REDESIGN OF THE NATIONAL HEALTH INTERVIEW SURVEY

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1. INTRODUCTION AND SUMMARY

The National Health Interview Survey (NHIS) uses a stratified multi-stage cluster sample of households and provides estimates of general health characteristics of the U.S. civilian noninstitutional population. The NHIS program began in 1957. The sample has always been drawn from a subset of the primary sampling units (PSUs) of the Current Population Survey (CPS). Over the years, some changes have been made in within PSU sampling, notably in the cluster size, but no attempt was made to redesign NHIS independently of CPS. However, in early 1980, a comprehensive research program was undertaken jointly by the Bureau of the Census and the National Center for Health Statistics (NCHS) to develop an optimum sample design for NHIS independently of CPS. As a result, many features of the NHIS have been changed for the Post-1980 census redesigned sample that is being introduced during 1985. This paper describes major research issues and all the design parameters and changes made in the new design. Coverage of the area sampling, overlap of the new design with old design, and the phase-in of the new design and its possible impact on NHIS data are also discussed.

Section 2 describes the old design and section 3 describes the redesigned NHIS. The phase-in of the redesigned sample is discussed in section 4.

2. THE OLD DESIGN

The post-1970 census NHIS sample was located in 376 PSUs (CPS A design) with 51,000 housing units designated for interview each year. The sample was spread across the 52 weeks of the year so that each week's sample was a national probability sample. There were 120 interviewers working on NHIS and only on the NHIS. They typically carried out, on the average, 6 or 7 weekly assignments per quarter. Thus, the sample was organized so that each week we had a national sample and each quarter each interviewer had a desirable workload. Interviewers in NHIS frequently travelled from their home PSU to other PSUs to accomplish their work (this was more cost effective than having interviewers in each PSU without sufficient workloads). The NHIS was conducted with compact clusters of four housing units each, so in a given year we had about 12,750 clusters of housing units in sample. The frame for the NHIS was like the frames used for other demographic surveys--addresses sampled from 1970 census in urban areas; area samples in which current listings were made in rural areas, and samples from building permits to reflect new construction in those areas where building permits were available from local records.

3. REDESIGNED NHIS

A comprehensive research program was undertaken jointly by the Bureau of the Census and the NCHS early in 1980 to research all aspects of the NHIS program, sample design, data collection costs, and estimation. The objective was to develop an optimum sample design for NHIS independently of CPS. Major issues included sampling frame, linkage of other health surveys with NHIS, oversampling minority domains of the population, telephone interviewing and rotation of the sample. Other topics included design features such as stratification, PSU definition, optimum number of sample PSUs and sample size, cluster size, the number of PSUs per stratum, panels of PSUs, overlap with old design, controlled selection and the phase in of the new design.

We provided NCHS about 21 alternative designs with costs and variances relative to the old design for selected combinations of sampling frame, number of PSUs, sample size and segment size. Some of these designs are shown in table 1. Design number 13 was selected for redesign since it satisfied best the multiple objectives of NHIS and other health surveys. The annual cost of NHIS will be about $4.1 million in 1984 dollars. The redesigned NHIS will be in 198 PSUs (52 SR and 146 NSR) with 61,400 housing units designated per year. These units will be selected in noncompact clusters of eight units each. All segments will be selected as area segment samples with current listings. New construction units, however, will be selected from building permits over the decade in noncompact clusters of four units. The annual as well as weekly samples will be representative of the civilian noninstitutional population of the United States.

Several design features will have an effect on variance components. The reduction in the number of PSUs and the selection of two PSUs rather than one per stratum will increase the between-PSU variance. The larger cluster size will increase the within-PSU variance. However, the improved stratification, the noncompact clusters, and, especially, the larger sample will decrease the variance. Overall, the selected design is expected to reduce the variance for many typical health estimates by about 6 percent. Some of the major differences between the old and the new design are given in table 2. The design parameters and changes made in the redesigned sample are discussed further in the sequel but research methodology and results for various topics will not be discussed in detail.

