

Changing BRFSS Protocols: Transition to Raking Weights and Incorporation of Cell Phone Sampling

Introduction:

Weighting techniques allow survey samples to be adjusted statistically so groups that are under- or over-represented in the sample more accurately represent the population. Sophisticated weighting methods of large datasets, now possible with improved technology, allow the incorporation of cell phone users into telephone sampling strategies.^{1,2} BRFSS data weighting processes will change from post-stratification to raking (or iterative proportional fitting) when the 2011 datasets are released in the spring of 2012.³

In addition, as cell phone use continues to increase, telephone surveys can no longer exclude cell phones users and hope to remain unbiased.⁴ Starting with 2011 data collection, BRFSS sampling protocols stipulate that at least 20% of the total number of completed interviews be collected from people who use their cell phones for at least 90% of their calls.⁵ However, these changes to the sampling and weighting strategies may change the prevalence estimates produced by BRFSS data.

Objective:

To begin to understand the impact of these changes, this report examines the differences in prevalence estimates that result from the old post-stratification and landline-only telephone data with the new raking weights and inclusion of cell phone samples for the 2009 and 2010 Montana BRFSS data.

Changing Methods:

Since the inception of BRFSS in 1984, the data have been weighted, first based on the probability of selection, and second based on post-stratification weight adjustment for each respondent. Post-stratification weighting forces the proportion of a given demographic subgroup in the sample to match the proportion of that subgroup in the population. For example, if females 18 to 24 years of age represent 5% of a survey sample, but U.S. Census Bureau population estimates indicate that 10% of the total population consists of females 18 to 24 years of age, then each female respondent

from that age group would be given a higher weight in the sample data to account for the difference. The assigned weight for each respondent in the dataset indicates how much each respondent will count in statistical procedures. In unweighted datasets, each respondent represents one person in the population. In weighted datasets, one respondent may represent 200 individuals, another may represent 50 individuals, and so on. Between 2003 and 2010, Montana used sex, age, and region in post-stratification procedures.

All 2011 BRFSS datasets will be weighted using raking procedures. Rather than adjust the survey population to match the overall population on only three demographic variables, raking weights will use the following eight demographic dimensions, some of which are the intersection of two demographic subgroups:

- age group by gender
- detailed race/ethnicity
- educational level
- marital status
- home owner or renter status
- gender by race/ethnicity
- age group by race/ethnicity
- telephone source (landline telephone only, both landline and cell phone, or cell phone only)

For those states that use regional weighting, such as Montana's five health-planning regions, the raking procedures include additional raking dimensions:

- region
- region by age group
- region by gender
- region by race/ethnicity

Raking adjusts for one demographic dimension at a time. For example, when weighting by age group and educational level, weights would first be adjusted for age groups alone, then those estimates would be readjusted for educational

groups. After adjusting for education the previously adjusted age groups may no longer match the population so further iterations may be needed. These iterations continue until the proportions of all the stated dimensions in the sample approach those of the population within the preset tolerance level of 0.025 percentage points, or after 75 iterations, whichever comes first.⁶

The 2009 and 2010 prevalence estimates released to date by Montana BRFSS and CDC have been derived from the old weighting method and landline-only samples. As the proportion of adults who use cell phones as their only telephone service increased, states began including cell phone interviews in 2009 (10% of complete interviews) and con-

tinued this sampling in 2010 (20% of complete interviews), in order to study the effects of these changes. This past year, CDC provided datasets to states that combined the cell phone data with the landline data for these two years and calculated additional weights using the raking methodology. The 2009 Montana sample included 407 completed cell phone interviews and 7,618 completed landline interviews, for a total sample size of 8,025. The 2010 Montana sample included 887 completed cell phone interviews and 7,304 completed landline interviews, for a total sample size of 8,191. The new 2009 and 2010 datasets allow states to explore further the differences in prevalence estimates that may occur because of the new protocol prior to the release of the 2011 dataset.

