

Overview of Sample Design Research for the National Health Interview Survey

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Key Words: Sample survey, population based survey

redesign budget for each survey.

1. Introduction

The National Health Interview Survey (NHIS) is one of the major data collection programs of the National Center for Health Statistics (NCHS). The sample design for the NHIS traditionally has undergone a redesign every 10 years. The last redesign was completed following the 1990 decennial census. It was implemented in 1995 and is scheduled to be in place through 2004; see Botman, *et al.* (2000) for details. The current redesign is scheduled for implementation in 2005. This paper provides an overview of several areas of sample design developmental research for the 2005-2014 redesign to address new and continuing data needs at both the subnational level and for minority and economic subdomains of the population. More specifically, this paper reviews the status of the current redesign research, decisions made to date, ongoing research, tasks yet to be completed, and future methodological research.

Research phase:

For the current NHIS redesign (2005-2014), the research phase has involved the formation of working groups for key research topic areas, the conduct of research, and preparation of detailed design specifications.

Implementation phase:

Finally, the Bureau of the Census prepares to implement the new design by selecting the within PSU sample, producing the sample listing, and preparing for the field data collection.

Below is an overview, in brief, of the structure of the 2005-2014 NHIS sample redesign research process:

2. Background for NHIS Sample Redesign

- Redesign every decade to utilize new population information from the decennial census
- Redesign to respond to new data requirements
- Redesign to implement new and/or more efficient sampling techniques

- Establish NCHS/Census MOU with major redesign research objectives (August 1999)
- Conduct monthly interagency NHIS redesign steering committee meetings (NCHS, Bureau of the Census, Agency for Healthcare Research and Quality) to monitor research progress
- Establish working groups and team leaders for key research topic areas and conduct research
- Award and monitor research contracts

3. Overview of Redesign Process

The redesign involves three major components:

The basic 2005-2014 NHIS redesign objectives and assumptions include:

Planning phase:

- Formation of Interagency Census Redesign Task Force Committee
 - Organized and chaired by staff of the Office of Management and Budget
 - Membership - U.S. Bureau of the Census and all government agencies for which the U.S. Bureau of the Census conducts their household survey(s)

- A cost neutral design with respect to the current design
- Retain current precision levels (or better) for non-Hispanic Blacks and Hispanics
- Improved national subpopulation estimates (demographic and economic) for new domains and with new precision requirements
- Improved state level estimates
- Flexible design to allow for rapid implementation of design changes in response to emerging needs for data

The primary purposes of the Task Force Committee are to coordinate all of the U.S. Bureau of the Census's sample redesign research, to develop a Memorandum of Understanding (MOU) for each survey to specify the redesign research to be undertaken, and to develop the

4. Specific Research Objectives (as outlined in NCHS/Census MOU)

- Evaluation of the definition of the sampling unit for the first stage of sampling. In particular,

investigation of the potential for subcounty primary sampling units (PSU).

- Evaluation of the linkage of the NHIS sample with the sample of other Census-conducted surveys, sharing of PSUs, and rotating PSUs.
- Evaluation of duplication versus unduplication of households between the NHIS and other surveys conducted by the U.S. Bureau of the Census.
- Evaluation of subdomain statistics including assessment of the trade-offs between minority versus state-level estimates.
- Optimizing the sample design to satisfy the need for statistics at both the national level and the state level.
- Development of a design that will best serve the Department of Health and Human Services' (DHHS) integrated surveys.
- Evaluation of the trade-offs in terms of precision and costs of various alternative designs through cost modeling.
- Evaluation of the potential for developing a flexible design.

