Adjustment for Unit Nonresponse in the National Health Interview Survey

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Abstract

The National Health Interview Survey (NHIS) is a continuous survey that has collected health data using personal interviews since 1957. The unit response rate historically has been high, above 90% for the first forty years of the survey. In the past decade, the unit response rate has declined to approximately 80%. We discuss changes in the methodology for unit nonresponse adjustment over the history of the survey, with a focus on potential future changes that employ auxiliary data.

Key Words: Sample Survey, Screening

1. Introduction

The National Health Interview Survey (NHIS) is the principal source of information on the health of the civilian noninstitutionalized population of the U.S. It is a continuous survey that has been in operation since 1957. The current NHIS sample design was implemented in 2006. We anticipate obtaining completed interviews at approximately 35,000 living quarters (households and noninstitutional group quarters such as college dormitories) each year. All persons at a sampled address are included in the NHIS interview, yielding a sample of approximately 87,500 persons each year. Sample sizes can increase or decrease appreciably, according to the availability of funding. Each interview is conducted via a personal visit to the living quarters by an employee of the U.S. Bureau of the Census, which is the data collection agent for the NHIS.

The NHIS sample consists of clusters of living quarters chosen within a first-stage sample of U.S. counties. This sampling method is used to control the costs related to personal visit interviewing. The cost of conducting personal visit interviews in a simple random sample of U.S. living quarters would be prohibitive, due to the amount of travel that would be required.

The current sample design of the NHIS is based on Census 2000 information. The current sample design is very similar to the previous sample design, which was in effect from 1995 to 2005 and was based on 1990 Census information. The sample design period before that spanned 1985 to 1994 and was based on 1980 Census information. The other previous sample design periods for which microdata files are available are: July 1, 1962 (beginning of fiscal year 1963) to 1972, and 1973 to 1984. Although the NHIS began in July 1957, microdata files were not retained prior to fiscal year 1963.

Additional information about the NHIS is available online at the NHIS home page, http://www.cdc.gov/nchs/nhis.htm.

NHIS unit response was approximately 95% for the first 35 years of the survey. NHIS unit response has decreased, particularly in the last decade. In 1990, the NHIS unit response rate was 95.5%; in 1995, 93.8%; in 2000, 88.9%; in 2005, 86.5%; in 2010, 79.5%. This drop in response rates is not specific to NHIS; response rates have fallen for virtually all major population surveys.

We discuss below the history of NHIS unit nonresponse adjustment, and the need for innovations being likely in the next NHIS sample design due to higher nonresponse levels.

2. NHIS Unit Nonresponse Adjustment: History

NHIS unit (household or other living quarters) nonresponse adjustment always has been based on geography. Conceptually, the unit nonresponse adjustment is carried out by inflating the sampling weights for all responding units within a segment (a compact cluster usually containing 4-16 addresses) to compensate for the nonresponding units within that same segment. The earliest written description of the unit nonresponse adjustment was given in "The statistical design of the Health Household-Interview Survey", 1958:

"Adjustment for noninterviews in the health survey is accomplished by a calculation that assumes that respondents within a given segment for a quarter represent the nonrespondents in that segment. In the rare instance in which less than half of a segment is interviewed, the noninterview adjustment is modified by evidence from reports of the entire Tab Area." ("Tab Area" is an abbreviation of "Tabulation Area". Tabulation Areas either were self-representing metropolitan areas or other large geographic areas.)

