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Using American Community Survey Disability Data to Improve the Behavioral Risk Factor Surveillance System Accuracy

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Starting in 2013, the Behavioral Risk Factor Surveillance System (BRFSS) included five of the six disability questions that are now common across national surveys including the American Community Survey (ACS). The common disability questions will potentially facilitate new disability research; however, the BRFSS disability prevalence estimates based on the new disability questions are substantially higher than the ACS-based estimates. We assessed possible explanations for the differences. We find that BRFSS sampling and nonresponse bias is the most likely explanation for the differences between the ACS and BRFSS estimates.

To reduce the BRFSS sampling and nonresponse bias associated with the disability questions and to increase the accuracy of disability prevalence estimates, we re-weight the Massachusetts BRFSS data. We find that the re-weighting methodology is a viable alternative to the current BRFSS weighting methodology.

Importantly, the re-weighing changes BRFSS population and subpopulation estimates compared to estimates based on the original weights, for example population estimates for the prevalence of diabetes, asthma, and smoking are lower with the re-weighted data. This is expected because the re-weighting decreased the disability prevalence estimates and persons with disabilities, on average, have a higher prevalence of diabetes, asthma and smoking compared to persons without disabilities.

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Introduction

The Behavioral Risk Factor Surveillance System (BRFSS) is a public health survey that collects data on U.S. adults' risk behaviors and health practices that can affect their health status. Starting in 2013, the BRFSS added five of the six disability questions that are now common across a number of national surveys including the American Community Survey (ACS). The addition of the common disability questions to the BRFSS will facilitate new research and new national, state, and sub-state estimates of the risk behaviors and health practices of persons with disabilities. However, the 2013 BRFSS disability prevalence estimates based on the new disability questions create uncertainty about the accuracy of the BRFSS. The BRFSS estimates are unexpectedly very different than the ACS-based estimates. Among persons 18 to 74, the BRFSS national disability prevalence estimate is 21% compared to the ACS estimate of 11%.[1] Among persons 75 and older, the BRFSS estimate is 42% and the ACS estimate is 43%. The reasons for the differences among the 18 to 74 age group are not known.

In this report, we describe the differences between the ACS and BRFSS estimates and assess possible explanations. Our assessment is not conclusive; however, our findings suggest that BRFSS sampling and nonresponse bias is the most likely explanation. We re-weight the BRFSS data to reduce the BRFSS sampling and nonresponse bias and assess the effect of the re-weighting on estimates of disability prevalence and other population and subpopulation characteristics. We demonstrate that re-weighting is a viable method to reduce sampling and nonresponse bias associated with disability.

BRFSS background

The BRFSS is a telephone survey conducted annually by individual states in collaboration with the Centers for Disease Control and Prevention (CDC). The administration of the state surveys is managed by state health departments following CDC guidelines that specify the sampling methodology, data collection and management procedures, quality assurance, weighting methodology, and standard survey content.

The BRFSS uses a disproportionate stratified sample that represents adults, 18 years of age or older, living in households within states. A random digit dialing (RDD) method, including both landline and cell phone numbers, is used to select the sample. States may define sub-regions (strata) within their states and disproportionately sample from these regions to ensure that smaller geographic regions are adequately represented. The BRFSS data are weighted to ensure the data are representative of the population of each state. The weighting method reduces non-response bias and allows for the incorporation of cell phone survey data. The median BRFSS state response rate in 2013 was 45.9% with a range of range of 29.0% to 59.2%.[2]

[1] The ACS estimates do not include individuals living in institutional group quarters.

[2] Courtney-Long, E. A., Carroll, D. D., Zhang, Q. C., Stevens, A. C., Griffin-Blake, S., Armour, B. S., & Campbell, V. A. (2015). Prevalence of disability and disability type among adults – United States. *Centers for Disease Control and Prevention MMWR.* 64(29), 776-783.

In 2013, five of the six disability questions developed by the U.S. Census Bureau for use in the American Community Survey were added to the BRFSS. The five questions are the following:

- Are you blind or do you have serious difficulty seeing, even when wearing glasses?
- Because of a physical, mental, or emotional condition, do you have serious difficulty concentrating, remembering or making decisions?
- Do you have serious difficulty walking or climbing stairs?
- Do you have difficulty dressing or bathing?
- Because of a physical, mental, or emotional condition, do you have difficulty doing errands alone such as visiting doctor's office or shopping?

ACS background

The ACS is a census survey collecting housing and population data and is conducted annually U.S. Census Bureau. The ACS uses an address-based sample drawn from the Census Bureau's inventory of known living quarters and selected nonresidential units in the U.S. and Puerto Rico. Approximately 3.5 million housing units are selected each year. The ACS is a mixed mode survey with four modes of data collection: internet, mail, telephone and personal visit.

The ACS data are weighted to ensure the data are representative of the full population, compensating for differences "in sampling rates across areas, differences between the fill sample and the interviewed sample, and differences between the sample and independent estimates of basic demographic characteristics."[3] The 2013 ACS response rate (housing unit) was 89.9%.

Comparison of ACS and BRFSS estimates for disability statistics

In this section we compare national (50 states and the District of Columbia) disability prevalence estimates based on the 2013 BRFSS and 2013 ACS and assess possible explanations for the differences. We do not estimate statistics for persons with hearing difficulties because the ACS hearing difficulty question is not included in the BRFSS. We consider a person to be disabled if she answers 'yes' to any of the five disability questions. We do not include ACS respondents who are living in institutional group quarters because these individuals are not covered in the BRFSS sample.