Sampling Frame and Linkage of Other Health Surveys with NHIS

Redesigned NHIS will use area samples rather than census address samples mainly to allow the use of subsamples of the NHIS sample for other health surveys like Family Growth Survey (FGS) and Medical Care Utilization and Expenditure Survey (MCUES). NCHS estimated that the additional cost involved in implementing an area design would be offset by the savings that would result from not having to design and select new samples for FGS, MCUES, and other health surveys. Another important advantage of the use of the NHIS sample for FGS, MCEUS, and other health surveys is that it will permit linkage of various health data sets.

Coverage

We expect the coverage of the area sampling to be about the same as that of the old multi-frame design. While area listing of households may pick up some census misses, it may also fail to list some obscure housing units. Potential sources of

differences in the coverage are described in table 3.

PSU Definition and Stratification of PSUs

As in the old design, each PSU comprises one or more contiguous counties and each metropolitan statistical area (MSA) is generally defined as a separate PSU. PSUs were stratified within four geographic regions by MSA/non-MSA status by a clustering algorithm using variables, proportion of population Spanish, below poverty, urban, unemployed and employed in manufacturing industries, and proportions of households with annual income less than $15,000. These variables were selected by a correlation analysis of health variables and census demographic and economic variables.

Two PSUs Per Stratum

Two PSUs per stratum will be selected so that "unbiased" estimates of variances can be obtained. This will enable better statistical analyses and tests than in the old design with one PSU per stratum.

Overlap With Old Design

PSUs were selected independently without attempting to maximize overlap with either the old NHIS or other surveys. There is little point to overlapping NHIS with other surveys, since NHIS interviewers work only on NHIS. Also, little, if any, of the sampling costs could be shared with other surveys because frames are different (area for NHIS, generally address for other surveys). Overlapping NHIS with old NHIS is also not very cost effective since the number of interviewers retained would not have been much greater for maximum overlap than for independent selection. Independent selection in a two PSUs per stratum design was preferred because it would provide better variance estimates.

Actually, only 79 entirely new PSUs were selected for the sample. The remaining sample PSUs are either completely or partially contained in the old design. About 76 percent of the new sample will be in continuing areas, i.e., areas that were in the old design, and 24 percent in new areas.

Controlled Selection

Controlled selection to ensure representation of each state in the sample was not used because NCHS indicated that this was not necessary for the NHIS. The advantages of variance estimation with independent selection of two PSUs per stratum would have been lost at least partially with controlled selection.

Improvement of Black and Other Small Domain Estimates

One of the major goals for the redesign was to improve the reliability of estimates for certain small domains of the population. The reliability of estimates for blacks will be improved considerably (8-25 percent) by optimally oversampling blacks in areas with large black populations while constraining variance increases for total population estimates to no more than 2-3 percent. This will also provide a larger sample for FGS. Oversampling for any of the other domains--Hispanic, poverty and aged--will not be done as the oversampling for one adversely affects the reliability for others. However, note that Hispanic and poverty variables were used in stratification to improve reliability of estimates for these two domains.

Interviewing Mode: Face-to-Face Vs. Telephone

Personal-visit interviewing has always been used in NHIS to collect data. This method has been preferred over telephone interviewing because of the belief that an interviewer can easily establish rapport with a respondent in a personal visit, better justify the legitimacy of the survey, minimize refusals and generally produce better quality data. The continuous rise in cost of personnal-visit interviewing had, however, promoted a growing interest in studying the feasibility of gradually introducing a random digit dialing (RDD) sample. Considerable efforts were made by the NCHS, University of Michigan on behalf of NCHS and by the Bureau of the Census in research and development of RDD methodology for NHIS. However, a great deal of uncertainty remained about the feasibility of administering the complex NHIS questionnaire by telephone and actual cost savings from RDD. Therefore it was decided to continue with face-to-face interviewing for the entire sample.