2.1 Nonresponse Adjustment Up Through 1984

The implementation of the unit nonresponse adjustment followed the above description through 1984. In practice, the adjustment was applied to the NHIS Person File weight instead of to the NHIS Household File weight, and the adjustment was done separately for persons living in households and persons living in other types of living quarters such as college dormitories. In a given segment, within each of the two living quarters groupings, intermediate person weights that contained factors for the NHIS sampling stages and a ratio adjustment for primary sampling unit (PSU) selection in non-self-representing PSUs were summed separately by responding and nonresponding units. At the segment level, a weighted total across responding and nonresponding units was computed. The nonresponse adjustment was computed as:

weighted total/weighted sum of responding units

provided that the result of this calculation was no greater than 2. If greater than 2, the adjustment was set equal to 2, and a second nonresponse adjustment was applied across all segments in the same Tabulation Area. The second nonresponse adjustment was of the form:

weighted total/(weighted total - "excess noninterviews")

where the "excess noninterviews" quantity was computed by subtracting the weighted sum of responding units from the weighted sum of nonresponding units when the nonresponse sum in a given segment was greater than the response sum.

2.2 Nonresponse Adjustment for 1985-1994

The Tabulation Area concept disappeared with the NHIS redesign that went into effect in 1985. The second nonresponse adjustment that formerly occurred across all segments in the same Tabulation Area when the nonresponse adjustment factors in one or more segments in the Tabulation Area were truncated to 2 was dropped.

2.3 Nonresponse Adjustment for 1995-1996

The 1995 NHIS sample design included a new feature, a screening procedure. Living quarters that had no black or Hispanic persons were subsampled. The subsampling occurred after all sample addresses were randomly divided into two groups, coded "I" (interview) and "S" (screen), prior to interviewing. All sampled households that had no black or Hispanic persons came into the NHIS sample from the I group. Sampled households that had no black or Hispanic persons in the S group were screened out. All households containing black and/or Hispanic persons in either group were interviewed. The screening procedure was one strategy for increasing the proportion of black and Hispanic persons in the NHIS sample. A weighting factor was applied to the sampled households that had no black or Hispanic persons in the I group to account for the screening in the S group.

The screening process introduced an issue for nonresponse adjustment that did not have to be addressed in previous NHIS survey designs. Previously, all households that were known to be occupied, but where no NHIS interview occurred, would be considered eligible for the survey and accounted for during the nonresponse adjustment process. The screening process changed this assumption. Specifically, consider the situation when the race/ethnicity composition of a household could not be determined because the interviewer never succeeded in making contact with the household. If there were one or more black or Hispanic persons in the household, then the household was an eligible nonresponding household and needed to be accounted for in the nonresponse adjustment process. If there were no black or Hispanic persons in the household, then the household was eligible for inclusion in the survey only if it was in the I group; if it was in the S group, it was not eligible.

Three changes were made to the nonresponse adjustment process in 1995. The first change was that living quarters no longer were divided into two groups (households versus other living quarters such as college dormitories) for the process. The second change moved the nonresponse adjustment process to before, rather than after, the ratio adjustment for PSU selection in non-self-representing PSUs. The third change was an alteration of the nonresponse adjustment that attempted to take account of the screening procedure.

2.4 Nonresponse Adjustment for 1997-2005

The 1995-1996 nonresponse adjustment did not distinguish between unknown status households in the I and S groups, so a different method was implemented in 1997. This method accounted for the difference in eligibility for inclusion in the survey, based on use of the I and S screening codes, as described above.

Another change that was implemented in 1997 was that the nonresponse adjustment was applied to the Household File weight, rather than the Person File weight. The nonresponse-adjusted Household File weight was then the starting point for creating the Person File weight.

A detailed description of the nonresponse adjustment as implemented in 1997 is as follows:

All of the households in a given segment that belong to one of the following four groups were eligible:

MI = household with black and/or Hispanic persons, I screening code
MS = household with black and/or Hispanic persons, S screening code
OI = household with no black or Hispanic persons, I screening code
UI = household with unknown race/ethnicity composition, I screening code

None of the households in the segment in the following group were eligible:

OS = household with no black or Hispanic persons, S screening code

Some, none, or all of the households in the segment in the following group were eligible:

US = household with unknown race/ethnicity composition, S screening code

If the number of households in the US group was not zero, the proportion of eligible households from this group in the segment was estimated using information from households with known race and/or ethnicity. The eligible proportion was estimated by summing the number of MI, MS, OI, and OS households in the segment and then computing:

$$MINPROP = (MI + MS)/(MI + MS + OI + OS)$$

assuming the denominator was not zero; otherwise, MINPROP was set equal to 0. Once MINPROP was defined, the complementary proportion OTHPROP was defined as [1−MINPROP] if the denominator of MINPROP was not zero; OTHPROP was set equal to 0 if the denominator of MINPROP was zero.

