INTEGRATION OF TWO SURVEYS, AN UPDATE

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The National Survey of Family Growth (NSFG) is conducted periodically by the National Center for Health Statistics (NCHS), with a national probability sample of women 15-44 years of age. Cycles I through III of the NSFG were based on probability samples specifically designed for the NSFG.[1],[2],[3] The NSFG IV sample design, however, was integrated with that for the National Health Interview Survey (NHIS). By integration (or linkage) we mean that the National Health Interview Survey (NHIS) sample for parts of 1985-1987 served as the sampling frame for the NSFG IV.

In the 1980's NCHS investigated the redesign and integration of its population-based health survey program.[4] One major research component carried out by Westat, Inc., under contract with NCHS, analyzed methods of linking the NSFG sample to the NHIS (including whether the linkage should be at the person or at the address level, or whether the contact with the women selected for the NSFG sample should be in person or by letter).[5] Another major research component examined alternative sample design options for linking the NSFG with the NHIS.[6]

The research indicated that the efficiency would be improved by linking the NSFG IV to the NHIS because of the features of a linked design. (1) The screening efforts to select a sample of women 15-44 years of age, which were required in prior cycles, would be unnecessary. And (2) the sampling efficiency for Black women was increased because the oversampling was no longer restricted to areas with high Black concentrations. Also, NCHS attempted to reduce NSFG IV nonresponse bias by using information on NSFG nonrespondents (for additional information see [7]).

The linkage, however, also complicated some aspects of the NSFG IV survey plan. NCHS intended to begin NSFG IV data collection immediately after the accumulation of its sample from the NHIS. NSFG IV data collection, however, started about a year after its entire sample was identified in the NHIS. Reductions in the size of the NHIS sample also affected the operations.

The sample design for the NSFG IV added some features and design enhancements not identified in earlier research. This paper focuses on one such NSFG sample and survey design feature.

Section 1 describes the NSFG and its associated requirements. Section 2 describes the NHIS sample design, including some circumstances not foreseen in the original planning for linking the NSFG IV to the NHIS sample. Section 3 describes the NSFG linkage to the NHIS, including the method of oversampling Black women. Section 4 indicates the NSFG IV sampling efficiency for nonBlack women was increased with a technique that would not usually be possible in population area samples. Section 5 presents data on some of the other sampling and survey effects of the NSFG linkage to the NHIS. Section 6 summarizes the paper.

NCHS intends to pursue additional research to evaluate the design integration of the NSFG. Such results will be reported at a later time.

1. NSFG IV REQUIREMENTS

The NSFG IV is designed to produce "data on the demographic and social factors associated with childbearing, adoption, and maternal and child health."[8] The NSFG data set, therefore, includes sensitive data items.

These NSFG objectives include survey analysis by race, marital status, and age. These objectives in part led Cycles III and IV to survey women regardless of marital status while Cycles I and II excluded never married women. Cycle III also oversampled women 15-19 years of age in order to permit more reliable analysis of survey data for teenagers. Design requirements for NSFG Cycle IV are delineated in [6]. These include precision requirements for domains defined by race and marital status. Concerns over confidentiality and the possibility that multiple respondents in a household might influence each other's reports led to a design in which only one sample woman 15-44 years of age in a sample household was to be selected even when more than one woman in the household was eligible for the survey. Also in order for NCHS to prepare more reliable NSFG IV estimates for Black women, NSFG IV oversamples Black women.

Thus the NSFG samples relative to the population include proportionately more Black women than nonBlack women and more women from households where only one woman is eligible for the NSFG than women from households where two or more women are eligible for the NHIS. In section 4 we describe the approach that reduces some of the variability in the probability of sample selection among nonBlack women selected for the NSFG IV sample. We also explain why the same approach could not be used for selecting the Black women for the NSFG IV sample.

2. NHIS SAMPLE DESIGN RELEVANT TO NSFG IV LINKAGE

The 1985-94 NHIS is based on a multistage probability plan that permits a continuous sampling of the civilian noninstitutionalized U.S. population.[9],[10] The sample is designed in such a way that the NHIS sample assigned to each week is representative of the target population and the weekly samples are additive over time.