5. Status of Research and Decisions Made to Date

Discussions regarding the 2005-2014 NHIS sample redesign began in December 1998 followed by three months of meetings and discussions to define specific redesign objectives taking into consideration the NHIS data requirements for the next decade. Research began in April 1999 and an overview of the redesign process, major research objectives and the redesign schedule was presented to the NCHS Executive Staff on July 1, 1999. The MOU with the U.S. Bureau of the Census for the NHIS sample redesign was signed by both agency heads in August 1999. A summary of the major redesign research areas and findings and decisions to date is as follows:

A. Target population definition

Research Objectives: One of the redesign research objectives called for examining an expansion of the NHIS target population from just the civilian noninstitutionalized population to the resident population. Resident population subgroups considered included persons in the military (on and off military bases) and persons in local jails and state and Federal prisons.

Decision: The target population for the NHIS will remain

the civilian noninstitutionalized population.

B. Inclusion of Puerto Rico in the NHIS design

Research Objectives: The question/feasibility of conducting the NHIS in Puerto Rico has been raised several times. A permanent field structure would have to be put in place and a staff of field interviewers and supervisors trained. There was no interest by other Federal agency survey sponsors to conduct their surveys in Puerto Rico; therefore, NCHS would have to unilaterally bear the large start-up costs and annual costs.

Decision: Puerto Rico will not be included in the NHIS redesign.

C. Sample design with linkage, sharing, or rotating PSUs

Research Objectives: Consideration of three alternative design options were considered: 1) use of a subsample of the U.S. Bureau of the Census's American Community Survey (ACS), 2) sharing of PSUs with those of other surveys, and 3) rotating noncertainty PSUs.

Decision: After preliminary discussions and research, a decision was made in August 1999 to not consider linkage, sharing or rotating PSUs.

D. Unduplication versus duplication

Research Objectives: The NHIS requires an area frame to avoid U.S. Bureau of the Census Title 13 confidentiality restrictions. Other surveys conducted by the U.S. Bureau of the Census that make use of a composite frame (list and new construction) switch to an area frame in those areas covered in the NHIS sample. In the past, the sample was unduplicated within segments (the secondary sampling units) so that no household was in two different surveys during the life of the sample design. This operation is expensive. An evaluation was undertaken to determine how much duplication between NHIS and other major surveys would likely occur during the life of the next NHIS sample design if past procedures for avoiding duplication were not used.

Decision: Since the expected level of duplication (on an annual basis) between the NHIS and other Census conducted surveys was estimated to be at a low level, the "unduplication" process will not be undertaken for the 2005-2014 redesign. The other reason for this decision was that if NCHS were to switch to a subcounty-based PSU design, there would not be an effective or efficient way to unduplicate between the NHIS and surveys with county based PSUs.

E. PSU definitions

Research Objectives: A major redesign research objective focused on the possibility of defining PSUs at the subcounty level, in contrast to the current method of defining PSUs as one or more contiguous counties. In particular, aggregates of Census tracts as PSUs were investigated.

Decision: A great deal of initial research was done to define tract-based PSUs, but as the research progressed, a number of issues surfaced. With both time and resources constraints for completion of the redesign, it was determined that there was insufficient time to carry out the necessary research and evaluation for subcounty-based PSUs. Thus, it was determined to not be possible to implement subcounty PSUs starting in 2005. The decision is to use county-based PSUs for the start of the next sample redesign in 2005. Additional research will be conducted on subcounty-based PSUs for possible implementation sometime during the next 10-year design period (probably at the earliest in 2008).

F. Universe of PSUs and first-stage sampling

Research Objectives: With the decision to use county-based PSUs for the 2005 NHIS, it was determined that the 2005 universe of PSUs should be the 1995 universe with some minor modifications.

Decisions:

1. NCHS, not the U.S. Bureau of the Census, will define, stratify, and select the PSUs. The universe has been created by NCHS and reviewed and accepted by the U.S. Bureau of the Census. (PSUs consist of counties, combined contiguous counties, or metropolitan areas.)
2. Although a recommendation was made to relax strict state-level stratification to facilitate reliable design-based estimation for a larger number of states than is possible with the current design and to permit the use of fixed resources for other analytical domains (such as minorities), the decision was made to maintain strict state level stratification for the first-stage of sample selection.
3. Stratification will be implemented to facilitate the creation of efficient variance estimators and the creation of a 4 panel subdesign as is in place for the current design.
4. Usually, two PSUs will be selected from each nonself-representing stratum (a few small strata may have only one PSU selected).