Table 1: Prevalence Estimates of Health-related Risks, Montana Adults 2009 and 2010

	Post-stratification Weights Landline Only				New Raking Weights Cell Phone & Landline			
	Wt.%	95% CI		UnWt. N	Wt.%	95% CI		UnWt. N
		LL	UL			LL	UL	
High Risk Behavior for HIV* (adults 18-64)								
2009 Survey	3.0	2.2	4.1	95	3.3	2.5	4.3	107
2010 Survey	2.6	1.6	4.2	77	3.1	2.4	3.9	114
No Leisure Time Physical Activity:								
2009 Survey	22.0	20.7	23.4	1,999	22.4	21.1	23.7	2,076
2010 Survey	21.6	20.2	23.1	1,916	22.7	21.4	24.0	2,093
Overweight (25 ≤ BMI < 30)								
2009 Survey	38.4	36.7	40.1	2,894	38.8	37.1	40.4	3,042
2010 Survey	37.8	35.9	39.7	2,721	38.5	37.0	40.1	3,054
Obese (BMI ≥ 30)								
2009 Survey	23.7	22.4	25.2	1,869	24.1	22.7	25.6	1,964
2010 Survey	23.5	22.0	25.1	1,825	23.8	22.5	25.1	2,017
Current Cigarette Smoker								
2009 Survey	16.8	15.5	18.2	1,268	19.1	17.7	20.5	1,357
2010 Survey	18.8	17.1	20.6	1,274	21.2	19.9	22.5	1,509
Current Smokeless Tobacco Use								
2009 Survey	7.4	6.4	8.5	446	7.8	6.8	8.9	476
2010 Survey	6.5	5.6	7.5	391	7.0	6.2	7.8	462
Binge Drinking (past 30 days)**								
2009 Survey	17.3	15.9	18.8	1,037	19.9	18.5	21.5	1,150
2010 Survey	17.0	15.4	18.6	956	19.6	18.3	20.9	1,197
Heavy Drinking (past 30 days)†								
2009 Survey	5.4	4.8	6.2	429	6.7	5.8	7.7	462
2010 Survey	5.3	4.6	6.1	395	6.3	5.6	7.1	473
Drinking and Driving (past 30 days)								
2010 Survey	4.8	3.8	6.0	170	5.8	4.9	6.9	211
Do Not Always Wear Seat Belt								
2010 Survey	28.3	26.5	30.2	2,050	30.3	28.8	31.8	2,327

* One or more of the behaviors: Used intravenous drugs, been treated for a sexually transmitted disease, given or received money or drugs for sex, or had anal sex without a condom.

** 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, Montana Adults 2009 and 2010

	Post-stratification Weights Landline Only				New Raking Weights Cell Phone & Landline			
	95% CI				95% CI			
	Wt.%	LL	UL	UnWt. N	Wt.%	LL	UL	UnWt. N
Ever Told by a Health Care Provider that You Have:								
Current Asthma								
2009 Survey	8.1	7.3	9.1	667	8.5	7.6	9.5	698
2010 Survey	9.1	8.0	10.3	657	9.7	8.8	10.7	751
Arthritis								
2009 Survey	27.5	26.2	28.8	2,792	28.3	27.0	29.7	2,879
High Blood Pressure								
2009 Survey	27.7	26.4	29.1	2,761	28.1	26.7	29.4	2,845
High Cholesterol								
2009 Survey	36.5	34.9	38.2	2,681	35.9	34.3	37.5	2,752
Any Cardiovascular Disease*								
2009 Survey	7.5	6.8	8.2	823	7.6	6.9	8.4	833
2010 Survey	8.2	7.4	9.0	861	8.7	7.9	9.5	913
Diabetes								
2009 Survey	6.8	6.2	7.4	746	7.0	6.3	7.7	768
2010 Survey	7.0	6.2	7.9	732	7.2	6.5	7.9	780

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

Table 3: Prevalence Estimates of Health Status, Access to Health Care, and Screening Tests, Montana Adults 2009 and 2010