Figure 1 compares the BRFSS and ACS estimates for disability prevalence over the life course. With the exception of the age 80 or older age group, the BRFSS estimates are higher compared to the ACS. The BRFSS and ACS estimates both indicate an increase in prevalence with increasing age; however, the rate of increase is greater among individuals age 65 and older in the ACS. This pattern is consistent across disability types (See Appendix Table 1) and particularly evident for the life course prevalence of persons reporting serious difficulty concentrating, remembering, or making decisions (see Figure 2).

[3] ACS Design and Methodology (January 2104), page 135.

Figure 1. 2013 ACS and BRFSS disability prevalence estimates by age group

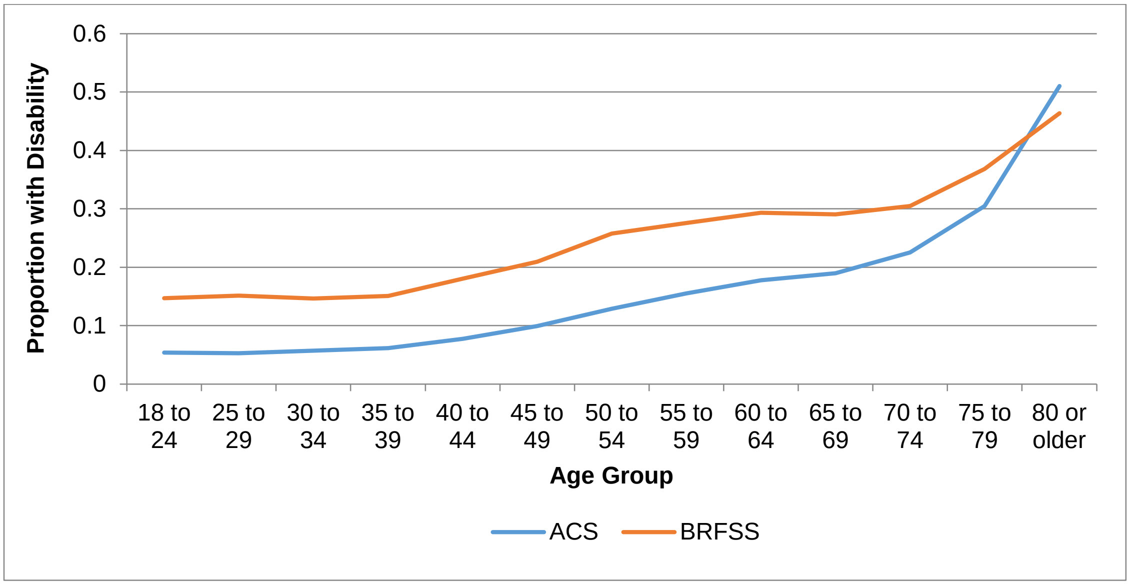
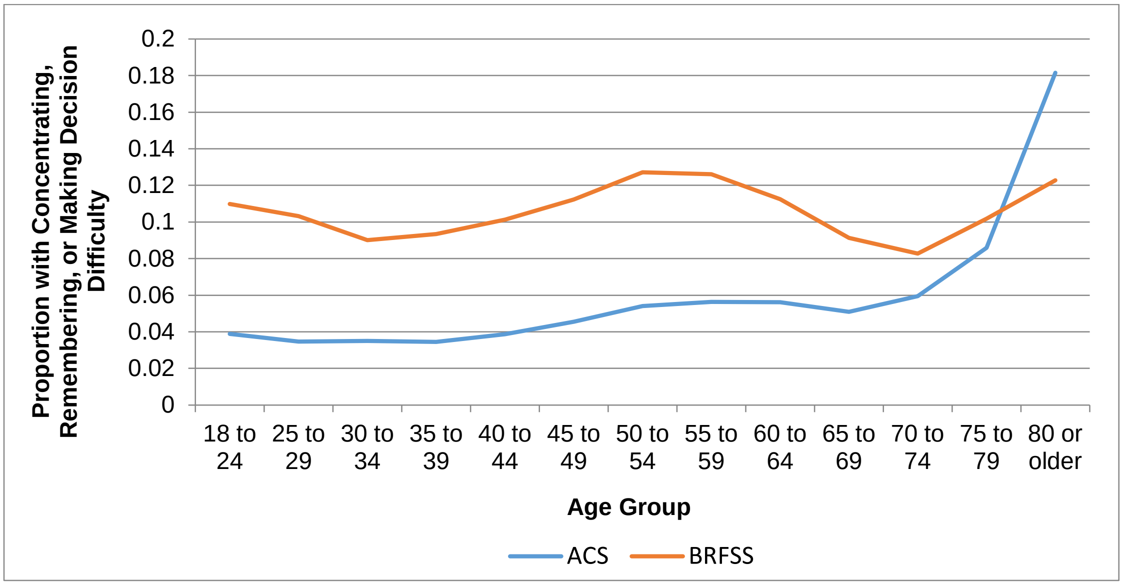


Figure 2. 2013 ACS and BRFSS estimates of prevalence of serious difficulty concentrating, remembering or making decisions by age group



The reasons for the differences between the BRFSS and ACS disability prevalence estimates are not known. There are three potential reasons: (a) differences between ACS and BRFSS sampling bias, (b) differences in nonresponse bias, and (c) differences in response bias.