G. Subnational statistics and metropolitan area statistics

Research Objectives: The 2005-2014 NHIS redesign has targeted the estimation of national demographic subdomains as an active design objective, and the estimation of state statistics as a passive design objective. Separate estimates for rural areas as a sub-area of nonmetropolitan areas as well as estimates for large metropolitan areas was also a redesign goal.

Decisions:

1. The redesign will not target specific states for reliable estimation, but rather provide the capabilities for state estimation through strict state level stratification (same as for the current design).
2. The survey will be designed to support separate estimates for the 3 metropolitan areas in the U. S. with the largest populations.
3. The survey will not be designed with the requirement to support separate estimates for rural areas as a sub-area of nonmetropolitan areas.
4. The precision of estimates from states with small NHIS sample sizes could be improved via supplemental sampling by random-digit-dialing surveys.

H. Minority and low income domain estimates

Research Objectives: With DHHS' 1998 Initiative to Eliminate Racial/Ethnic Disparities in Health (U.S. Department of Health and Human Services, 1998), a major objective of the 2005-2014 NHIS design is to provide reliable national estimates for demographic (especially minority) and economic subdomains of the population. In particular, in comparison to the current design, there are new domains of interest along with new precision requirements.

Decisions:

1. In addition to continuing the current production of reliable annual estimates for Hispanics and non-Hispanic blacks, the redesign research should also focus on the feasibility of producing reliable estimates on an annual basis for non-Hispanic Asians. Specific age and sex domains for each minority group also exist.
2. The ability to produce reliable annual estimates for the elderly population by race and ethnicity, within the age groups 65-74 and 75+, is a major design objective.
3. The ability to produce reliable estimates on an annual basis for the low income population by race and ethnicity should be evaluated.

4. The ability to produce reliable estimates for Hispanic subgroups (e.g., Mexican-Americans) and non-Hispanic Asian subgroups (e.g., Chinese-Americans) combining 2 or 3 years of NHIS data should be assessed. Specific age and sex domains for each minority subgroup also exist.

Selected Preliminary Findings:

1. The current design (1995-2004), which oversamples non-Hispanic blacks and Hispanics, can produce annual estimates for these groups with satisfactory precision. The same is true for the low income population. However, this is not true for non-Hispanic Asians. The most common exception to satisfactory precision for groups other than non-Hispanic Asians occurs in the most detailed subdomains, i.e., those defined by sex and age within a race-ethnic group (e.g., Hispanic males and females 75+ years of age).
2. With respect to Hispanic and non-Hispanic Asian subgroups, estimates based on pooling two years of NHIS data can be produced with satisfactory precision for Mexican-Americans, but not for other Hispanic subgroups and not for any non-Hispanic Asian subgroups.

I. Within PSU design and density stratification

Research Objectives: The current within PSU design research is focusing on the formation of density strata "cut-points" (boundaries). It has been determined that the density strata of the current design are too fine (i.e., they are too numerous, resulting in sparse or empty strata in many PSUs). A major challenge is determining density strata for non-Hispanic Asians. While the proportion of non-Hispanic Asians out of the total U.S. population is known to have increased from 1990 to 2000, there is no indication that their density has increased. Thus, the challenge is how to sample this subpopulation group at reasonable cost.

Decisions:

1. The number of density strata in the area frame for the redesign should be reduced from the currently defined 20 density strata. The use of 12 or less density strata is being considered, and, in some PSUs with small populations, only a few density strata may be used. In some PSUs, little gain is obtained with finer stratification. The use of fewer strata in comparison to the current design should provide more robustness over time and more efficiency in variance estimation. Research should include assessing the impact of defining density strata, in part, by Asian density levels.

