Methods for Combining State BRFSS Survey Data for National Estimation

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1. Introduction

Although the Behavioral Risk Factor Surveillance System (BRFSS) was designed to collect valid, uniform state-specific data concerning risk behaviors and preventive health practices, it has been widely used by public health practitioners and researchers alike to support national estimates of behavioral risk factor prevalence. The objectives of our study included:

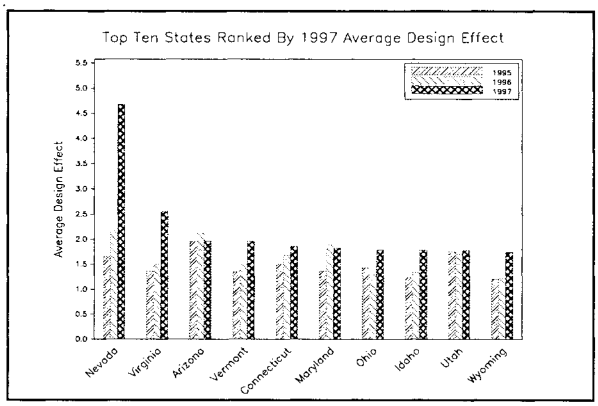
- Developing a method for combining BRFSS state estimates to produce national risk factor prevalence estimates;
- Comparing national BRFSS estimates computed using the new method with prevalence estimates from the National Health Interview Survey (NHIS); and
- Investigating time trends in national BRFSS national estimates.

Section 2 describes aspects of our assessment of state survey designs that were part of the investigation of the feasibility of combining state estimates. Section 3 describes the methods developed for combining state estimates. Section 4 compares the new combined estimates for the target years (1995-97) to estimates based on the NHIS. Section 5 examines time trends in national-level estimates computed with the new method. Finally, Section 6 provides some conclusions and recommendations.

2. Assessment of state survey designs

To evaluate the feasibility of computing national estimates using BRFSS data, we considered the degree to which state sampling designs deviated from the recommended BRFSS protocol, as well as sampling and nonsampling errors in state-level estimates. We evaluated state-level sampling error in two ways. First, we examined the coefficient of variation (CV) in survey weights, because prevalence estimates from survey designs with greater variability in survey weights have larger standard errors. We also examined the design effect (DEFF) for each of the 20 health risk factors included in the analysis, and the average DEFF over these key items. Figure 1 presents the top ten states in the ranking by 1997 average DEFFs. By both measures, large sampling errors were observed in Alaska, Arizona, and California in 1995; the CV of the weights for these states was 1.11, 1.02 and 1.15, respectively.

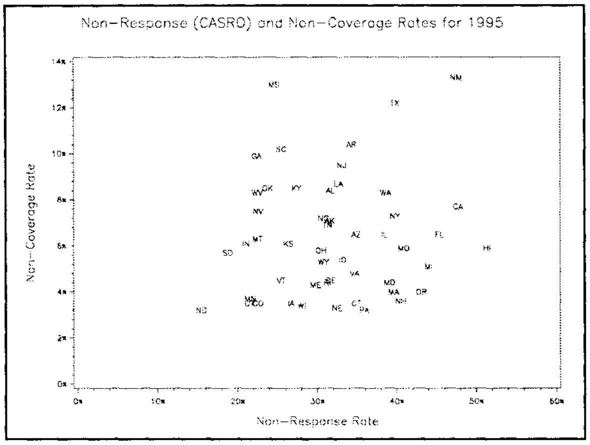
Figure 1: Top 10 Average Design Effects from the 1995, 1996, and 1997 BRFSS, Ranked by 1997 Average Design Effect.



We assessed non-sampling error in state-level prevalence estimates by examining measures of noncoverage and nonresponse. Nonresponse was measured using upper bound response rates and response rates computed using the convention set by the Council of American Survey Research Organizations (CASRO). Upper bound response rates include only sampling units that are known to be eligible in the denominator. CASRO response rates apportion units with unknown eligibility among eligible and ineligible households. New Mexico, California, Oregon, Missouri, Massachusetts, and Pennsylvania had substantial nonresponse in 1995 by both measures. Noncoverage was measured as the sum of the proportion of households without telephones and the proportion of households with telephones not covered in the frame. New Mexico, Texas and Mississippi have large noncoverage rates for the years included in this analysis.