Sampling and Nonresponse Bias

The BRFSS is vulnerable to sampling bias because there is some non-coverage in all RDD samples; some individuals are not included in the population of phone numbers. The growth in phone number portability, internet-based phone services, and cell phones has exacerbated the coverage problems. In comparison, the ACS uses an address-based sample drawn from the Master Address File (MAF), the Census Bureau's official inventory of known living quarters and selected nonresidential units used for the decennial census. The MAF is continually updated using data from the U.S. Postal Service and other operational sources. MAF inaccuracies may also result in sampling bias. We are not aware of any studies that estimate sampling bias in the BRFSS or ACS; however, the differences in sampling strategies between the BRFSS and ACS may result in differences in sampling bias.

The BRFSS is also vulnerable to nonresponse bias because of its relatively low response rates, ranging from 29.0% to 59.2% across states. The ACS response rates are much higher and therefore, the ACS is much less vulnerable to non-response bias. Completion of the ACS is mandated by law and the ACS response rate is approximately 89.9%.

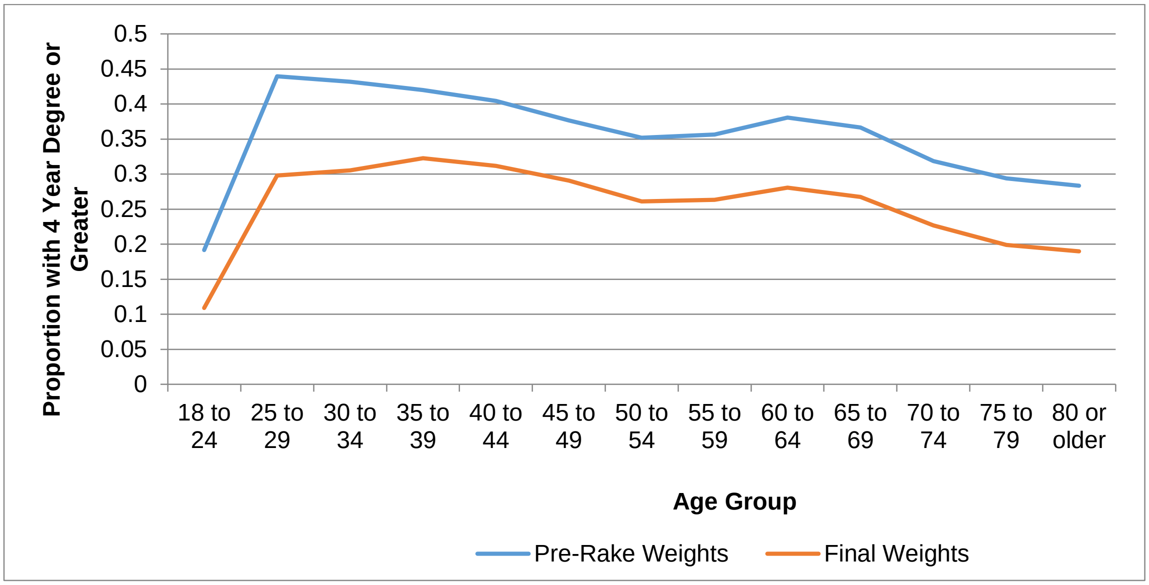
The BRFSS vulnerabilities to sampling and nonresponse bias are known and the BRFSS weighting methodology was designed to reduce the vulnerabilities. A key component of the BRFSS weighting methodology is a weight adjustment technique, iterative proportional fitting (raking). Raking adjusts the preliminary survey weights (pre-raking weights) to create *final weights* whereby the final weighted distributions of selected variables (e.g. age, gender, and race) match known distributions. The known distributions are selected from sources that are considered to be more accurate than the BRFSS, for example U.S. Census information.[4] We refer to variables used in the raking process as the 'raking dimensions.' The BRFSS raking dimensions are the following: location, location by sex, location by age, location by race, phone type, age by race, sex by race, home ownership status, marital status, education level, race, and sex by age. Disability is not a raking dimension.

Raking reduces sampling and nonresponse bias of population and subpopulation estimates within the raking dimensions. We observe this in the BRFSS data. For example, we illustrate the reduction in sampling and nonresponse bias in the BRFSS education estimates by comparing education level estimates based on the pre-raking weights with estimates based on the final weights. Figure 3 shows the BRFSS life course estimates for the proportion of persons with a 4-year college degree or higher based on the BRFSS pre-raking weights and the estimates based on the final weights. The raking process adjusts the BRFSS weights so that the BRFSS estimates match the U.S Census information. Raking decreased the estimated percentage of persons with a college education for all age groups; the decrease ranges from 43% for the 18 to 24 age group to 23% for the 40 to 44 age group. Sampling and response bias accounts for these decreases and the magnitude of decreases indicate that there was substantial BRFSS sampling and nonresponse bias prior to the raking adjustments. Based on the changes in educational levels associated with raking, it is evident that those individuals with a 4-year degree or higher are more likely be

[4] Pierannunzi, C., Town, M., Garvin, W., Shaw, F. E., & Balluz, L., (2012). Methodologic Changes in the Behavioral Risk Factor Surveillance System in 2011 and Potential Effects on Prevalence Estimates. *Center for Disease Control MMWR*, 61 (22). 410-413.

sampled and respond to the BRFSS compared to individuals with less education. We do not know the mechanisms causing this. We are not able to separately estimate sampling bias and nonresponse bias. In the remainder of the paper we refer to the combined bias.

