Kansas Behavioral Risk Factor Surveillance System (BRFSS)
Changes in Survey Methodology and Impact of Methodology Changes on Prevalence Estimates Generated by the 2011 BRFSS

BRFSS is the world’s largest annual population–based survey system tracking health conditions and risk behaviors in the United States since 1984. It is coordinated by the Centers for Disease Control and Prevention (CDC) and is conducted in every state and several territories in the United States. The Bureau of Health Promotion (BHP), Kansas Department of Health and Environment (KDHE) conducted the first BRFSS survey in Kansas in 1990 as a point-in-time survey. Since 1992, BHP has conducted the Kansas BRFSS survey annually, thus providing an ability to examine the burden and monitor the trends of various diseases and risk factors/behaviors that are of public health importance in Kansas. BRFSS is the only source of population-based data for several public health indicators in Kansas.

BRFSS was designed as a random digit dial (RDD) telephone survey of non-institutionalized adults 18 years and older living in private residences with landline telephone service. The survey sampling method excluded individuals without telephone service and those who live in institutions such as dormitories, nursing homes, prison and military bases. The survey sample excluded only a small portion of the population and provided weighted estimates that were generalizable to the adult population of each state/territory.

However, in recent years, data from the National Center for Health Statistics indicate that the proportion of U.S. households with wireless (also known as cellular) telephone only service is rising steadily. This increase has been more rapid since 2009 (Figure 1).

Figure 1: Estimated Percentage of Households with Wireless (Cellular) Telephone Only Service — National Center for Health Statistics, United States, 2008–2011


According to the National Health Interview Survey (NHIS), more than 3 of every 10 American households (31.6%) had wireless (cellular) telephone only service during the first half of 2011. This means an increase of 1.9 percentage points since the second half of 2010. In first half of 2010, 26.6 percent of households had wireless (cellular) telephone only service with an increase of 2.1 percentage points since the second half of 2009. Also, the percentage of households with dual telephone service (both landline & cell phone service), receiving all or almost all calls on cellular telephone is also increasing. According to NHIS, in
2011, nearly 1 of every 6 U.S. households (16.4%) with dual telephone service received all or almost all calls on cell phones as compared to 15.6 percent households with dual telephone service in 2010.1

The percentage of adults living in households with wireless (cellular) telephone only service has also been increasing steadily (Figure 2 and 3). In January-June 2003, about 3 percent of the all adults lived in households with cellular telephone only service as compared to approximately 30.2 percent of all adults in January-June 2011. A more rapid increase in this percentage is seen in more recent years. During first half of 2010, one in every 4 adults (24.9%) lived in households with cellular telephone only service; one year before that i.e., during January-June of 2009, 1 in every 5 adults (21.1%) lived in households with cellular telephone only service; 2 years before that i.e., during January-June 2007, only 1 in every 8 adults lived in households with cellular telephone only service (12.6%); and during the first half of 2006, only 1 of every 10 adults (9.6%) lived in cellular telephone only service households.1,2 The percentage of adults with no telephone service remained the same throughout this time period.1 The NHIS shows a similar increasing pattern in the percentage of children living in cellular telephone only service households (Figure 2 and 3).1,2

Figure 2: Estimated Percentage of Adults and Children with Wireless (Cellular) Telephone Only Service — National Center for Health Statistics, United States, 2003–2011

The 2011 NHIS data also shows differences in the demographic characteristics of adults living in cellular telephone only service households. It is seen that people who have cellular telephone only service are younger adults. The percentages of adults living in these cellular telephone only service households in different age groups are as follows: 46.8 percent of adults aged 18-25 years; 58.1 percent of adults aged 25-29 years; 46.2 percent of adults aged 30-34 years; 34.3 percent of adults aged 35-44 years; 21.6 percent of adults aged 45-64 years; and 7.9 percent of adults aged 65 years and older. Thus, the percentage of adults living in cellular telephone only service households decreases with increasing age beyond 35 years of age. This disproportionate number of younger adults in wireless only households may bias estimates derived from the landline telephone surveys. A higher percentage of men (31.4%) live in wireless only households than women (29.1%). The adults living alone (38%) and with unrelated adults (71.3%) are more likely to live in these households than those living with spouses or other adult family members (23.2%). A higher percentage of adults living in poverty (46.8%) and near poverty (38.1%) live in these households than with higher income (27.7%). About half of all adults renting their home (52.5%) lived in these households as compared to adults owning their home (20.6%). A higher percentage of adults living in the Midwest (33.5%), South (33.6%) and West (30.3%) live in these households than those living in the Northeast (18.8%). A higher percentage of Hispanic adults (40.8%) and non-Hispanic African American adults (32.5%) live in these households than non-Hispanic white adults (27.6%).