Let WH = conditional inflation weight that accounts for all stages of sampling (primary sampling unit (PSU) selection, within-PSU selection, etc.).

The following weighted sums (with respect to WH) were computed across the segment:
WH (MI) = weighted sum of sample class MI households
WH (MS) = weighted sum of sample class MS households
WH (OI) = weighted sum of sample class OI households

WH (MI, res) = weighted sum of responding sample class MI households
WH (MS, res) = weighted sum of responding sample class MS households
WH (OI, res) = weighted sum of responding sample class OI households

Then, the nonresponse factor for the segment was computed as:

NR = [WH (MI)+ WH (MS)+ WH (OI) + f1(UI)+ f2(US)]/
[WH (MI, res)+ WH (MS, res)+ WH (OI, res)]

where f1(UI) denotes a partition of the households in UI using MINPROP and OTHPROP, with appropriate WH factors applied to each piece, and f2(US) denotes estimation of the proportion of households containing black and/or Hispanic persons in US using MINPROP, and with the appropriate WH factor applied to that piece. The modeling assumption being applied in both f1(UI) and f2(US) is that the proportion of households in these groups that contain one or more black or Hispanic persons is the same as the proportion of households where the race/ethnicity composition is known.

More specifically,

f1(UI) = WH(OTH) (OTHPROP × UI) + WH(MIN) (MINPROP × UI)

f2(US) = WH(MIN) (MINPROP × US)

where

WH(OTH) (OTHPROP × UI) = weighted sum of the estimated proportion of UI households with no black or Hispanic persons, where the weight WH(OTH) was the weight applied to households with no black or Hispanic persons in the segment.

WH(MIN) (MINPROP × UI) = weighted sum of the black and Hispanic estimated proportion of UI households, where the weight WH(MIN) was the weight applied to households with black and/or Hispanic persons in the segment.

WH(MIN) (MINPROP × US) = weighted sum of the black and Hispanic estimated proportion of US households, where the weight WH(MIN) was the weight applied to households with black and/or Hispanic persons in the segment.

In essence, the nonresponse factor NR consisted of a numerator that was an estimate of the total number of eligible households in a given segment, and a denominator that was the total number of interviewed households. Weight factors that account for subsampling within the segment were included as appropriate.

The final household nonresponse adjustment factor for the segment, Wnr, was defined as:

Wnr = minimum (NR, 2.0)

That is, the final factor was truncated to 2 to control the variability in the weights due to this factor. Typically, fewer than 0.5 percent of segments used this truncated factor.

2.5 Nonresponse Adjustment for 2006-present

In the 2006 NHIS sample redesign, households with Asian, Hispanic, and/or black persons are oversampled. The above description of the 1997-2005 nonresponse adjustment, with the modification of adding "Asian" to any occurrence of "black", "Hispanic", above, describes the current nonresponse adjustment process.

3. Adjustment for Nonresponse to the Sample Adult, Sample Child Modules

The 1997 NHIS questionnaire redesign created several new modules. Many questions formerly asked of all adult family members were asked only of a randomly selected "sample adult". Many questions formerly asked about children in the family (if any children were present) were asked only about a randomly selected "sample child". Initially no nonresponse adjustment was done for nonresponse to these modules. However, a 2009 NHIS nonresponse bias analysis (Moriarity, 2011) determined that a geographic nonresponse adjustment was needed, and this was implemented beginning with the 2010 NHIS data. The geographic nonresponse adjustment method for the Sample Adult weight and the Sample Child weight is very similar to the current household nonresponse adjustment procedure; the Sample Adult procedure is described next.