Figure 3. Comparison of BRFSS estimates for proportion with 4 year degree or greater, pre- and post-raking

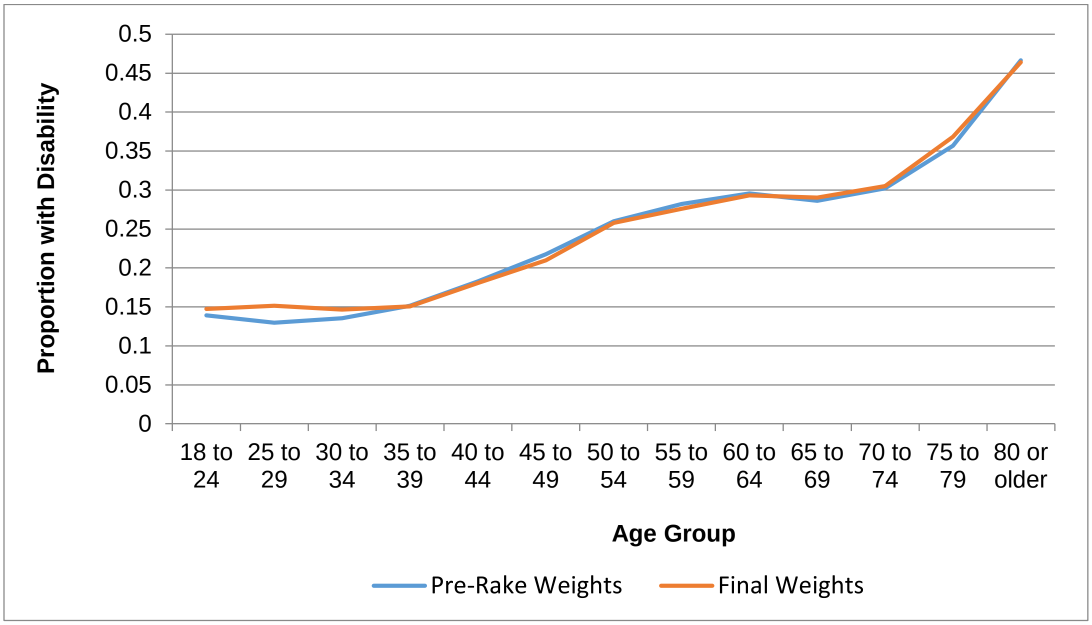


Is it plausible that the difference between ACS and BRFSS disability prevalence estimates could be caused by sampling and nonresponse bias? Given that there is a mechanism that causes substantial sampling and nonresponse bias in education estimates it is plausible that there may also be a mechanism, albeit not the same mechanism, that causes substantial bias in disability. The magnitude of the difference between education estimates based on pre-raking weights and final weights is comparable to the magnitude of the difference between the ACS and BRFSS estimates in disability (See Figure 1 and 3). This suggest that if the level of sampling and nonresponse bias is associated with disability is comparable with the level of bias associated with education, the magnitudes of the differences in ACS and BRFSS disability prevalence estimates are consistent with a sampling and nonresponse explanation.

Another indication of the magnitude of the BRFSS sampling and nonresponse bias is provided by a one-to-one comparison of pre-raking weights to final weights. The correlation between the pre-raking weights and the final weights is 0.75 indicating that only 56 percent of the variation in the final weights can be explained by the variation in the pre-raking weights. Thus, approximately 44 percent of the variation in the final weights is explained by the raking process, the adjustments to the pre-raking weights to accommodate for sampling and nonresponse bias. This indicates that the BRFSS sampling and nonresponse bias associated with the raking dimensions is substantial.

Does the raking adjustment also reduce sampling and nonresponse bias associated with disability? Analysis of the BRFSS data indicates that it does not. Figure 4 shows the BRFSS life course estimates for disability prevalence estimated with the pre-raking weights and the final weights. There is no apparent difference between the disability prevalence estimates. Thus, if there is substantial sampling and non-response bias associated with disability, the raking process does not reduce it.

Figure 4: Comparison of BRFSS disability prevalence, pre- and post-raking



Response bias

Response bias is the second potential explanation for the disability prevalence differences between the ACS and BRFSS. Even though the common disability questions are used in the BRFSS and ACS, difference in response bias is possible. The surveys have differences in survey content and survey administration and this may result in response bias differences. For example, response bias will occur if some people fail to report their disability because of perceived negative consequences. Perceived negative consequences could include discrimination, loss of employment, or loss public benefits. This response bias likely exists in both the ACS and BRFSS. However, response bias by itself is not an explanation for the difference between ACS and BRFSS disability prevalence estimates. It would be necessary for the levels of response bias to be different in the ACS and BRFSS in order to account for the differences in disability prevalence estimates.

There are reasons to believe that the response bias may be less in the BRFSS compared to the ACS. The BRFSS is a public health survey administered by state public health departments containing questions on health and health risk behaviors. The ACS is a census survey administered by the federal government containing questions on household characteristics, including employment and income. These differences in survey content and administration could result in differences in response bias. People may believe that there is less risk to disclosing disability on a public health survey administered by health departments compared to a census survey administered by the federal government, there would be less response bias in the BRFSS. If this is the case, we would expect higher disability prevalence in the BRFSS and we observe this in the disability prevalence estimates (see Figure 1).