The increased number of households with cellular telephone only service, increased use of cell phones in households with dual telephone service, and differences in the demographic profile of the people who live in cellular telephone only service households represent a threat to the validity of traditional Random Digit Dialing (RDD) surveys such as BRFSS. The CDC has researched extensively in the past several years to identify the strategies to maintain representativeness, coverage and validity of BRFSS data. This research has helped in understanding the impact of growing cellular telephone use on survey data. In 2004, the CDC convened an
expert panel of survey methodologists to address the challenges and implications faced by the BRFSS due to growing effects of cellular telephone only service households. The panel’s two major recommendations were to include cellular telephone households in the survey sample by using dual-frame sampling method (landline and cellular telephone samples) and to improve the weighting, adjustment and estimation methods that could reduce potential bias and maintain validity of the population-based estimates generated through dual frame sampling method of the BRFSS survey.

In response to the first recommendation from the expert panel of survey methodologists, the Division of Behavior Surveillance (DBS) of the CDC asked all states and territories to conduct a cellular telephone pilot survey in 2009 and 2010 in addition to the regular landline RDD BRFSS survey. The data generated through these pilot surveys were used by the CDC scientists to test and further refine dual-frame sampling and weighting methodologies. In 2011, CDC advised all states and territories to implement a dual frame sampling methodology for the BRFSS survey and to include both adults 18 years and older living in private residences with landline telephone service, and adults 18 years and older living in private residences with cellular telephone only service. The states were advised to target at least 20 percent of their total sample of complete interviews to be from cellular telephone only service households. In 2012, the CDC further advised all states to make the following two additional changes in the BRFSS methodology: 1) inclusion of respondents living in households with both cell phone and landline service but receiving 90 percent or more of their calls on cell phones (cellular telephone mostly households) in cell phone survey sample; and 2) inclusion of residents living in college housing with landline and/or cellular telephone service in both landline and cell phone samples. These changes in the BRFSS survey sampling methodology will allow inclusion of respondents from the cellular telephone mostly households, as well as respondents living in college housing, thus making the survey sample more representative of the general population.

In accordance with the second recommendation from the expert panel, the CDC began testing a more advanced and statistically sophisticated survey weighting method known as iterative proportional fitting method (also referred as "raking" method) and started exploring the possibility of replacing existing post-stratification weighting method with this method. The iterative proportional fitting (IPF) or raking method allows for the introduction of additional demographic variables (e.g., education level, marital status and home ownership) into the statistical weighting process, which is not possible with the use of post-stratification weighting method. The post-stratification weighting method used for weighting the BRFSS data in 2010 and preceding years included a limited number of variables (age, gender, race/ethnicity and geographic region) in the weighting process of survey data. The addition of variables in the weighting process using IPF or raking methodology will assist in further reducing the potential for bias and increasing the representativeness of survey estimates for the general population. The new weighting methodology also allows for the incorporation of an essential variable of telephone source (landline or cellular telephone) in the weighting process needed for adjustment of telephone source in combined landline and cellular telephone sample obtained from the dual frame sampling methodology. The IPF weighting method, instead of adjusting weights to categories, adjusts for each dimension separately in an iterative process. The process continues up to 75 times or until data converge to Census estimates for these variables. The CDC has adopted the IPF method for weighting 2011 BRFSS data in place of the post stratification method. The CDC and all states have used weight variables created through this new methodology for analysis of 2011 BRFSS data and generation of prevalence estimates of health indicators.
Impact of application of changes in 2011 BRFSS survey methodology on estimates of health indicators:

Adoption of the changes in BRFSS survey methodology including use of dual frame sampling and IPF (raking) weighting methods will influence the state-level, as well as national-level prevalence estimates generated by the analysis of survey data for 2011 and subsequent years. The 2011 prevalence estimates of health indicators will vary from the estimates that were obtained by the analysis of data collected through surveys conducted in 2010 and preceding years. The absolute increases or decreases in the prevalence estimates of health indicators obtained from the analysis of the 2011 BRFSS survey are not reflecting any real changes in the actual prevalence of diseases, risk factors/behaviors and other health indicators in the general population. These variations in the estimates are caused by the addition of cellular telephone households to the survey sampling frame and adoption of new advanced statistical method for weighting of the survey data.3