	Post-stratification Weights Landline Only				New Raking Weights Cell Phone & Landline			
	95% CI				95% CI			
	Wt.%	LL	UL	UnWt. N	Wt.%	LL	UL	UnWt. N
Fair or Poor General Health								
2009 Survey	14.5	13.3	15.8	1,365	15.7	14.5	17.0	1,419
2010 Survey	15.0	13.7	16.4	1,356	15.8	14.8	17.0	1,484
Self-Reported Disability								
2009 Survey	22.1	20.8	23.4	2,083	23.8	22.4	25.2	2,174
2010 Survey	26.0	24.4	27.7	2,264	26.7	25.4	28.1	2,474
No Health Care Coverage (adults 18-64)								
2009 Survey	21.3	19.5	23.3	969	24.0	22.2	25.8	1,078
2010 Survey	22.6	20.4	24.9	962	25.4	23.8	27.2	1,216
Could Not Afford to See Dr.								
2009 Survey	13.5	12.3	14.8	933	16.2	14.9	17.7	1,022
2010 Survey	13.4	11.9	15.0	833	14.8	13.6	16.0	996
No Personal Doctor								
2009 Survey	25.3	23.6	27.1	1,411	28.0	26.4	29.7	1,577
2010 Survey	26.2	24.3	28.2	1,365	28.7	27.2	30.2	1,717
No Routine Check-up in Past Year								
2009 Survey	42.3	40.5	44.1	2,826	44.0	42.3	45.7	3,044
2010 Survey	44.3	42.3	46.3	2,775	44.9	43.3	46.5	3,229
Ever Been Tested for HIV (adults 18-64)								
2009 Survey	34.4	32.4	36.4	1,556	36.2	34.2	38.2	1,699
2010 Survey	34.4	32.0	36.8	1,467	35.5	33.8	37.4	1,781
Had Cholesterol Check								
2009 Survey	72.0	70.1	73.8	5,999	70.8	69.1	72.5	6,242
Had Mammogram in Past 2 years (women 40+)								
2010 Survey	67.4	65.3	69.4	2,337	66.3	64.1	68.4	2,446
Had Pap Test in Past 3 years (women 18+)								
2010 Survey	78.3	75.6	80.7	2,107	77.4	75.1	79.5	2,366
Had FOBT* in Past 2 years (adults 50+)								
2010 Survey	14.6	13.4	15.9	763	14.7	13.5	16.1	799
Had Sigmoidoscopy/Colonoscopy (adults 50+)								
2010 Survey	61.0	59.2	62.7	3,025	60.1	58.2	61.9	3,162

* Fecal Occult Blood Test, also called a Blood Stool Test. A test used for colorectal cancer screening.

Results:

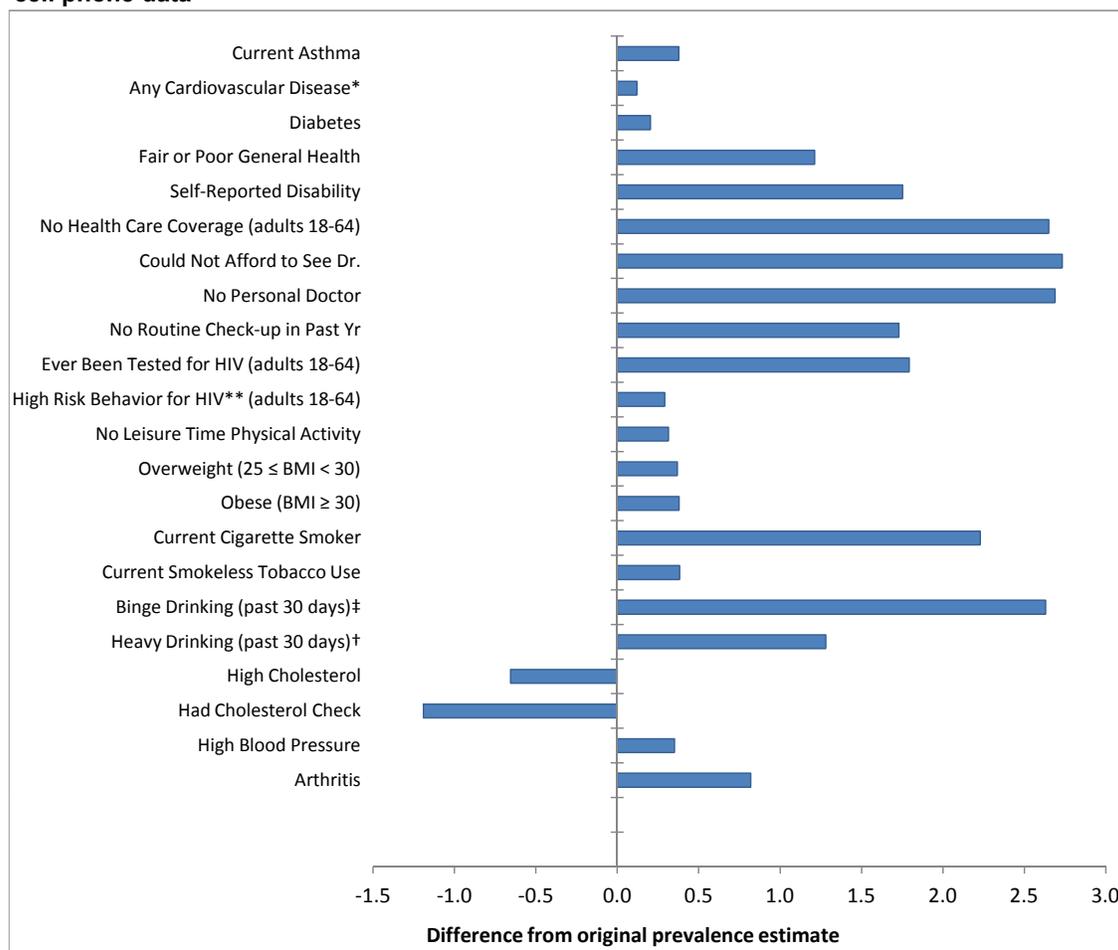
The Montana 2009 and 2010 prevalence estimates have been calculated using both the old and new weighting procedures. Tables 1 through 3 present selected BRFSS estimates that use post-stratification weights with landline data only (Post-stratification Weights of Landline Only) and raking weights with both landline and cell phone data (New Raking Weights Cell Phone & Landline combined). Comparing prevalence estimates in each year using the old and new methodologies allows for an initial assessment of the direction and the magnitude of the changes that can be expected as BRFSS transitions to new weighting and data collection methods in the 2011 survey.