Is it plausible that differences in response bias account could account for the difference in disability prevalence between the ACS and BRFSS? We do not have the data needed to determine this with certainty. It is evident however, that the response bias differences would need to be large. The BRFSS disability prevalence estimate among working-age individuals is approximately double the ACS estimate. For differences in response bias to account for this, approximately half of the individuals that report disability in the BRFSS would need to fail to report disability in the ACS for response bias reasons. The differences in BRFSS and ACS survey content and survey administration we discussed above appear to be relatively minor and unlikely to result in the level of response bias differences necessary to account for such large differences in disability prevalence. However, there may be factors we have not considered and we cannot rule out the possibility.

Assessment of Explanations Summary

In summary, there are three possible explanations for the differences ACS and BRFSS disability prevalence estimates, differences in sampling bias, nonresponse bias and response bias. We combine the sampling bias and nonresponse bias reasons together because we could not assess them separately. We do not have data to conclusively determine the explanation; however, we posit that the BRFSS sampling and nonresponse bias is the most likely explanation. There are three reasons. The first is the large BRFSS sampling and nonresponse bias observed in the BRFSS in the raking dimensions. With such large observed bias, it is plausible that comparable bias could also be associated with disability. The magnitude of the sampling and nonresponse bias in the BRFSS, as indicated by bias in education level estimates, are comparable in magnitude to the differences between the ACS and BRFSS disability prevalence estimates. Thus, it is plausible that sampling and nonresponse bias could account for differences in disability prevalence. Second, the raking process does not change BRFSS disability prevalence estimates, indicating that raking process does reduce sample and non-response bias in disability if existent. Finally, the differences in BRFSS and ACS survey content and survey administration that could affect response bias appear to be relatively minor and are unlikely to account for the large differences in disability prevalence.

Replication of Weighting Methodology

In the remainder of the report, we assume that BRFSS sampling and nonresponse bias associated with disability status is the reason for the difference in disability prevalence between the ACS and BRFSS. We illustrate a re-weighing process to reduce the sampling and nonresponse bias. We begin in this section by re-weighting the BRFSS data, without taking disability into account, to demonstrate that we are able to replicate the BRFSS weighting methodology. In the next section, we re-weight the data taking disability into account. We choose a single state, Massachusetts, to simplify our re-weighting process. We do not expect the results to be different for other states; however, this should be confirmed.

Because of limitations in the publicly available data, we are not able to fully replicate the BRFSS weighting methodology; however, our results indicate that the replication is sufficient for our purposes. The BRFSS raking is conducted on up-to 16 dimensions, including county and region. The county data are not included in the publicly available dataset and we do not include this dimension in our raking.[5] We refer to the weights created in our replication process as the "validation weights" and the original BRFSS weights at the "original weights." We compare the validation weights to the original weights using a variety of summary statistics. First, we compare original weight and validation weight univariate statistics. Second, we use regression to determine the association between the original weights and the validation weights. Third, we compare statewide BRFSS estimates generated with original and validation weights. Finally, we compare subpopulation BRFSS estimates generated with original and validation weights. To do this, we compare estimates for the cells of a seven-dimension table. The cells are defined by the following: age, sex, race, marital status, education, home ownership and phone types.[6] The categories within each dimension are identical the categories used in raking. We omit cells where the weights do not influence the cell estimates, for example zero-count cells or cells where the proportion of individuals in a cell with a given characteristic is either 0 or 1. For each cell, we estimated weighted population counts and prevalence proportions for the following: smoking; asthma; high blood pressure; excellent, very good or good health; internet use in the last 30 days; disability; and cost-related problems obtaining care. We estimate statistics using both the original weights and validation weights. We compare the subpopulation (cell) estimates using univariate statistics and regressions. The regression model examines the associations between the subpopulation estimates based on the original weights (dependent variable) and the validation weights (independent variable).

The statistics described below indicate that our replication weighting methodology is valid. The original weights and validation weights univariate statistics (mean, standard deviation, 75th percentile, median and 25th percentile) are very similar (Table 1). The linear regression slope estimate of the original weights vs. the validation weights is 0.98 and the r-squared is 0.87 indicating a strong one-to-one association between the original weights and the validation weights. The variation in the validation weights accounts a high percentage (87%) of the variation in the original weighs. We did not expect to account for 100% of the variation because our weight replication process does not fully replicate the weight adjustments for geographic regions; complete geographic data are not publicly available.

Table 1: Univariate statistics for Massachusetts original weights and validation weights

Statistic	Original Weights (n=15071)	Replicate Weights (n=15071)
Mean	352	352
Standard Deviation	440	417
75th Percentile	494	505
Median	201	209
25th Percentile	52	53

[5] Region is included in the dataset and our analysis suggests that the region included in the dataset is strongly correlated with but not identical to the region variable used in raking. We use the region variable available in the dataset for raking.

[6] These are a subset of the raking dimensions.

The population estimates (means and confidence intervals) based on the original weights and the validation weights are approximately equal (Table 2). The subpopulation analysis also indicates that the subpopulation estimates are approximately equal for the original weight estimates and the validation weight estimates (Table 3). The slopes range from 0.98 to 1.0 indicating a one-to-one association. The r-squared values range from 0.94 to 1.0 indicating that nearly all the variation in the cell means based on the original weights is accounted for by the cell means based on the validation weights.