Rotation of the Sample

Several rotation plans with some overlap of sample units one or more years apart were developed to improve estimates of level and more significantly, estimates of change over time. These rotation plans would have saved between $250,000 and $430,000 per year if second time-in-sample housing units could be interviewed by telephone. A rotation design, however, reduces the reliability of multi-year estimates for small domains such as Black, Hispanic, poor, or persons over 65 for which annual estimates are not reliable. A rotating sample also decreases the number of households available for use in other health surveys and increases the respondent burden. The estimation of change which is generally small was considered less important than the estimation of small domains or the linkage of various health surveys. Thus, it was decided to continue the old scheme of selecting a new sample of households every year while retaining the sample PSUs for the entire decade.

Panels of PSUs

Four panels of PSUs will be formed so that each panel is a national sample. This will enable NCHS to use fewer PSUs than are in NHIS for FGS and MCUES. Panels also could be used efficiently for large sample reductions that may be required for budgetary reasons.

Some Methodological Improvements

Considerable improvements were made in sample design methodology in a coordinated research with CPS and other demographic surveys conducted by the Bureau of the Census. Modified Friedman-Rubin clustering procedures were used for stratification of PSUs and sorting of enumeration districts (EDs) within PSUs. Each survey used an appropriate set of geographic and socioeconomic variables for stratification and ED sorting. Area segmenting and new

construction sampling procedures were also improved.

Scheduling of interviewer assignments for specific weeks has been computerized for the redesigned NHIS sample to better maintain work efficiency and the distribution of the sample in four census regions, and in central cities, urban and rural areas in each region approximately equal from week to week.

4. PHASE-IN OF THE NEW DESIGN

The objective of the phase-in is to quickly make new interviewers proficient in administering the complex NHIS questionnaire and minimize their impact on data in 1985. The phase-in plan called for hiring about 40 new interviewers and giving them six practice assignments during the last quarter of 1984. Also about 100 of the old interviewing staff of 120 would be retained. The phase-in was estimated to cost about $600,000 in 1984 dollars. However, because of the budget cut in 1985, one of the four panels was dropped to reduce the sample by 25 percent. Only nine new interviewers were hired and given three practice assignments to cut the phase-in cost by about 1/3

As in the 1970 redesign, no plan was made to maintain two designs as part of phase-in to measure the impact of new design or staff. Based on the analysis of year-to-year changes, we do not expect the phase-in of the new design to have major impact on NHIS data in 1985. However, should large significant differences in health characteristics between 1984 and 1985 be observed, further analysis of data from the overlapping and nonoverlapping areas could possibly explain whether differences were due to real changes in health characteristictics or due to new design/ new staff.

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Table 1. YEARLY OPERATIONAL COSTS AND TOTAL COSTS FOR VARIOUS DESIGNS
(Costs in 1982 dollars in thousands)