2. Alternatives to density stratification may prove more beneficial to sampling selected subpopulation groups. For example, adaptive sampling might be advantageous to the oversampling of non-Hispanic Asians. Research and pilot testing is needed in this area; this research probably will not be completed in time for implementation in 2005.

3. Potential changes to the current NHIS screening rules whereby some non-Hispanic Asian households are "screened out" should be evaluated.

J. Cost modeling

Research Objectives: A major component of the redesign research effort is the inclusion of a detailed cost analysis and modeling task -- a very ambitious and complex task. Because a major objective of the NHIS is to produce national minority domain estimates, in some cases for new domains and with new precision requirements, oversampling with screening will likely continue to be a design feature and the level of its use may be increased. Thus, a major focus of the cost modeling task is to determine the ratio of the cost for a screening interview to a completed interview. This information will be used to evaluate the costs associated with alternative design options for targeted subdomains of the population.

Decisions/Findings:

1. Cost analysis/modeling research should be a collaborative effort of NCHS and the U.S. Bureau of the Census's Field Division.
2. Obtaining and synthesizing cost structure data for the NHIS is a complex task.
3. A cost model with interviewer assignment level costs has been determined to be more useful rather than a model that included PSU level costs (to better reflect actual field operations).
4. A cost model should be developed which permits the average housing unit-level costs to be calculated for varying percents of "screened in" and "screened out" households.
5. Preliminary results, based on the current NHIS, appear to indicate that the cost of an interview that results in a household being "screened out" is not much less than the cost of a full interview. This is an important finding. More research is in progress to validate these preliminary results.

K. Survey integration

Research Objectives: The primary focus of the NHIS

sample design is for a design that will meet the NHIS survey objectives for reliable demographic, economic, and some subnational statistics, and, secondly, a design that will facilitate and enhance survey integration. Survey integration is synonymous with the linking of surveys. The motivations for survey integration are to reduce survey costs and increase analytical potential. The primary objectives of the survey integration research is to determine how successful linkage has been with some existing surveys and to investigate the statistical inference problems associated with survey integration.

Decisions/Findings:

1. Linkage at the sample person level provides the largest potential for cost savings related to reduced level of screening in the linked survey. Survey integration may result in cost savings for one survey, but not another. For potential cost savings to exist, the NHIS must include a large proportion of the linked survey's target population. The cost savings will be determined by the trade-off between reductions in screening costs and cost increases due to higher survey refusal rates and tracing of respondents.

2. Past experience with linkage has demonstrated the most success with linkage when applied to other face-to-face household surveys like the Medical Expenditure Panel Survey (MEPS). Linkage of the NHIS and the NCHS's National Health and Nutrition Examination Survey through use of a subsample of NHIS PSUs was implemented for the 1999-2000 surveys, but more recently dropped, and linkage to NCHS's National Hospital Discharge Survey was used in the past, but any realized benefits have not been documented. For the short term, we will consider only face-to-face household survey linkage.

3. Linkage at the sample person level provides the largest potential for improving analytical precision. Finding solutions to statistical inference problems is a multi-faceted, long-range research project. Solutions will be affected by the variables and population characteristics chosen for analysis across the linked surveys. A major methods research effort is needed in this area.

L. Sample design flexibility

Research Objectives: A major new initiative of the 2005-2014 design is to build flexibility into the design to allow NHIS to be responsive to emerging needs for data on demographic and geographic domains or, for example, by socioeconomic status, in a timely and cost efficient manner. Specifically, one goal is to allow for intra-decade design changes, i.e., to develop a design that is not locked into place for 10 years with no potential for change. The decision to not unduplicate the NHIS sample (see section

5D) will provide the opportunity for intra-decade design changes involving the selection of additional PSUs or additional sample within PSUs.