The effect of dual frame sampling method (inclusion of households with cellular telephone only service in the survey sampling frame) on the BRFSS estimates of health indicators can be examined by the comparison of estimates generated by the analysis of data collected through landline telephone sample and combined landline and cellular telephone sample. Differences resulting from application of new weighting methodology can be seen by comparison of estimates produced by applying post-stratification and IPF (raking) methods on landline telephone survey data.3 The comparison of estimates of health indicators generated from 2010 national BRFSS data using three different methods (analysis of 2010 landline telephone survey data with application of post-stratification weighting methodology; analysis of 2010 landline telephone survey data with application of the new IPF weighting methodology; and analysis of combined landline and cellular telephone survey data with application of the new IPF weighting methodology) is shown in Figure 5. The differences in the prevalence estimates produced by using these three methods vary by indicator. No or slight differences are seen for certain indicators such as asthma, stroke, coronary heart disease, diabetes and no physical activity, whereas larger differences are seen for certain other indicators such as current cigarette smoking and health insurance.
The results of similar analysis conducted on 2010 Kansas BRFSS data for the examination of current cigarette smoking prevalence are illustrated in Figure 6. An estimate of 17 percent is obtained for the prevalence of current cigarette smoking from the analysis of 2010 Kansas BRFSS landline survey data with the application of post stratification weighting method, whereas an estimate of 22 percent is obtained from the analysis of the same landline telephone survey data with application of the new weighting methodology. The point estimate of 22 percent generated by the application of the new weighting methodology is higher when compared to the point estimate of 17 percent generated by the application of the old weighting methodology. Thus, the difference in these two estimates is due to the application of two different weighting methodologies on the same survey sample. The third estimate of 24.1 percent for the prevalence of current cigarette smoking is obtained from the analysis of combined landline and cellular telephone sample data and application of the new weighting methodology. This estimate is higher than the other two estimates. Thus with use of the dual frame sample and new weighting methodology, the absolute value of the current cigarette smoking prevalence obtained from the same year’s dataset is higher than that obtained from the analysis of the single frame sample regardless of whether the old or the new weighting methodologies are applied.
The comparison of prevalence estimates for selected health indicators from 2010 and 2011 Kansas BRFSS survey\(^5\) is shown in Figure 7. The changes are seen in the 2011 prevalence estimates for some indicators such as fair/poor health, current smoking status, binge drinking and lack of health care coverage; however, the estimates for some indicators such as obesity, diabetes and current asthma do not change much. The impact of the changes in the survey methodology on the prevalence estimates varies for different indicators. A similar pattern is seen on the prevalence estimates of different health indicators at the national level (Figure 5).

Figure 8 demonstrates the comparison of estimates of current cigarette smoking prevalence calculated from 2010 Kansas BRFSS data using a landline telephone survey sample and post-stratification weighting methodology and the 2011 Kansas BRFSS data using a dual frame sample (combined landline and cellular telephone sample) and iterative proportional fitting (raking) weighting methodology. The first estimate of 17 percent for the current cigarette smoking is calculated by using landline telephone survey sample and application of post-stratification weighting method (official 2010 estimate published on Kansas and CDC BRFSS websites). The second estimate of 22 percent for current smoking is calculated from the combined
landline and cellular telephone survey sample and application of the new weighting method. The difference in these two estimates is similar to that seen in the 2010 estimates shown in Figure 6 (first and third estimates). In 2010, the CDC advised to use 10% of total sample for the cellular telephone survey. In 2011, the CDC recommended use of 20 percent of the total combined sample for the cellular telephone survey to get more representative estimates.

Figure 8: 2010 and 2011 Prevalence Estimates of Current Cigarette Smoking in Kansas by Weighting Method and Telephone Sample – Kansas BRFSS

![Figure 8](image)


Figure 9 shows prevalence estimates for current cigarette smoking by year, weighting method and telephone source for the United States during 2000-2010 based on the national data. The preliminary analysis conducted by the CDC using 2007-2010 data showed that the adoption of new weighting methodology shifts the aggregated trend line for current cigarette smoking upward by 2.3-2.8 percentage points for the year 2007-2010. However, the shape and slope of the trend lines does not change. A slightly further upward shift was seen in the absolute estimates by the addition of cell phone households to the aggregated state samples for 2009 and 2010.3

Figure 9: Prevalence Estimates for Current Cigarette Smoking for the United States – BRFSS 2000-2010

![Figure 9](image)


Figure 10 shows the estimates for the prevalence of current cigarette smoking in Kansas during 2000-2010 calculated from the landline telephone survey data with the application of the old weighting methodology.
addition, estimates calculated for 2009 and 2010 using landline telephone surveys for these two years with the application of new weighting methodology and estimates calculated for the 2009, 2010 and 2011 combined landline and cellular telephone surveys (280 complete cellular telephone survey interviews for 2009; 800 complete cellular telephone survey interviews for 2010; and 3,200 complete cellular telephone survey interviews for 2011 surveys) with the application of the new weighting methodology are also shown. The absolute estimates for 2009, 2010 and 2011 are shifted slightly upward, however the shape and slope of the trend lines does not change.