Number of PSUs	376 PSUs				200 PSUs						222 PSUs	242 PSUs
Sampling Frame	Multi	Area	Area	Area	Area	Area	Area	Area	Area	Area	Area	Area
Segment Size	Segment 4		Seg. 6	Seg. 8	Segment 6			Segment 8			Segment 6	
Sample Size	50,800	50,800	54,400	58,100	57,600	52,600	50,000	61,400	53,100	50,000	56,000	50,000
Number of Interviewers	120	120	121	130	131	126	124	137	131	128	112	109
Design's Number	(1)	(2)	(3)	(4)	(7)	(9)	(11)	(13)	(15)	(18)	(19)	(21)
1. Yearly Operations												
A. Variable Costs	3,486	3,563	3,413	3,531	3,398	3,194	3,053	3,476	3,078	2,948	3,439	3,084
B. Fixed Costs	609	609	609	609	609	609	609	609	609	609	609	609
Total	4,095	4,172	4,024	4,140	4,007	3,758	3,662	4,085	3,687	3,557	4,048	3,693
2. Savings												
A. Compared to a 376 PSU design, area frame (design #2)	77(2)	0(0)	148(4)	32(1)	165(5)	414(12)	510(14)	87(2)	485(14)	615(17)	124(3)	479(3)
B. Compared to a 376 PSU design, multi-frame (design #1)	0(0)	-77	71(2)	-45	88(3)	337(10)	433(13)	10(0)	408(12)	538(16)	47(1)	402(12)
3. Change in Variance (Design's variance/current variance)												
A. Upper Bound	1.00	1.00	1.00	1.00	1.00	1.08	1.13	1.00	1.13	1.20	1.00	1.00
B. Lower Bound (include gain from restratification, noncompact segments and ED sorting)	1.00	.98	.97	.96	.94	1.02	1.07	.94	1.07	1.12	.96	1.05
4. Phase-in Costs (1/10) 1/	0	0	0	0	49	44	42	55	49	46	31	28
5. Implementation Costs (1/10) 1/	354	475	486	486	514	467	446	513	444	418	506	447
Total Costs	4,449	4,647	4,510	4,636	4,570	4,269	4,150	4,653	4,180	4,021	4,585	4,168
Increase in travel costs due to noncompact segments	-	42	35	32	37	34	32	34	29	27	36	32

NOTES: 1) A minus denotes an increase in costs.
2) Number in parenthesis show savings percentages based on the appropriate variable cost (i.e., 3563 or 3,486).

1/ 1/10 of the total cost is added as an average annual cost for the entire decade for comparison of costs for various designs.

Table 2. MAJOR DIFFERENCES BETWEEN THE OLD AND NEW DESIGN OF THE NHIS

	OLD DESIGN	NEW DESIGN
Sampling Frame	Address Area New Construction	---- Area New Construction
PSUs	Multicounty 1970 SMSAs	Multicounty 1980 MSAs
Self-representing (SR)	156	52
Nonself-representing (NSR)	220	146
Total	376	198
Per NSR Stratum	1	2
Sample Size (Housing Units)	51,000	61,400
Cluster Size		
Old Construction		
Address	4 Compact	--
Area	4 Noncompact	8 Noncompact
New Construction	4 Noncompact	4 Noncompact
Panels	Not Defined	4
Minority Estimates	Post Stratification for age-sex-race	Post Stratification for age-sex-race Stratification for Hispanic, Poor Oversampling for Black

Table 3. NHIS Coverage: Potential sources of differences due to going from the 1970 list frame design to the 1980 area frame design with area segments replacing address segments.

Address Segment	Area Segment
Lister goes to specific address as identified in census. Finds address or determines what happened since census.	Lister canvasses land area. No assurance that census addresses are accounted for in area segment listing. However, past experience indicates that listing errors in area segments are due to boundary problems, poor maps, and difficult-to-canvass areas. This occurs in more rural type area segments, and should not be problematic in block area segments which replace address segments.
Lister is provided with number of units census listed at address. Compares this to number of units listed for current survey and inquires about differences, presumably accounting for any real errors, as well as changes since the census, or census errors.	Lister does not have a census count to which to compare for verification. Even if the census count were available, it would be very time-consuming and difficult to account for differences within the block canvassed and listed. Also, it probably violates the sanctity of Title 13 to provide the NHIS lister with census information about number of units listed.
Lister does not have an opportunity to identify structures that have converted from entire nonresidential at the time of the census to partially or wholely residential at the time of the current survey listing.	Canvassing for current status of structures identifies structures converted from nonresidential (although presumably the interviewer is not normally aware that the structure was nonresidential in the census).
Year-built determined for unduplication purposes only if structure appears to have been built after the census (presumably as a replacement for the census structure which has since been demolished).	Year built determined at all structures to unduplicate with permit segments. The accuracy of year-built determination is not known. Indication is that persons tend to telescope forward, reporting year built as more recent than it actually is. The extent to which census structures may be lost this way is not known.