Table 2: Comparison of Massachusetts population prevalence estimates based on original and validation weights

	Estimates Based on Original Weights			Estimates Based on Validation Weights		
Characteristic	Mean	Lower Confidence Interval	Upper Confidence Interval	Mean	Lower 95% Confidence Interval	Upper 95% Confidence Interval
Smoking	0.112	0.104	0.121	0.113	0.105	0.121
Asthma	0.167	0.157	0.177	0.164	0.154	0.174
Good, very good or excellent health	0.861	0.853	0.870	0.860	0.852	0.868
Internet use	0.822	0.813	0.831	0.810	0.800	0.819
Employed	0.580	0.567	0.592	0.574	0.562	0.586
Disability	0.203	0.193	0.213	0.205	0.195	0.215
High blood pressure	0.293	0.282	0.304	0.292	0.282	0.303
Cost related problem obtaining health care	0.085	0.078	0.092	0.087	0.080	0.095

Table 3: Regression results, original weight vs. validation weight subpopulation estimates

Characteristic	Cells (n)	Original Weight Cell Mean (SD)	Validation Weight Cell Mean (SD)	Slope	R-Squared
Population	1627	3264 (8971)	3264 (8919)	1.00	1.0
Smoking	488	0.25 (0.23)	0.25 (0.22)	1.00	0.96
Asthma	654	0.29 (0.22)	0.28 (0.21)	1.00	0.94
Good, very good or excellent health	655	0.68 (0.24)	0.68 (0.24)	1.00	0.95
Internet use in past 30 days	618	0.64 (0.28)	0.62 (0.28)	1.03	0.96
Employed	734	0.54 (0.27)	0.53 (0.27)	1.01	0.96
Disability	700	0.37 (0.25)	0.37 (0.25)	0.99	0.95
High blood pressure	747	0.41 (0.25)	0.41 (0.25)	1.00	0.95
Cost related problem obtaining health care	559	0.23 (0.22)	0.24 (0.22)	0.99	0.95

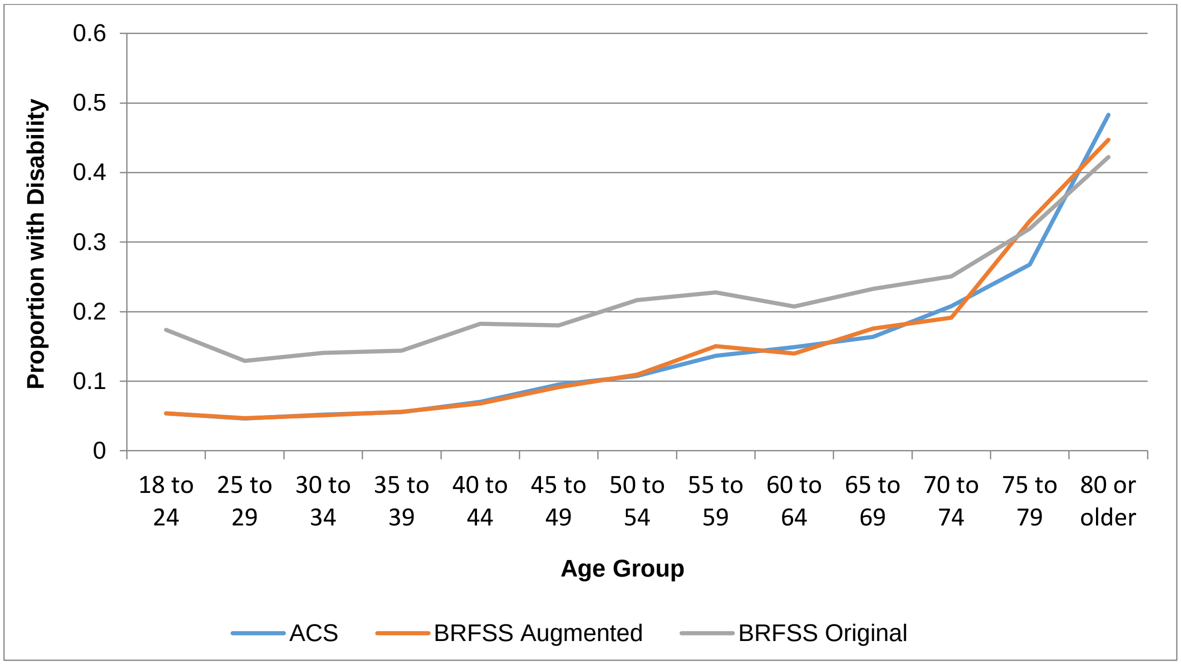
Note: Slopes are estimated with linear regression without an intercept. The R-Squared are estimated with an intercept. The cells are defined by the following dimensions: age, sex, race, marital status, education, home ownership and phone types

Augmenting weighting methodology with disability

In this section, we re-weight the data using the validation weighting methodology described above augmented with the addition of six disability raking dimensions. We refer to this as the 'augmented weighting methodology.' The six new raking dimensions are: disability by age and the five disability types by age. We use the 2013 Massachusetts ACS to determine the population counts within disability raking dimensions. In essence, the augmented weighting methodology adjusts the weights in the disability raking dimensions so that the BRFSS distributions match the ACS distributions.