Several new features of the NHIS sample design introduced in 1985 are particularly relevant to this paper. The NHIS improved the precision of the estimates for Black persons. This was accomplished by the use of disproportionate sampling in PSU's with between 5 and 50 percent Black population. Sampling rates for the selection of segments were increased in areas known to have the highest concentration of Black persons.

In 1985-1986 the NHIS sample size was cut because of budgetary restrictions. The 1985 NHIS sample size was cut by 1/4. The 1986 NHIS sample size was cut by 1/2. For 1987 the full sample was implemented. These cutbacks in the NHIS sample affected the linkage of the NSFG to the NHIS. The next section will discuss the implications on the NSFG IV of these cutbacks in the NHIS.

3. DESIGN OF THE NSFG IV SAMPLE

Waksberg and Northrup evaluated seven alternative NSFG IV sample and operational designs linked to

the NHIS, which yield identical levels of precision.[6] These alternatives encompassed 100 versus 200 primary sampling units sample designs; the use of sample addresses versus sample persons (who must be tracked between the time of NHIS and NSFG interviews); and the accumulation of sample cases in the NHIS until the desired NSFG sample was attained before data collection versus continuous interviewing. The evaluation measures include cost, response rates, and potential problems.

In order to attain a fixed precision, sample sizes under the alternative sample designs varied due to the differences in design effects. "The design effects [in the NSFG IV] arise from a number of features in the sample design, principally, the variability in sampling rates among certain segments of the population; subsampling in multi-eligible households; and the use of multiple stage sample designs involving between PSU effects, between segment effects, and variability in segment sizes[6]."

NCHS originally planned to obtain the entire NSFG IV sample from the 1986 NHIS. Since the full NHIS sample is partitioned into four national subdesigns or panels, the alternatives on the NHIS sample used as the sampling frame for the NSFG corresponded to either two panels (about 100 PSU's) or four panels (about 200 PSU's). In 1986 NCHS, however, fielded half the full NHIS sample only (i.e., two panels) because of budget constraints.

While from the 1986 NHIS the NCHS was able to select a sufficient number of nonBlack women for the NSFG IV sample, from the 1986 NHIS a sufficient number of Black women was not available. The Black NSFG IV sample came essentially from women identified in the fourth quarter of 1985 (85Q4), all of 1986, and the first quarter of 1987 (87Q1). NCHS could not link the NSFG IV sample to the NHIS sample for (1) 85Q3 or prior samples or (2) 87Q2 or subsequent samples. These NHIS samples were already committed to other purposes.

4. NSFG IV SAMPLING TECHNIQUES USED TO REDUCE SAMPLING VARIANCES

Most, but not all, features of the NSFG IV sampling design are fixed because of its linkage with the NHIS. As noted in section 3, the NSFG IV selected for its sample virtually every (eligible) Black women in the 85Q41 through 87Q1 at the rate of one per household. There was, however, some flexibility in selecting the NSFG IV sample of nonBlack women from the NHIS. It was, for example, desirable to minimize the time between NHIS and NSFG IV interviews in order to reduce tracking problems when women moved between the time of NHIS and NSFG IV interviews.

The NSFG IV primarily departs from a self-weighting sample design because (1) to increase the reliability of survey estimates for Black women, the NSFG oversamples Black women and (2) the NSFG samples only one eligible women per household even if the household contains more than one woman eligible for the survey. This variability in the NSFG IV sampling rates increases the variability of the NSFG IV sampling weights.

Table 1, which is table 6 in [6], shows that the distribution of the NSFG inferential population by number of NSFG eligibles per household varies considerably by race and marital status. In particular, a much larger proportion of ever married women than never married women reside in households with only one NSFG eligible. This

directly affects the within-household probability of NSFG sample selection: in a household with one NSFG eligible the within-household probability of NSFG sample selection is 1; in a household with two NSFG eligibles the within-household probability of NSFG sample selection is 1/2; .... Thus unless the NSFG sample design was able to compensate for such disproportionate within-household sampling, NSFG sample would less efficiently represent never married women. Unfortunately there was no way of improving the method of sampling Black women for the NSFG IV, since almost all NHIS households with available Black women were included in the sample. However, it is possible to increase the efficiency of the nonBlack sample, as described below.