Figure 2 shows a scatterplot of non-response and non-coverage rates for the 1995 BRFSS. Similar figures for 1996-97 helped identify states that due to large non-sampling errors may affect the accuracy of combined national estimates. We investigated potential problem states along sampling and non-sampling errors, and assessed their likely impact on national estimates. This assessment that included a sensitivity analysis of the impact of individual states (Section 4).

Figure 2: CASRO-Based Non-Response Rates versus Non-Coverage Rates for States Participating in the 1995 BRFSS.



3. Stratified Method for National Estimates and Key Health Risks

Our method for generating national estimates from the BRFSS capitalizes on the fact that state samples are independent. Individual states can thus be treated as strata in a stratified analysis. States were classified into two major groups on the basis of the type of sampling design they used. One group of states used variations on a two-stage cluster design that construct clusters as blocks of telephone numbers (following the method of Waksberg, 1978). The other group uses stratified, list-assisted sample designs that typically oversample blocks with higher densities of working residential numbers. Disproportionate stratified sampling is the most commonly used form of list-assisted design. The number of states using list-assisted stratified sampling designs increased from 16 in 1995 to 22 in 1997, largely because list-assisted designs are simpler and less costly to implement.

Each group-level estimate is a weighted sum of individual state estimates, where stratum weights are proportional to the state population. National estimates, in turn, are computed as weighted sums of the two group estimates, where weights reflect the proportion of the national population in each group of states. We used the stratified method to compute prevalence estimates for 20 selected key health indicators (16 in 1996).

We chose 20 key health risk factors from the BRFSS for this analysis because a) they were included in the survey instruments of all participating states; b) they were, with a couple of exceptions, included in the BRFSS survey instrument during all three years covered by the analysis (1995 to 1997); and c) the BRFSS survey questions that addressed these factors were consistent with questions in the NHIS survey instrument. In addition, we considered item (non)response rates in this selection. The risk factors included seven items concerning medical history, four items involving cigarette use, four items concerning HIV exposure and diagnostic testing; and three items concerning health care.

4. Sensitivity Analysis and Comparisons with NHIS estimates

The sensitivity analysis examined the impact of state-level sampling and nonsampling error in national estimates computed with our stratified approach. California, Texas, and New York have large populations and large average design effects, nonresponse rates, and/or noncoverage rates for the years included in the analysis. We excluded California, Texas, and New York, one at a time, from the data set and compared the resulting point estimates and standard errors for each of the 20 key health risk factors to national estimates using all the states. The absolute differences in point estimates are small. For example, in 1995, 24.4 percent of respondents reported receiving a flu shot in the previous year when all 50 states are included in the stratified analysis. When New York is excluded, the estimate is 24.7 percent; when Texas is excluded, the estimate is 24.3 percent; and when California is excluded, the estimate is 24.5 percent. As anticipated, standard errors of estimates increased when data for Texas and New York were excluded from the calculations because the sample size decreased. Interestingly, when data for California were excluded, standard errors decreased, illustrating the potential influence of large errors, even on putatively robust national estimates.

We compared national estimates of risk factor prevalence computed using the stratified approach to national estimates derived from the National Health Interview Survey (NHIS), using the most recent NHIS data available at the time of the analysis, which were for 1995. Findings of the two surveys are generally consistent for the 16 risk factors included in this analysis (we excluded four risk factors from the analysis because the form of the questions on the two survey instruments differed too much to permit valid comparisons). For 13 of the 16 comparisons shown in Table 1, the prevalence estimates from the two data sets differed by less than five percent, and nine of the sixteen differed by two percent or less.

5. Time trends in state and national estimates

Time trends in national estimates provide benchmarks against which state public health authorities can measure changes in behavior among residents of their own states. Trend estimates for each state are premised on independent annual samples since any serial correlation is negligible. Although serial correlations may exist among annual prevalence estimates for eight small states that use two-stage cluster (Waksberg) sampling designs, the sample sizes of these states are too small to influence the sheer mass of the national sample.