The sample adults are a subsample of respondents in the NHIS Person File, so the NHIS Person File weight (prior to the final ratio adjustment to independent population estimates) is the starting point for the Sample Adult weight. The initial Sample Adult weight is created by multiplying by a factor that accounts for the sample adult sampling. This step is carried out for both respondents and nonrespondents to the Sample Adult module. Two weighted sums are formed within a segment: the total across Sample Adult module respondents and nonrespondents, and Sample Adult module respondents. The weighted total is divided by the weighted respondent sum. If the resulting number is greater than 2, it is truncated to 2. This yields the Sample Adult weight nonresponse adjustment factor.

4. Exploration of Other Approaches to Adjustment for Nonresponse

Maitland et al. (2008) examined the possibility of using paradata for NHIS nonresponse adjustment. They found a low correlation between NHIS paradata and NHIS survey data, which indicated that the paradata variables available at that time had limited utility for nonresponse adjustment.

Dahlhamer and Jans (2011) developed response propensity models for the NHIS. They found low correlations between response propensities and several health outcomes for the family and the sample adult, suggesting that there is limited utility in using the models for nonresponse adjustment.

5. Conclusion

NHIS unit response was very high for the first three decades of the survey. This has changed in the past 15 years. The current nonresponse adjustment procedure does attempt to adjust for nonresponse. Perhaps improvements can be made, and research is warranted.

We intend to explore the possibility of reintroducing a second-stage nonresponse adjustment, akin to the Tabulation Area adjustment that was done through 1984.

NHIS interviewers input interview attempt information (e.g., date/time of attempt) into The NHIS Contact History Instrument. We are looking to identify measures to be added to the NHIS Contact History Instrument that would be predictive of both response and NHIS survey data.

We intend to explore new types of nonresponse adjustment, e.g., the calibration weighting described by Kott and Liao (2012). We plan to continue exploring the possibility of using paradata, response propensity models, etc. for nonresponse adjustment.

References

Botman S, Moore T, Moriarity C, and Parsons V. Design and Estimation for the National Health Interview Survey, 1995-2004. Vital Health Stat 2(130). 2000.

Dahlhamer JM, Jans M. With an eye toward Responsive Design: The development of response propensity models with the National Health Interview Survey. Presented at 22nd International Workshop on Household Survey Nonresponse, Bilbao, Spain, September 5, 2011.

Kott PS, Liao D. Providing double protection for unit nonresponse with a nonlinear calibration-weighting routine. Survey Research Methods, Vol. 6, No. 2, 105-111. 2012.

Kovar MG, Poe GS. The National Health Interview Survey design, 1973–1984, and procedures, 1975–83. Vital Health Stat 1(18). 1985.

Maitland A, Cordero CC, Kreuter F. An Exploration into the Use of Paradata for Nonresponse Adjustment in a Health Survey. 2008 Proceedings of the Joint Statistical Meetings, 2250-2255.

Massey JT, Moore TF, Parsons VL, Tadros W. Design and estimation for the National Health Interview Survey, 1985–94. Vital Health Stat 2(110). 1989.

Moriarity, C. 2009 National Health Interview Survey Sample Adult and Sample Child nonresponse bias analysis. Available at: http://www.cdc.gov/nchs/data/nhis/nr_bias_analysis_report_2009_NHIS.pdf

National Center for Health Statistics. The statistical design of the Health Household-Interview Survey. Health Statistics. PHS Pub. No. 584-A2. Public Health Service. Washington: U.S. Government Printing Office. 1958.

National Center for Health Statistics. Health Interview Survey procedure, 1957–1974. National Center for Health Statistics. Vital Health Stat 1(11). 1975.