Decisions:

1. Options for sample reduction as well as sample expansion should be examined. The decision to use a first-stage PPS sample will result in about 65% of the U.S. population being sampled in certainty strata. These strata are the larger metropolitan areas and contain high concentrations of race-ethnic domains that are now or may be of future interest. Sample expansions should be easier to design and implement in this large certainty component. For sample reduction, we will use the "4 panel" sub-design strategy as in the past. The panels can be combined with calendar quarters and years to reduce sample and also to allocate the NHIS for survey linkage as is currently done for MEPS.

2. Research should be undertaken to explore use of data from the 2000 decennial census and from the American Community Survey (ACS) to help identify areas where targeted population subgroups live for targeting of subpopulations in the future. (Note: NHIS can use ACS summary statistics, but not the ACS sample or microdata, because of Title 13 restrictions.)

6. Research to be Completed in Preparation of Final Design Specifications for Delivery to Census

The NHIS redesign efforts for the remainder of 2001 and 2002 will focus on defining the measure of size for selection of PSUs, refining the definition of density strata, and refining the cost modeling for evaluation of alternative design and oversampling options. In addition, since the current NHIS oversampling and screening strategies will likely not yield estimates with satisfactory precision for elderly minorities, research will be undertaken to evaluate the use of a dual frame sample (area sample and list sample, such as Medicare file) to help monitor the health of our aging population. Use of a dual frame sample poses significant challenges as discussed in Ezzati *et al.* (1995). Research will also continue on evaluation of a dual frame approach (area sample and random-digit-dialing sample) to achieve reliable design based state-level estimates.

7. Future Methodological Research

While significant research has been conducted in preparation for implementation of a redesigned NHIS sample in 2005, a number of future, longer term methodological research areas have been identified. For example, evaluation of use of American Community Survey (ACS) data to help identify areas where targeted population subgroups reside will be undertaken to

potentially improve sample design efficiency. Restrictions on disclosure of data under Title 13 preclude NCHS from using Census information about individuals. The extent to which subpopulation data availability will improve from potential use of the ACS will depend, in part, on decisions regarding disclosure and sharing of information under Title 13. However, other uses of aggregate ACS data will be investigated in the absence of any data sharing legislation.

In addition, we will develop a comprehensive research agenda to evaluate use of sub-county based PSUs in the NHIS as opposed to the current county-based definition. Potential advantages of tract-based PSUs, for example, include greater flexibility in release of public use micro-data, more refined stratification, a reduction in sample clustering with improved precision and variance estimation stability, and formation of PSUs of approximately equal size, thus reducing between PSU variance.

NHIS like other general population based health surveys have used density stratification, oversampling, and screening, separately and in combination, with general success to obtain samples of rare subpopulations. However, these methods are often ineffective in obtaining samples of sufficient size at reasonable cost when the subpopulation of interest is small or when the subpopulation is widely dispersed throughout the total population. Thus, important research and pilot testing needs to be conducted to determine the anticipated benefit and the feasibility of alternative new sampling strategies to target selected subpopulations, such as sequential methods and link tracing designs. Research will also be initiated to examine the feasibility of employing matrix sampling as a framework for assessing the linking of NHIS and other population based surveys conducted by NCHS or other agencies.

The NHIS is typically designed for a 10-year period and the sample is divided into subsamples that are assigned for data collection for each year of the 10-year period. This is done without any consideration of changes in trends in population distributions over time which may be particularly important for minority population groups. Shifts in minority population subgroups over time can affect the efficiency of the NHIS design for oversampling targeted minority subpopulations. For example, changes at the census block group level could affect the minority density strata. Some analysis of this issue has been done, but more in-depth study is needed.

Finally, we will continue to research and evaluate design options that maximize design flexibility so as to allow NHIS to make mid-decade design changes in a timely manner in response to emerging needs for data to monitor the Nation's health.

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