Little change occurred over the three year period analyzed in the number of respondents who reported having smoked at least 100 cigarettes in their lifetimes, the percentage who reported that they received counseling concerning their most recent HIV test results, the percentage who reported very good or excellent general health, and self-reported average height. Changes in prevalence that were statistically significant but appear unimportant in public health or biological terms were observed for several of the health risk factors, including: the number of cigarettes smoked in a day by "some day" smokers, the percentage of respondents who reported they currently smoked, the percentage who reported that they had some form of health insurance coverage, the percentage who reported that they were unable to see a physician during the preceding year because of cost, and the average weight reported by respondents. Changes that were both statistically significant and consequential, in public health or biological terms, occurred in the prevalence of three risk factors related to HIV infection. The percentage of persons who said they had their blood tested for evidence of HIV infection increased steadily, from 47 percent in 1995 to 50 percent in 1996 and 52 percent in 1997. A concomitant increase occurred in the percentage of tested persons who reported that they received their test results, from about 82 percent to about 87.5 percent. A smaller increase occurred in the percentage of respondents who said they donated blood since 1985, from approximately 20 percent to more than 21.5 percent.

6. Conclusions

In conclusion, we developed a method for computing national estimates of risk factor prevalence that is computationally straightforward and appropriately account for the varying state sample designs and state population sizes. Implementing our approach requires only the published BRSFF data, contemporaneous population estimates for each state, and knowledge of the sampling approach employed by each state.

The sensitivity analysis indicates that national estimates are not immune from the effects of sampling and nonsampling error. Particularly for subgroups defined by age, gender, and race/ethnicity, sampling and nonsampling errors may lead to bias and a problematic loss of precision in national estimates.

National estimates computed from BRFSS data are reassuringly similar to estimates computed with a completely independent data set, the National Health Interview Survey (NHIS). This concordance supports the use of BRFSS estimates, which are more promptly available than data from NHIS and other national surveys, to support national program and policy decisions. Direct comparisons of estimates from BRFSS and NHIS are not always advisable because their survey instruments often frame questions that address the same topic in markedly different ways. For four of the 20 health risk factors in our analysis, questions from the two survey instruments differed so much that direct comparisons of the two estimates were not warranted.

We identified only a few statistically significant temporal changes in the 20 health risk factors examined that we judged substantively important for public health purposes. However, our analysis indicates that national estimates based on BRFSS data are sufficiently precise to identify relatively modest year-to-year changes in risk factor prevalence. BRFSS is, therefore, very useful for annual national surveillance of behavioral risk factors.

Table 1 Comparison of BRFSS and NHIS National Estimates, 1995

Key Health Risk Factors[1]	Estimate (Standard Error) 1995 BRFSS	1995 NHIS[2]	Absolute Difference in Estimate
1. Percent reporting ever been told by a doctor, nurse or other health professional that he/she had high blood pressure	23.33% (0.23)	15.64% (0.37)	7.69%
2. Percent reporting had flu shot in past 12 months	24.43% (0.23)	23.00% (0.29)	1.43%
3. Percent reporting ever had a pneumonia vaccination	13.95% (0.20)	11.75% (0.30)	2.20%
4. Percent reporting ever been told by a doctor that he/she had diabetes	4.96% (0.16)	4.54% (0.17)	0.42%
5. Percent reporting smoked at least 100 cigarettes in entire life	46.77% (0.27)	48.10% (0.47)	-1.33%
6. Percent reporting now smoke cigarettes (current smoking prevalence)	22.15% (0.22)	24.68% (0.40)	-2.53%
7. Percent reporting ever had blood tested for HIV (includes only respondents aged < 45 years)	42.36% (0.37)	36.43% (0.62)	5.93%
9. Percent reporting received results of last HIV test (includes only respondents aged < 45 years)	80.98% (0.41)	81.15% (0.81)	-0.17%
10. Percent reporting received counseling about HIV test results (includes only respondents aged < 45 years)	33.50% (0.58)	27.96% (0.98)	5.54%
11. Percent reporting any kind of health coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare	86.36% (0.22)	85.84% (0.22)	0.52%
14. Percent reporting general health is excellent or very good	57.05% (0.27)	61.64% (0.31)	-4.56%
15. Average number of cigarettes smoked per day by current smokers who smoke every day	18.40 (0.13)	20.20 (0.22)	-1.80
16. Average number of cigarettes smoked per day on days smoked by smokers who smoke some days	7.55 (0.22)	5.38 (0.25)	2.17
18. Average weight (lbs)	165.40 (0.23)	165.80 (0.34)	-0.40
19. Average height (in)	67.06 (0.02)	66.96 (0.04)	0.10
20. Average Body Mass Index (BMI)	25.77 (0.03)	27.02 (0.09)	-1.25

[1]Key Health Risks Factors 8, 12, 13, and 17 are excluded because questions on the BRFSS and NHIS are not comparable.
[2]Source: National Center for Health Statistics (1995)