All Montana prevalence estimates calculated with the raking methodology using landline and cell phone data were

less than three percentage points different from estimates using the post-stratification weights for the landline-only samples. Among the 22 measures evaluated for the 2009 survey, nine differed by less than one-half of one percentage point, 11 differed by less than one percentage point, and five differed by more than two but less than three percentage points (Figure 1). Among the 24 measures evaluated for the 2010 survey, three prevalence estimates differed by less than one-half of one percentage point, 14 differed by less than one percentage point, and four differed by more than two but less than three percentage points (Figure 2). The largest changes for both survey years were in the prevalence estimations of binge drinking, current cigarette smoking, having no personal healthcare provider, and lacking health care coverage.

Including cell phone users in the Montana BRFSS sample

Figure 1: 2009 Montana BRFSS -- Changes in prevalence estimates using raking weights and cell phone data



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

** One or more of the behaviors: Used intravenous drugs, been treated for a sexually transmitted disease, given or received money or drugs for sex, or had anal sex without a condom.

‡ 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.

changed the demographic distribution of the sample. In both the 2009 and 2010 surveys, the inclusion of cell phones resulted in a sample that had a greater proportion of adults less than 35 years of age compared to the sample of only landline telephones. Despite this difference, prevalence estimates are similar between the two datasets.

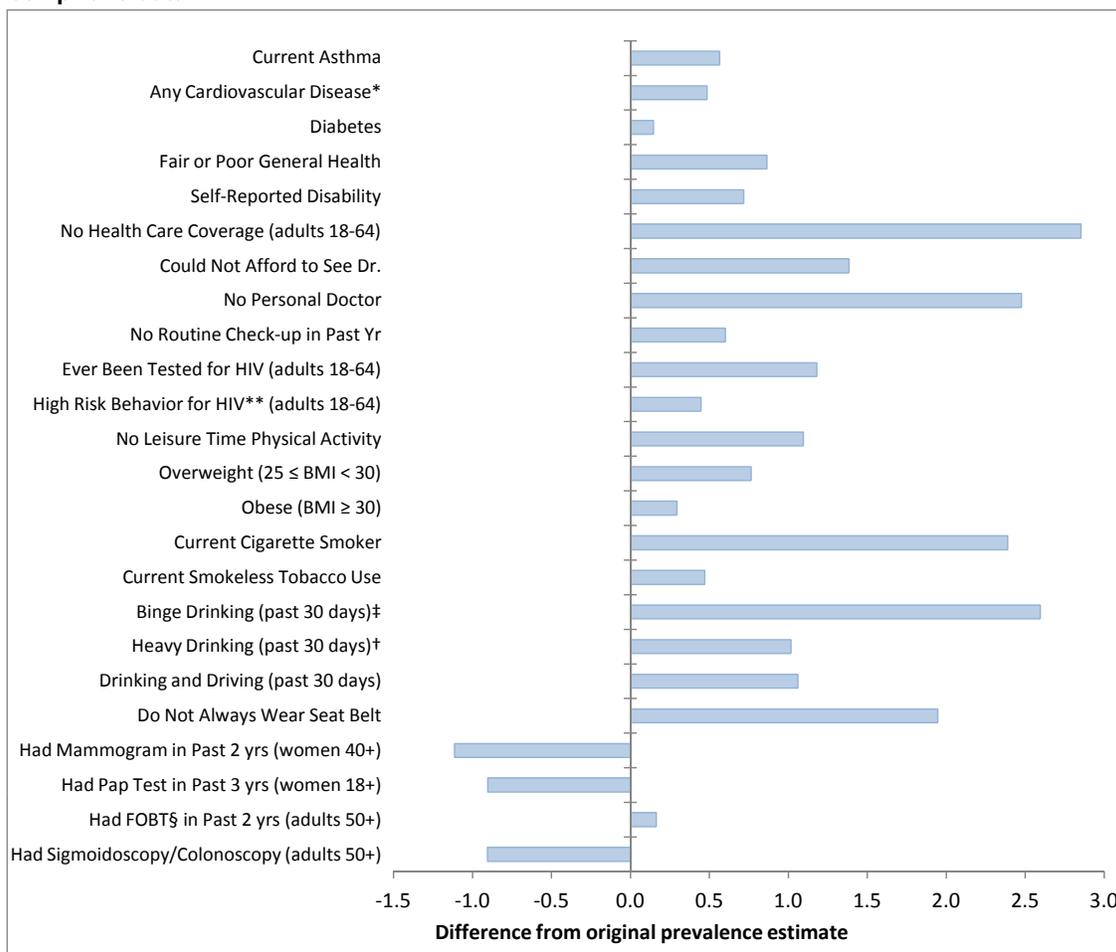
Conclusions and Recommendations:

With the release of the 2011 datasets, CDC and all BRFSS states will provide only prevalence estimates using landline and cell phone combined samples and weighting variables based on the expanded sociodemographic raking methodology. Adoption of the new raking weighting methods will improve the quality of BRFSS data in two ways. First, the sample will be adjusted to match the population based on a wider range of demographic characteristics. Second, rak-

ing methods allow for the inclusion of cell phone users. In the past, adults who used cell phones only were excluded from BRFSS samples due to the inability to provide accurate weights to both landline and cell phone users. The methodological changes of controlling more factors through the raking processes and including cell phone users in the sampling frame will improve the accuracy of BRFSS through better representation of the non-institutionalized adult population.

Some differences in prevalence estimates, however minimal, are to be expected when data from cell phone users and raking procedures are used. Public health prevention programs, policy makers, and other BRFSS data users will need to evaluate whether the differences in prevalence estimates between years that use the old versus new methodologies represent meaningful differences for their

Figure 2: 2010 Montana BRFSS -- Changes in prevalence estimates using raking weights and cell phone data



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

** One or more of the behaviors: Used intravenous drugs, been treated for a sexually transmitted disease, given or received money or drugs for sex, or had anal sex without a condom.

‡ Consuming five or more alcoholic drinks for men or four or more drinks for women on one occasion in past 30 days.

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§ Fecal Occult Blood Test, also called a Blood Stool Test. A test used for colorectal cancer screening.

program efforts. To evaluate the differences in prevalence estimates over time, data users will have access to the newly released 2009 and 2010 datasets, which include cell phone data and raking weights. The true differences in measures over time are not discernible if comparisons are made between prevalence estimates calculated with post-stratification weights and estimates calculated with raking weights and cell phone users' data. Therefore, time trend graphs of BRFSS data will need to show a break in the trend line between years that use cell phone samples with raking weights and prior years that do not incorporate these strategies. CDC and states will continue to monitor the impact of the methodological changes to BRFSS and help to explain the changes to policymakers.

Background:

The Montana Behavioral Risk Factor Surveillance System (BRFSS) has been collecting and reporting state-specific, population-based estimates of health-related data since 1984. The purpose of this statewide telephone survey of Montana residents aged 18 and older is to gather information regarding personal health risk behaviors, selected medical conditions, and the prevalence of preventive health care practices among Montana adults. A full set of Montana yearly questionnaires and health indicators can be found on the Department of Public Health and Human Services (DPHHS) BRFSS database query system website at: www.brfss.mt.gov. The CDC website also provides national, state, and some local area prevalence estimates of health indicators, as well as access to downloadable datasets for further analyses at: www.cdc.gov/brfss.

Survey Limitations:

The BRFSS relies on self-reported data. This type of survey has certain limitations: many times, respondents have the tendency to underreport some behaviors that may be considered socially unacceptable (e.g., smoking, heavy alcohol use); conversely, respondents may over report behaviors that are desirable (e.g., physical activity, nutrition). Cross-sectional design makes causal conclusions impossible. In addition, the sample sizes used to calculate the estimates in this report vary as respondents who indicated, "don't know," "not sure," or "refused" were excluded from most of the calculation of prevalence estimates. BRFSS data collected through 2008 excludes households without landline telephones.

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Endnotes:

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