As expected, the re-weighting results in BRFSS life course disability prevalence estimates, based on augmented weights, that are approximately equal to ACS estimates (see Figure 5). The estimates are also approximately equal for each disability type (See Appendix, Table A.2). These results demonstrate that augmenting the current BRFSS weighting methodology by adding disability raking dimensions is viable.

Figure 5. Comparison of Massachusetts ACS and BRFSS (augmented weights) disability prevalence estimates, by age group



Population-based estimates based on the original weights differ from the population estimates based on the augmented weights (see Table 4). As expected, the estimate for the proportion of persons with disabilities decreased from 0.203 to 0.121. Persons with disabilities, on average, have higher smoking prevalence, lower employment rates, and poorer health compared to persons without disabilities. Thus, the decrease in disability prevalence correspondingly decreased the population estimates for the prevalence of smoking, asthma, high blood pressure, and cost-related problems obtaining care and increased the population prevalence estimates for good, very good or excellent health status and employment.

Table 4: Comparison of Massachusetts population prevalence estimates based on original and augmented weights

	Estimates Based on Original Weights			Estimates Based on Augmented Weights		
Characteristic	Mean	Lower Confidence Interval	Upper Confidence Interval	Mean	Lower 95% Confidence Interval	Upper 95% Confidence Interval
Smoking	0.112	0.104	0.121	0.103	0.095	0.111
Asthma	0.167	0.157	0.177	0.152	0.143	0.162
Good, very good or excellent health	0.861	0.853	0.870	0.881	0.874	0.889
Internet use	0.822	0.813	0.831	0.813	0.803	0.823
Employed	0.580	0.567	0.592	0.600	0.587	0.612
Disability	0.203	0.193	0.213	0.121	0.114	0.128
High blood pressure	0.293	0.282	0.304	0.279	0.269	0.290
Cost related problem obtaining health care	0.085	0.078	0.092	0.080	0.073	0.087

The subpopulation-based estimates also differ (see Table 5). The differences are consistent with the differences in the population estimates described above. The regression results indicate that the re-weighting affected some subpopulations more than others. For example a regression of the asthma subpopulation estimates based on the original weights (independent variable) and the estimates based on the replicate weights indicates that 79% of the variation in the subpopulation means based on original weights is accounted for by the means based on the augmented weights. Thus, the re-weighting process reduced the estimates for the prevalence of asthma; however, the extent of the reduction varies across subpopulation. This is expected. Subpopulations will vary in disability prevalence and in the association between disability and the respective characteristic (e.g. asthma) in the subpopulation.

Table 5. Regression results, original weight vs. augmented weight subpopulation estimates

Characteristic	Cells (n)	Original Weight Cell Mean (SD)	Augmented Weight Cell Mean (SD)	Slope	R-Squared
Population	1627	3264 (8971)	3264 (8961)	1.00	0.99
Smoking	488	0.25 (0.23)	0.24 (0.23)	1.00	0.82
Asthma	654	0.29 (0.22)	0.27 (0.22)	1.01	0.79
Good, very good or excellent health	655	0.68 (0.24)	0.71 (.24)	0.95	0.81
Internet use in past 30 days	618	0.64 (0.28)	0.63 (0.28)	1.00	0.87
Employed	734	0.54 (0.27)	0.56 (0.27)	0.95	0.88
Disability	700	0.37 (0.25)	0.25 (0.23)	1.25	0.80
High blood pressure	747	0.41 (0.25)	0.39 (0.25)	1.00	0.86
Cost related problem obtaining health care	559	0.23 (0.22)	0.23 (0.22)	0.96	0.89

Note: Slopes are estimated with linear regression without an intercept. The R-Squared are estimated with an intercept. The cells are defined by the following dimensions: age, sex, race, marital status, education, home ownership and phone types

Discussion

We find that the difference between the ACS and BRFSS disability prevalence estimates are most likely because of a limitation of the BRFSS survey methodology, sampling and nonresponse bias associated with disability. In other words, individuals with disabilities are more likely to be sampled and respond to the BRFSS than individuals without disabilities and this causes bias. The BRFSS survey methodology may be modified to address this limitation. The common disability questions in the ACS and BRFSS make it technically feasible to reduce the sampling and nonresponse bias associated with disability by adding disability to the BRFSS weighting methodology. Doing so results in consistent BRFSS and ACS disability prevalence estimates and very likely improves the accuracy of BRFSS disability estimates. We demonstrated that this is feasible using the Massachusetts BRFSS. The feasibility for other states should also be evaluated.

Reducing bias associated with disability will not only improve the accuracy of BRFSS disability estimates, it will also improve population and subpopulation estimates for a range of health and health risk characteristics, for example estimates for smoking rates and disease prevalence. Disability status is associated with health status, disease conditions and health risk behaviors and consequently, improving the accuracy of disability prevalence will also improve the accuracy of these estimates. For example, our results based on the Massachusetts BRFSS suggest that the current BRFSS overestimates population smoking rates, diabetes prevalence and asthma prevalence. It is likely that the U.S. population is healthier and engages in fewer health risk behaviors than the 2013 BRFSS estimates suggest.

Our analysis suggests that BRFSS sampling and nonresponse bias is the reason for the differences in ACS and BRFSS disability prevalence estimates but this finding is not conclusive. Further research is needed. In the interim until there are additional research findings, there is a dilemma. Should BRFSS users continue to estimate health conditions and health risk behaviors from the current BRFSS? Or, should BRFSS users make estimates based on re-weighted data as described in this report? In some circumstances, this decision will substantially affect the estimates. For example, disability prevalence estimates differ by a factor of 2 for some age groups. Our findings suggest that estimates based on re-weighted data will be more accurate.