Table 2, which is table 2-1 in [11], shows the relative sampling weight resulting from within-household sampling and expected sample sizes with a sample similar to that for NSFG II and III. The (within-segment and total) design effect for NSFG percentage estimates of nonBlack women due to within-household sampling is gauged using the rationale and formula in [6]. NCHS nearly eliminated the design effect for NSFG percentages estimates due to within-household sampling, following a recommendation by Joseph Waksberg. Mr. Waksberg suggested disproportionately selecting women from households identified in the NHIS with two or more women eligible for the NSFG. This was done by extending the period during 1986 in which eligible nonBlack women in households with two or more eligible persons were selected from the NSFG IV sample. Since each week of the NHIS sample comprises a random subsample of the total annual sample, accumulating time periods retained the probability sample aspect of the sampling process.

As a result of this sampling feature, the NSFG IV nonBlack sample closely approximates the distribution by the number of eligibles per households that would result from a self-weighting sampling plan. This approach cuts the (within-segment) design effect for the NSFG percentage estimates for nonBlack women by about 11 percent because it increases the representation in the NSFG sample of nonBlack women in multi-eligible NSFG households. This corresponds to a reduction in the total survey design effects for nonBlack women of about the same proportion. In fact the NCHS later decided to further align the distribution of NSFG sample by the number of NSFG eligibles per household to that resulting from a self-weighting sample by sampling nearly all nonBlack women from multi-eligible households identified in the 87Q1 NHIS at the rate of one per household.

This approach did reduce the variability in the sampling rates for nonBlack women in the NSFG IV sample. The coefficient of variation (CV) of the final sampling weights for nonBlack women aged 15-44 in the 1987 NHIS is 0.33; the CV of the final sampling weights of nonBlack women in the NSFG IV is 0.39. By comparison the CV for the final sampling weights of nonBlack women in NSFG III is 0.63.

5. OTHER EFFECTS OF LINKING THE NSFG IV SAMPLE WITH THE NHIS

So far this paper has focused on the advantages of using a NSFG linked sample design. There were, however, some aspects of the linkage that resulted in more complicated procedures being used or reduced the cost savings experienced. Almost all of these complications were caused by or

exacerbated by an unexpected delay of nine months in starting the field work on the NSFG IV.

—Sample selection. NCHS selected the NSFG sample twice. Because NSFG data collection was unexpectedly delayed by about a year, NCHS had to reselect the NSFG sample. If the sample was not reselected, at the time of data collection the youngest person in the NSFG sample would have been about 16 years of age. Including data on teens about 15 years of age at interview was considered quite important, because for many women the onset of sexual activity begins at about this age.

—Sample maintenance. The NSFG IV linked sample was made up of preselected women who had to be tracked, and when they moved, interviewed at their new location. Table 3 shows by race the number of women who had moved between the NHIS and NSFG and whether their move was identified by advance tracking carried out in the central office or whether it required in-field tracking once data collection activities began. The table shows that 35 percent of the women in the sample moved at least once between the NHIS and NSFG, with 26 percent needing in-field tracking. Both tracking and the additional travel time required to interview movers at their new locations were costly, and the staff time spent on these activities reduced to some extent the savings experienced from the eliminating of the screening of households for eligible women.

Additional problems related to movers included: (1) the number of women not located at all, and (2) those who were located but had moved too far away from the interviewing staff to justify the travel cost for conducting an interview. Five percent of the sample NSFG IV women were not located and another 1/2 percent moved out of the interviewing area.

The problems of sample maintenance were increased by the delay in starting NSFG data collection because the number of movers increased as the elapsed time between the two studies increased. This is illustrated by table 4 that shows the number of movers by NHIS quarter. These mover rates are comparable to the mobility rates for 16-44 year old women shown in research done to assess the viability of linkage.[6]

—NSFG sample degradation and frame errors. At the time of the NSFG interview, only about 1 percent of women who were reported as eligible in the NHIS were no longer eligible for the NSFG (see table 5). Sample degradation, thus, was not a serious problem. For example, some women in the NSFG IV sample moved out of the U.S. Other parts of the NSFG sample were ineligible because of errors (in NHIS reporting or processing).

