 | 25.0 | 28.4 | 5,487 | 28.0 | 26.2 | 29.9 | 5,804 |
| Current Cigarette Smoker | 20.2 | 18.6 | 21.8 | 5,749 | 22.6 | 20.9 | 24.3 | 6,079 |
| Current Smokeless Tobacco Use | 5.6 | 4.8 | 6.4 | 5,483 | 5.9 | 5.0 | 6.9 | 5,787 |
| Binge Drinking* | 18.7 | 16.5 | 20.8 | 2,955 | 20.2 | 18.2 | 22.1 | 3,240 |
| Heavy Drinking** | 6.6 | 5.4 | 7.8 | 2,945 | 7.3 | 6.1 | 8.5 | 3,226 |

*Consuming five or more alcoholic drinks for men or four or more drinks for women on one occasion in past 30 days.
**Consuming an average of more than two drinks for men or more than one drink for women per day in past 30 days.

**Table 2. Prevalence estimates of chronic conditions, Alaska adults 2011**

| | Post-stratified Weights Landline Only | | | | Raked Weights Cell Phone & Landline | | | |
|---|---|---|---|---|---|---|---|---|
| | | 95% CI | | | | 95% CI | | |
| | Wt. % | LL | UL | UnWt. N | Wt. % | LL | UL | UnWt. N |
| Current Asthma | 13.9 | 11.9 | 15.8 | 3,197 | 14.1 | 12.4 | 15.8 | 3,523 |
| Arthritis | 20.6 | 18.7 | 22.4 | 3,181 | 21.6 | 19.9 | 23.4 | 3,507 |
| High Blood Pressure | 28.7 | 26.5 | 30.9 | 3,192 | 30.1 | 28.1 | 32.1 | 3,522 |
| High Cholesterol | 32.5 | 30.1 | 34.0 | 2,547 | 34.8 | 32.4 | 37.2 | 2,740 |
| Any Cardiovascular Disease* | 3.9 | 3.3 | 4.5 | 5,713 | 4.3 | 3.6 | 5.0 | 6,042 |
| Diabetes | 6.9 | 5.9 | 7.8 | 5,781 | 7.8 | 6.7 | 8.8 | 6,111 |

*Any cardiovascular disease includes a diagnosis of one or more of the following conditions: heart attack or angina.

**Table 3. Prevalence estimates of health status, access to health care, and screening tests, Alaska adults 2011**

| | Post-stratified Weights Landline Only | | | | Raked Weights Cell Phone & Landline | | | |
|---|---|---|---|---|---|---|---|---|
| | | 95% CI | | | | 95% CI | | |
| | Wt. % | LL | UL | UnWt. N | Wt. % | LL | UL | UnWt. N |
| Fair or Poor General Health | 12.9 | 11.6 | 14.2 | 5,763 | 15.1 | 13.7 | 16.6 | 6,092 |
| Self-Reported Disability | 25.2 | 22.9 | 27.6 | 2,987 | 26.3 | 24.3 | 28.4 | 3,281 |
| No Health Care Coverage (adults 18-64)‡ | 17.7 | 16.0 | 19.4 | 4,585 | 22.1 | 20.2 | 24.0 | 4,888 |
| Could Not Afford to See Doctor‡ | 14.3 | 12.9 | 15.7 | 5,757 | 17.6 | 15.9 | 19.2 | 6,080 |
| No Personal Doctor | 31.4 | 29.5 | 33.4 | 5,735 | 32.9 | 30.9 | 34.8 | 6,061 |
| No Routine Check-up in Past Year | 40.3 | 37.6 | 43.0 | 3,139 | 41.7 | 37.4 | 44.1 | 3,453 |
| No Cholesterol Check | 29.5 | 26.8 | 32.2 | 3,076 | 31.5 | 29.2 | 33.8 | 3,385 |
| No Sigmoidoscopy/Colonoscopy (adults 50+) | 34.3 | 31.4 | 37.2 | 1,659 | 35.0 | 31.9 | 38.0 | 1,716 |

‡95% Confidence intervals do not overlap.

(Continued from Page 5)

To provide additional context for interpretation, public health analysts will be able to produce estimates by raked weighting for more recent years, from 2007 to the present, and data including both landline and cell phone respondents will be available from 2011 on. As additional BRFSS data are analyzed and released, these improved estimates will be available on the Section of Chronic Disease Prevention and Health Promotion (CDPHP) website and will be included in future CDPHP publications.

The BRFSS is widely looked upon as an important source for credible data about behavioral risk factors and chronic conditions. The changes that have been made will help ensure that the BRFSS can continue to be a valuable source of information for health planning and improvement.

## REFERENCES

1. Blumberg SJ, Luke JV. Wireless substitution: Early release of estimates from the National Health Interview Survey, January–June 2011. National Center for Health Statistics. December 2011. Available from: http://www.cdc.gov/nchs/nhis.htm.
2. Blumberg SJ, Luke JV, Ganesh N, et al. Wireless substitution: State-level estimates from the National Health Interview Survey, January 2007–June 2010. National health statistics reports; no 39. Hyattsville, MD: National Center for Health Statistics. 2011.
3. Link, MW, Battaglia, MP, Frankel, MR, Osborn L, Mokdad AH. Reaching the US cell phone generation: comparison of cell phone survey results with an ongoing landline telephone survey. Public Opinion Quarterly. 2007, Vol. 71: No 5, 814-839.

For more information about the Alaska Behavioral Risk Factor Surveillance System please visit:

**http://dhss.alaska.gov/dph/Chronic/Pages/brfss/default.aspx**