Appendix 1

Table A1. 2013 ACS estimates of disability prevalence by type

Age Group	Any of the Five Difficulties	Difficulty Seeing	Difficulty Concentrating, Remembering, Making Decisions	Difficulty Doing Errands Alone	Difficulty Dressing, Bathing	Difficulty Walking, Climbing Stairs
18 to 24	0.054	0.011	0.039	0.021	0.008	0.010
25 to 29	0.053	0.011	0.035	0.021	0.008	0.014
30 to 34	0.057	0.011	0.035	0.024	0.010	0.021
35 to 39	0.061	0.012	0.035	0.025	0.011	0.027
40 to 44	0.078	0.017	0.039	0.032	0.015	0.041
45 to 49	0.099	0.023	0.045	0.039	0.020	0.058
50 to 54	0.129	0.028	0.054	0.050	0.029	0.085
55 to 59	0.155	0.032	0.056	0.058	0.034	0.110
60 to 64	0.178	0.035	0.056	0.066	0.039	0.132
65 to 69	0.190	0.040	0.051	0.069	0.041	0.146
70 to 74	0.226	0.049	0.060	0.092	0.051	0.175
75 to 79	0.305	0.066	0.086	0.144	0.077	0.236
80 or older	0.510	0.126	0.181	0.334	0.181	0.400

Table A2. 2013 BRFSS estimates of disability prevalence by type

Age Group	Any of the Five Difficulties	Difficulty Seeing	Difficulty Concentrating, Remembering, Making Decisions	Difficulty Doing Errands Alone	Difficulty Dressing, Bathing	Difficulty Walking, Climbing Stairs
18 to 24	0.148	0.028	0.110	0.030	0.007	0.024
25 to 29	0.153	0.030	0.103	0.042	0.014	0.042
30 to 34	0.147	0.028	0.090	0.045	0.017	0.052
35 to 39	0.152	0.028	0.093	0.048	0.023	0.066
40 to 44	0.182	0.038	0.102	0.062	0.040	0.104
45 to 49	0.213	0.060	0.113	0.073	0.045	0.129
50 to 54	0.260	0.070	0.128	0.087	0.058	0.174
55 to 59	0.279	0.071	0.127	0.093	0.064	0.204
60 to 64	0.297	0.068	0.114	0.086	0.060	0.228
65 to 69	0.293	0.058	0.092	0.071	0.048	0.229
70 to 74	0.308	0.056	0.084	0.077	0.049	0.242
75 to 79	0.371	0.070	0.102	0.100	0.050	0.292
80 or older	0.466	0.097	0.123	0.162	0.069	0.361

Table A3. 2013 Massachusetts ACS estimates of disability prevalence by type

Age Group	Any of the Five Difficulties	Difficulty Seeing	Difficulty Concentrating, Remembering, Making Decisions	Difficulty Doing Errands Alone	Difficulty Dressing, Bathing	Difficulty Walking, Climbing Stairs
18 to 24	0.054	0.008	0.041	0.022	0.010	0.009
25 to 29	0.046	0.009	0.032	0.020	0.007	0.013
30 to 34	0.052	0.007	0.035	0.023	0.007	0.018
35 to 39	0.056	0.008	0.030	0.024	0.011	0.024
40 to 44	0.070	0.014	0.036	0.030	0.014	0.032
45 to 49	0.095	0.020	0.047	0.036	0.019	0.052
50 to 54	0.107	0.018	0.049	0.046	0.025	0.069
55 to 59	0.136	0.028	0.058	0.051	0.032	0.086
60 to 64	0.149	0.029	0.056	0.061	0.033	0.095
65 to 69	0.164	0.026	0.045	0.067	0.034	0.120
70 to 74	0.208	0.046	0.053	0.079	0.041	0.164
75 to 79	0.268	0.060	0.087	0.131	0.073	0.210
80 or older	0.483	0.130	0.162	0.328	0.176	0.362

Table A4. 2013 Massachusetts BRFSS estimates of disability prevalence by type, augmented weights

Age Group	Any of the Five Difficulties	Difficulty Seeing	Difficulty Concentrating, Remembering, Making Decisions	Difficulty Doing Errands Alone	Difficulty Dressing, Bathing	Difficulty Walking, Climbing Stairs
18 to 24	0.054	0.008	0.041	0.022	0.010	0.009
25 to 29	0.047	0.008	0.033	0.018	0.005	0.010
30 to 34	0.051	0.008	0.034	0.025	0.009	0.020
35 to 39	0.056	0.014	0.028	0.022	0.012	0.021
40 to 44	0.068	0.008	0.037	0.031	0.013	0.033
45 to 49	0.091	0.019	0.045	0.039	0.019	0.057
50 to 54	0.110	0.019	0.050	0.044	0.025	0.063
55 to 59	0.151	0.023	0.069	0.063	0.038	0.092
60 to 64	0.140	0.036	0.048	0.050	0.028	0.092
65 to 69	0.176	0.033	0.051	0.074	0.046	0.135
70 to 74	0.191	0.035	0.044	0.069	0.025	0.141
75 to 79	0.330	0.078	0.135	0.193	0.132	0.251
80 or older	0.447	0.120	0.132	0.292	0.138	0.339