—NSFG coverage degradation. As the time increased between NSFG data collection and the end of the period used to accumulate the NHIS sample for the NSFG IV sampling frame, the gap increased between the NSFG target population and the NSFG sampling frame. For example, the NSFG IV sample does not include any women eligible for the NSFG at the time of its data collection, but having moved from another country to the U.S. between April 1987 and May 1988 (after the period used to accumulate the NHIS sample for the NSFG sampling frame). Coverage degradation was not a serious problem.

—Cluster size. The use of a linked design for the NSFG IV resulted in a geographic distribution of women to be interviewed that was different from

earlier cycles. Differences in the clustering of the sample resulted in changes to the organization and the management of the NSFG IV data collection staff. NSFG III used a 79 PSU design, while the sample for NSFG IV used a 156 PSU design, practically twice as many. The interviewing staff was almost the same size, 250 interviewers for Cycle III and 248 interviewers for Cycle IV. For Cycle III most PSU's were staffed with two or more interviewers, while most Cycle IV PSU's had only one interviewer. This difference complicated the management of the interviewing staff because, for Cycle IV, when an interviewer did not work out for some reason, in most cases her PSU had no interviewer to take over the work. This required the NSFG IV data collection management staff to make more use of travelling interviewers than on previous Cycles.

Another complication added by the linked sample design was the number and size of the local geographic clusters in the Cycle IV sample. The NSFG III sample included 886 small geographic clusters (868 area segments and 18 college dormitories); the area segments were designed to yield 8 selected respondents. The linked NSFG IV sample design had a larger number of segments with a smaller number of women in each. The original NSFG IV sample included 3,367 NHIS segments with an average of 3 sample women per segment. There were fewer women per segment by the time of NSFG IV data collection because of movers. Table 6 shows the distribution of the Cycle IV sample women across NHIS area segments before and after moving is taken into consideration. Table 6 shows that after movers are taken out of their original clusters, 4,737 women, or 44 percent of the sample, were living in clusters that did not include any other sample women. Another 27 percent of the sample were living in clusters of 2 or 3 women. The lack of clustering meant that when an interviewer travelled to a segment to meet with a respondent, if the respondent was not available for any reason, there was seldom any other NSFG IV interviewing to be done in that segment. This resulted in a very high ratio of travel time to interviewing time.

The smaller size of both PSU's and segments in the NSFG IV sample design resulted in an increase in interviewer travel both locally and between PSU's. The increased travel, of course, resulted in increased costs that reduced the savings from linkage. The problem was increased with the schedule delay because of the increase in movers. It should be noted, however, that smaller cluster sizes yield lower variances, and thereby provide a benefit of the linked sample design that offsets the negative aspects of the complicated data collection management structure.

—Variance estimation. For several reasons NCHS had to employ more complex variance estimation methodology for the NSFG IV than in earlier cycles of the NSFG: (1) In 1985-1987 the NHIS is based on three different sample designs; and (2) NCHS used a different sample design in the NSFG IV for Black women than that for nonBlack women.

6. SUMMARY

The NSFG IV sample design was linked to the NHIS. This offered a number of advantages to the NSFG IV. For example the linkage allowed oversampling of Black women without large additional screening costs. The linkage of the NSFG IV to NHIS also complicated the NSFG survey plan. Some of these

complications were due to unforeseen circumstances, while others were due to the particular way the NSFG IV linkage was implemented.

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Table 1. Distribution of Eligible Women by Number of Eligible Women in Household, According to Race and Marital Status

Number of Eligible Women in Household	Black Marital Status		NonBlack Marital Status	
	Ever Married	Never Married	Ever Married	Never Married
	Percent			
1 woman	75.1	47.5	82.6	39.9
2 women:				
2 ever married	1.9	...	1.3	...
1 ever and 1 never married	15.6	16.6	12.3	24.1
2 never married	...	17.3	...	16.9
3 women:				
2 ever and 1 never married	1	0.5	0.3	0.2
1 ever and 2 never married	5.1	10.9	2.9	11.4
3 never married	...	2.5	...	3.5
4 women*:				
2 ever and 2 never married	...	...	0.1	0.2
1 ever and 3 never married	1.3	4.0	0.5	2.7
4 never married	...	0.7	...	1.1

*Includes 5 or more eligible person households.
Source: Table 6 of [6]

Table 2. Selection procedures of nonBlack women for NSFG IV
as compared to self weighting samples, in alternative sampling frames

	Total		Number of Eligible Women per Household			
			1	2	3	4+
Percent of eligibles in population	100		68	23	7	2
Sample size with selfweighting	6,250	(a)	4,434	1,450	456	180
NSFG IV—Improved Sample Design (Linked to 1986 NHIS)						
NHIS available sample	12,167		8,315	2,813	852	190
Available after subsampling	10,049		8,315	1,407	284	43
Best sample distribution	6,520		4,786	1,407	284	43
Relative sampling weight	1.02	(b) (c)	1	1.15	1.73	2.42
Sampling similar to NSFG II and III						
Sample distribution	6,520		5,436	920	192	30
Relative sampling weight	1.13	(b)	1	2	3	4.2

(a) Assumes target NSFG nonBlack sample is 6,520.
(b) Design effect resulting from disproportionate sampling.
(c) The final design effect decreased this even further by
   expanding the nonBlack sample by about 500 cases.
Source: Table 2 of [11].

Table 3. Distribution of Movers in the NSFG Sample

Movers in NSFG IV Sample	Total Sample		Black Sample		NonBlack Sample	
	# (n=10,694)	%	# (n=3,526)	%	# (n=7,168)	%
All movers	3,697	35	1,327	38	2,370	33
Movers found during advance tracking	882	8	265	8	617	9
Movers found during data collection	2,815	26	1,062	30	1,753	24

Table 4. Distribution of NSFG Movers by NHIS Quarter

Movers in NSFG IV Sample	Total Sample			Black Sample			NonBlack Sample		
	n	#	%	n	#	%	n	#	%
All movers	10,694	3,697	35	3,526	1,327	38	7,168	2,370	33
Movers from 1985 Qtr 4	703	318	45	690	312	45	13 *	6	46
Movers from 1986 Qtr 1	943	419	44	460	210	46	483	209	43
Movers from 1986 Qtr 2	1,548	561	36	503	197	39	1,045	364	35
Movers from 1986 Qtr 3	3,084	961	31	534	188	35	2,550	773	30
Movers from 1986 Qtr 4	3,071	1,039	34	517	182	35	2,554	857	34
Movers from 1987 Qtr 1	1,345	399	30	822	238	29	523	161	31

*NonBlack sample from NHIS 1985 Quarter 4 were women who had been reported as Black in the NHIS.

Table 5. Distribution of Ineligibles in the NSFG IV Sample

Ineligibles in NSFG IV Sample	Total Sample (n= 10,694)		Black Sample (n= 3,566)		NonBlack Sample (n= 7,128)	
	#	%	#	%	#	%
All reasons	128	1.2	42	1.2	86	1.2
Sex*	6	0.1	0	0	6	0.1
Age*	22	0.2	11	0.3	11	0.2
Deceased	18	0.2	10	0.3	8	0.1
Moved out of U.S.	52	0.5	6	0.2	46	0.6
Institutionalized	9	0.1	5	0.1	4	0.1
In military	16	0.1	9	0.3	7	0.1
Other	5	0	1	0	4	0.1

*Information on sex and date of birth on the NHIS tape file, which determines NSFG eligibility, was in error.

Table 6. Distribution of NSFG IV Sample Women Across Area Segment Before and After Moving

Number of Women Living in Segment	Number of Segments in in Original Sample	Number of Segments After Moving
0	0	497
1	828	1,040
2	718	732
3	608	476
4	472	319
5	306	160
6	207	83
7	90	22
8	59	20
9	30	8
10	18	8
11	8	0
12	9	1
13	7	1
14	1	0
15	4	0
16	1	0
17	1	0