Figure 10: Prevalence Estimates for Current Cigarette Smoking for the Kansas – BRFSS 2000-2011

![Weighted Prevalence Estimates for Current Smokers by Year, Weighting Method, and Telephone Source – Behavioral Risk Factor Surveillance System (BRFSS), KS 2000-2011](image)

Source: Kansas Behavioral Risk Factor Surveillance System, Bureau of Health Promotion, KDHE
Note: Current cigarette smoking estimates for landline survey with application of post-stratification weighting method for 2009 and 2010 were 18% and 17% respectively (blue line); for landline survey with application of raking weighting method for 2009 and 2010 were 23% and 22% respectively (clear circles); and for combined landline and cellular telephone survey (combined samples) with application of raking weighting method for 2009, 2010 and 2011 were 22.5%, 24% and 22% respectively (blue circles).

To account for the changes in population, behaviors, technologies and standards, adjustments in the methodology of the public health surveillance systems are needed. These adjustments are essential for generation of valid and representative estimates of health statistics from these public health surveillance systems. In the past, changes have been made in the methodology of several health surveillance systems. For example, in 2002, changes were made to the methods used by the National Survey on Drug Use and Health by the Substance Abuse and Mental Health Services Administration (SAMSHA) to account for the changes in survey standards. These changes in the methodology of the survey led to changes in the estimates that were not related to changes in real prevalence. In 1999, to stay current with advances in medical science in terms of disease nomenclature and etiology and to ensure the international comparability of health statistics, the Tenth Revision of the International Classification of Diseases (ICD-10) was implemented in the United States on mortality statistics by replacing the Ninth Revision of the ICD (ICD-9) that was used prior to 1999. This switch from ICD-9 to ICD-10 codes resulted in discontinuities in the cause-of-death trends from 1998 through 1999. In 1993, the case definition of Acquired Immune Deficiency Syndrome (AIDS) was expanded beyond the surveillance definition published in 1987. This expansion of the case definition of AIDS resulted in a substantial increase in the number of reported AIDS cases. The increase in number of AIDS cases
reported in the first quarter of 1993 reflected the changes in surveillance procedures associated with implementation of the 1993 expanded case definition.\(^8\) Thus, when changes are made in the methods of a health surveillance system, adjustments must be made to address the discontinuities in the resulting incidence, prevalence or mortality statistics caused by the incorporation of changes in surveillance methods that are not related to actual changes in the disease morbidity and mortality. In addition, changes are seen in trend lines of the health indicators produced by examining the data over several years. Thus, discontinuities in the trend lines for the indicators occur along with difficulty in interpreting long-term trends.

To account for the changes in the use of different sources of telephone service in the general population as well as in certain socio-demographic subgroups and to maintain the representativeness, coverage and validity of data, the CDC has made the adjustments in the 2011 BRFSS survey methodology. Due to these changes in the 2011 BRFSS survey methodology, comparisons cannot be made between the prevalence estimates of the health indicators generated for the previous years and those generated for 2011 and beyond. The shifts in 2011 BRFSS estimates as compared to the estimates from previous years have occurred due to implementation of new survey methods, rather than changes in the actual prevalence of the diseases or risk factors in the population.\(^3\) Trends cannot be compared and interpreted using data generated from two different methodologies.\(^2\) The changes in the 2011 data are likely to show indications of somewhat higher occurrence of risk behaviors that are common to younger adults and to certain racial or ethnic minority groups. The size and direction of the effect of the new methodology on the prevalence estimates varies by health indicators.\(^3\) The CDC has recommended to not compare 2011 BRFSS estimates with 2010 estimates (officially published) as the difference in sampling frame and weighting methodology renders them incomparable.

The Kansas BRFSS Program has followed the CDC guidelines to remain in alignment with the CDC BRFSS program and with other states. The program has implemented the new survey methodology including use of dual frame sampling methodology (landline plus cellular telephone) and iterative proportional fitting (raking) weighting method starting in 2011. The implementation of these methodologic changes has impacted prevalence estimates of the public health indicators generated from 2011 survey. Differences in prevalence estimates of certain indicators compared to Kansas BRFSS surveys conducted in 2010 and preceding years are observed. As the change in methodology has allowed adjustment for changes seen in the use of telecommunication technology in Kansas, the prevalence estimates generated by the 2011 Kansas BRFSS are highly representative of the Kansas adult population (non-institutionalized adults 18 years and older living in private residence with landline and/or cell phone service). The 2011 Kansas BRFSS survey prevalence estimates of the health indicators cannot be compared with the estimates from BRFSS surveys conducted in 2010 and preceding years because any observed difference is not real. There is no actual change in health indicator prevalence in the general population. The observed difference is artifactual, which is an artificial change due to change in survey methodology (adding cellular telephone only service households and changing weighting methods). A break in the trend lines of these estimates will occur between 2010 and 2011. The 2011 BRFSS estimates will constitute the new baseline going forward to assess and monitor population based health indicator trends from 2011 onwards.

References:


