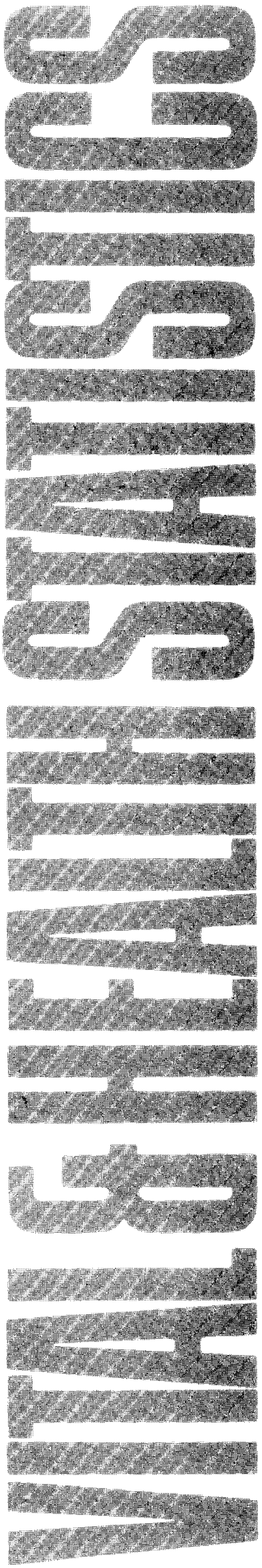

Design Alternatives for Integrating the National Medical Expenditure Survey With the National Health Interview Survey

Research was undertaken to evaluate alternative methods of selecting a sample of eligible respondents for the National Medical Expenditure Survey (NMES) from the National Health Interview Survey (NHIS). This report presents estimates of the effects of alternative design options, obtained by statistical modeling techniques, for linking the NMES with the NHIS. The estimated survey costs for alternative linked and unlinked design options are compared for fixed precision. The findings indicate that substantial savings would be realized by linking the NMES to the NHIS if a premium is put on small-domain estimates.

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Foreword

This is the second report presenting results of research on the effects of integrating the designs of the National Center for Health Statistics (NCHS) national household sample surveys, which heretofore were designed as independent surveys. Design integration would be accomplished by using the files of the National Health Interview Survey (NHIS), the largest and only continuing NCHS population survey, as the sampling frame for NCHS's other population surveys. Research findings with respect to linking the 1987 National Survey of Family Growth (NSFG) to NHIS were presented in an earlier report in this publication series, and the findings relating to the 1987 National Medical Expenditure Survey (NMES) are presented in this report.

The earlier report indicated that significant economies would be realized by linking NSFG to NHIS because NSFG requires a substantial oversampling of households with black females. However, it was unreasonable to assume that the NSFG findings would necessarily apply to NMES because NSFG is a single-time retrospective survey and NMES is a panel survey. As such, the population domains of interest would be different for NMES and NSFG. As it turned out, the NMES and NSFG research findings were quite similar. Among other things, this report concludes that substantial savings would be realized by linking NMES to NHIS if NMES puts a premium on small-domain estimates.

I provided technical oversight to this project, which was conducted under a contract with the Research Triangle Institute. Dr. Andrew White was instrumental in guiding this report through the publication process by working closely with the authors and the editors.

Monroe G. Sirken
Associate Director for Research and Methodology

Symbols

- - -	Data not available
. . .	Category not applicable
-	Quantity zero
0.0	Quantity more than zero but less than 0.05
Z	Quantity more than zero but less than 500 where numbers are rounded to thousands
*	Figure does not meet standard of reliability or precision
#	Figure suppressed to comply with confidentiality requirements

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Design Alternatives for Integrating the National Medical Expenditure Survey With the National Health Interview Survey

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Chapter 1
Introduction

Current planning for population-based surveys conducted by the National Center for Health Statistics (NCHS) suggests that the data systems can be integrated to save on data collection costs, to reduce respondent burden, and to increase the utility of the resultant data. As part of the NCHS effort to evaluate advantages of an integrated data system, Research Triangle Institute examined alternative designs for integrating the National Medical Expenditure Survey (NMES) with the larger National Health Interview Survey (NHIS). NMES will be a longitudinal study of the 1987 health care utilization and expenditures of civilian noninstitutionalized residents of the United States. This report summarizes the results of an investigation to assess the feasibility of linking the two surveys.

As a baseline for comparison, specifications for an unlinked NMES design were developed. Selected independently of NHIS, this unlinked design results in a stratified, clustered area sample similar to that of the 1980 National Medical Care Utilization and Expenditure Survey. For flexibility of NCHS planning, two sample sizes were used: 6,000 and 10,000 responding households. The 6,000-household design is similar in size to the 1980 National Medical Care Utilization and Expenditure Survey. The 10,000-household design was added so that NCHS could evaluate the improved precision for surveying smaller domains with the larger sample against the increased survey cost. Survey costs for the two sample size alternatives were modeled as well as the variances for selected statistics of interest.

The second design for which specifications were developed was a linked dwelling unit design. The linked dwelling unit design selects the sample of individuals to be included in NMES by subsampling NHIS sample dwelling units. In round 1 of NMES, the occupants of the subsampled dwelling units would be interviewed. Rounds 2–5 of date collection would use the same procedures as the unlinked NMES design. To measure the effect of the number of NHIS primary sampling units (PSU's) from which the NMES sample dwelling units are selected, both a 100-PSU and a 200-PSU linked dwelling unit design were investigated. For each design, two sample size alternatives were also investigated. These two sample sizes are those required to yield the same precision as the unlinked design with 6,000 and 10,000 responding households.

The third set of specifications developed were for a linked household design. The linked household design selects a sample of NHIS households for inclusion in NMES. The individuals within the subsampled households are interviewed in round 1 whether or not they live in the clustered NHIS sample dwelling units. Rounds 2–5 data collection uses the same rules as the unlinked design. As in the linked dwelling unit design, to assess the effect of the number of PSU's, designs were developed for both 100 PSU's and 200 PSU's; two sample sizes were investigated. These sample sizes were determined as the sizes required to yield the same precision as the unlinked design with 6,000 and 10,000 responding households.

Each of these designs is self-weighting; that is, all sample individuals are selected with the same probability. In many ways this eliminates the chief advantage of linkage with NHIS. With knowledge of individual characteristics available for NHIS sample respondents, added precision can be obtained for small domains without proportionally increasing the size of the total sample. To evaluate this feature of NHIS linkage, a fourth and final design type was investigated. This design is an optimally allocated linked household design in which the precision constraints set for the total population and the Medicaid population were based on those achieved by the unlinked design. Instead of arbitrarily determining the number of NHIS PSU's and segments to include, optimal sizes were determined for these components.

The development of these four designs is described in the following chapters. An important finding of this investigation is that there appears to be little relative gain from linkage when the final design is self-weighting. The principal gain from the linked self-weighting design is in the elimination of costs associated with counting and listing. Because the NMCUES interview pattern for all rounds was adopted in this investigation (personal interviews are used in the first two rounds and telephone interviews in the third and fourth rounds), there is little gained from the names, addresses, and telephone numbers of NHIS sample individuals. The optimally allocated design, however, uses characteristics of NHIS respondents to oversample heavy users of health care services and to increase the precision for small domains without proportionally increasing the size of the total sample.

Chapter 2
The unlinked National Medical Expenditure Survey design

The unlinked National Medical Expenditure Survey (NMES) designs studied in this investigation were patterned after the design used for the 1980 National Medical Care Utilization and Expenditure Survey (NMCUES). Specifically, an area sampling approach was used incorporating a self-weighting design in which each sample individual is selected with equal probability. The sample sizes required to yield 6,000 and 10,000 responding households were determined as well as the survey costs associated with these designs. The variances achieved by the unweighted, unlinked NMES design were modeled for use in sample size determination for the remaining designs.

Definition

The unlinked sample design is a stratified, multistage area probability design in which each sample dwelling unit is selected with equal probability. (In this report, the term "dwelling unit" refers to either a housing unit or a group quarters listing unit.) The first-stage sample consists of primary sampling units (PSU's) that are counties, parts of counties, or groups of contiguous counties. The second-stage sample consists of secondary sampling units that are census enumeration districts or block groups. Smaller area segments constitute the third stage. All of the dwelling units within these sample segments are listed. During the fourth stage of sampling, dwelling units within these sample segments are designated for inclusion in the NMES sample.

All civilian noninstitutionalized individuals residing in the sampled dwelling units in round 1 are included in the survey. Single college students in the 17–22-year age range are linked to their parents' residence and included in the survey only when their parents' residence is selected. Round 1 data collection uses personal interviews except for college students living outside a 2-hour, one-way drive of a sample PSU. In this case, telephone interviewing is used.

In round 2, these key persons are interviewed in their round 2 location. Individuals and families that moved must be traced to determine their new addresses. Individuals who joined the family of a key individual by birth or return from an institution, the military, or an overseas residence are included in NMES as a key person. Other individuals joining the families of key persons are classified as nonkey. Data are collected for both key and nonkey persons. The data for key persons are needed for person-level analyses. The data for nonkey persons are needed for family-level analyses only. Data collection in round 2 also uses personal interviews except for college students and movers outside a 2-hour, one-way drive from a sample PSU.

In round 3, data collection is primarily by telephone, with personal interviews conducted only for households without telephones and households requesting personal interviews. Key persons who move from their round 2 locations must be traced and interviewed at their new locations. Nonkey persons who moved are interviewed only when a key person moves with them. Individuals who are born or who return from an institution, the military, or overseas residence are included as key persons. Other individuals joining the families of key persons are classified as nonkey; data are gathered for them only during the time in which they were members of a key person's family.

The mode of data collection in round 4 follows that of round 3 with similar guidelines for key and nonkey persons. Because December 31 is the end of the survey reference period, approximately 30 percent of the sample is not interviewed in round 4 but instead early in round 5 (that is, shortly after January 1 of the next year).

The final round of data collection primarily uses personal interviewing under the same guidelines used in previous rounds to define key and nonkey persons and to determine movers who will be followed.

Sample size determination

Two sets of sample sizes were required for the unlinked NMES design: A sample size sufficient to yield 6,000 responding households, and a sample size sufficient to yield 10,000 responding households. To obtain these sizes, a precise definition was needed for "responding household." It was decided to use responding originating base reporting units (OBRU's) and to describe the sample sizes needed as those yielding an OBRU design with 6,000 responding and an OBRU design with 10,000 responding. These OBRU's are the round 1 reporting units (RU's) after college student RU's are linked back to parent RU's. Because data collection costs relate to reporting units (RU's) and rounds, sample sizes in terms of these units were developed.

The first step in this process was to model the 1980 NMCUES experience starting with the set of control system records generated by responding OBRU's. (In the NMCUES, an OBRU was defined to be responding if it was linked to an RU that completed an interview in any of the five data collection rounds.) The NMCUES contained 6,269 responding OBRU's. These responding OBRU's generated 6,603 com-

pleted RU interviews in round 1, 6,519 completed RU interviews in round 2, 6,528 completed RU interviews in round 3, 4,559 completed RU interviews in round 4, and 6,561 completed RU interviews in round 5. These were more RU interviews than there were responding OBRU's because OBRU's containing college students required more than one RU assignment to handle the different addresses at which data collection occurred. The NMCUES interviews occurred in 135 PSU's and 809 segments.

Because the NMES should experience no worse than the nonresponse and attrition encountered by the 1980 NMCUES, the NMCUES experience was ratio adjusted to produce the sample sizes required for the OBRU designs with 6,000 and 10,000 responding. These sample sizes are summarized in table 1. For modeling convenience, it was assumed that the Research Triangle Institute (RTI) General Purpose Sample would be used, which contains 102 PSU's. The average segment size was set to the 1980 NMCUES experience of eight responding OBRU's. With eight responding OBRU's per segment, the OBRU design with 6,000 responding would require 750 segments, and the OBRU design with 10,000 responding would require 1,250 segments.

Variance modeling

As a baseline for comparison of the unlinked with the linked designs, the precision of the linked designs was fixed to that of the unlinked design for selected key statistics and key domains. The designs were then compared with respect to sample sizes and costs. The domains of interest were the total population, those individuals below 150 percent of poverty, Medicare recipients, Medicaid recipients, and individuals from families with college-educated heads of households. The statistics of interest were as follows:

- Average number of hospital visits.
- Average number of facility visits.
- Average number of office visits.
- Average annual expenditure for hospital visits.
- Average annual expenditure for facility visits.
- Average annual expenditure for office visits.
- Average annual out-of-pocket expense for hospital visits.
- Average annual out-of-pocket expense for facility visits.
- Average annual out-of-pocket expense for office visits.
- Proportion with large out-of-pocket expenditures.

To determine the sample sizes required for the linked designs, the variance was modeled for the OBRU unlinked, self-weighting designs with 6,000 and 10,000 responding using the 1980 NMCUES data.

The NMES estimation approach constructs means in terms of total person-years rather than in terms of all persons ever existing in the data collection year. For domain k, the mean utilization or expenditure per person-year is estimated as

$$\overline{Y}_k(\text{NMES}) = \frac{\sum_{i \in S} W(i)\delta_k(i)Y(i)}{\sum_{i \in S} W(i)T(i)\delta_k(i)} \qquad (1)$$

where $W(i)$ = analysis weight for the ith person

$\delta_k(i) = 1$ if the ith person belongs to the kth domain and 0 if not

$Y(i)$ = response of the ith person

$T(i)$ = time-adjustment factor for the ith person

The numerator estimates total expenditures or utilization and the denominator the average annual number of persons in the population (that is, the total person-years). The time-adjustment factor $T(i)$ is the total days that person i is eligible divided by the number of days in the year.

Large out-of-pocket expenditures are defined as "annualized" out-of-pocket expenditures of $200 or more. The annualized out-of-pocket expenditure is the annual out-of-pocket expenditure divided by the fraction of the year during which the person is eligible. For domain k, the proportion with large out-of-pocket expenditures is estimated as

$$\overline{Y}_k(\text{NMES}) = \frac{\sum_{i \in S} W(i)T(i)\delta_k(i)Y(i)}{\sum_{i \in S} W(i)T(i)\delta_k(i)} \qquad (2)$$

where $Y(i) = 1$ if the person had large out-of-pocket expenditures and 0 if not.

The variables used in constructing these estimates were interim variables from the NMCUES analysis files and not the final variables contained in the public use files. For this reason, the estimates in this report may differ from those in other NMCUES reports.

The variance of $\overline{Y}_k(\text{NMES})$ was derived assuming a three-stage household survey design patterned after the 1980 NMCUES sample design with PSU's of standard metropolitan statistical area, or county-size and area segments (SEG's) selected as noncompact clusters of dwelling units. The households containing at least one RU response are designated as responding OBRU's. Using this approach, the variance of $\overline{Y}_k(\text{NMES})$ may be modeled as

$$\text{Var}\,[\overline{Y}_k(\text{NMES})] = \frac{\sigma_k^2(\text{PSU})}{r} + \frac{\sigma_k^2(\text{SEG})}{r\bar{s}} + \frac{\sigma_k^2(\text{OBRU})}{r\bar{s}\bar{t}} \qquad (3)$$

where $\sigma_k^2(\text{PSU})$ = between-PSU, within-stratum variance component for domain k

r = number of PSU's

$\sigma_k^2(\text{SEG})$ = between-segment, within-PSU variance component for domain k

$\bar{s}$ = average number of segments per PSU

$\sigma_k^2(\text{OBRU})$ = between-OBRU, within-segment variance component for domain k

$\bar{t}$ = average number of responding OBRU's per segment

The variance components were estimated using 1980 NMCUES data.

The variance components estimation program, developed at RTI by Shah[1] for evaluating the efficiency of complex sample designs, was applied to the NMCUES data to produce the generalized composite components for PSU's, segments (SEG's), and OBRU's. VMCPNLS estimates the composite variance components in terms of an expression for the variance of a multistage Horvitz-Thompson estimator derived by Gray.[2] For the NMCUES design, VMCPNLS yields a four-stage analysis including a between-PSU component [$\sum_k^2$(PSU)]; a between-segment, within-PSU component [$\sum_k^2$(SEG)]; a between-OBRU, within-segment component [$\sum_k^2$(OBRU)]; and a between-person (PID), within-OBRU component [$\sum_k^2$(PID)].

Because there is no subsampling of household members in NMCUES, the four-stage decomposition produced by VMCPNLS must be converted to the three-stage decomposition specified in equation (3). With the four-stage model, the PSU and segment components are equivalent to the corresponding parameters of the three-stage model. The OBRU-level component can be estimated from the four-stage components as $\sum_k^2$(OBRU) + $\sum_k^2$(PID)/$\bar{n}$ where $\bar{n}$ is the average number of responding persons per responding OBRU. Using the 1980 NMCUES data, $\bar{n}$ is estimated to be 2.73.

The variance components estimated using the 1980 NMCUES data contain an effect due to unequal weighting of the NMCUES sample. To remove the unequal weighting effect, these components were converted to the variance proportions Δ_k(PSU), Δ_k(SEG), and Δ_k(OBRU) by dividing by the total variation or

$$\Delta_k(\text{PSU}) = \frac{\sum_k^2(\text{PSU})}{\sum_k^2(\text{TOT})} \tag{4}$$

$$\Delta_k(\text{SEG}) = \frac{\sum_k^2(\text{SEG})}{\sum_k^2(\text{TOT})} \tag{5}$$

$$\Delta_k(\text{OBRU}) = \frac{\sum_k^2(\text{OBRU}) + \sum_k^2(\text{PID})/\bar{n}}{\sum_k^2(\text{TOT})} \tag{6}$$

where $\sum_k^2$(TOT) is defined as

$$\sum_k^2(\text{TOT}) = \sum_k^2(\text{PSU}) + \sum_k^2(\text{SEG}) + \sum_k^2(\text{OBRU}) + \frac{\sum_k^2(\text{PID})}{\bar{n}} \tag{7}$$

Table 2 displays these variance proportions for the 5 domains of interest and the 10 outcome measures described earlier.

To obtain the σ^2 variance components used in modeling the variance of the key statistics, the variance proportions were multiplied by the estimated population variance for the kth domain, denoted by $S^2(k)$. That is,

$$\sigma_k^2(\text{PSU}) = \Delta_k(\text{PSU})S^2(k) \tag{8}$$

$$\sigma_k^2(\text{SEG}) = \Delta_k(\text{SEG})S^2(k) \tag{9}$$

$$\sigma_k^2(\text{OBRU}) = \Delta_k(\text{OBRU})S^2(k) \tag{10}$$

A Taylor series approximation for the simple random sampling variance of a combined ratio estimator was used to estimate $S^2(k)$. The numerator was the Y total for domain k and the denominator the total person-years for domain k. (See equations (1) and (2).)

These three-stage variance component estimates were used to estimate the variances that would be achieved by self-weighting NMES OBRU designs with 6,000 and 10,000 responding. The terms remaining to be specified in the variance expression presented in equation (3) are the number of PSU's, r; the average number of segments sampled per PSU, $\bar{s}$; and the average number of OBRU's sampled per segment, $\bar{t}$. For modeling purposes, the RTI's General Purpose Sample was assumed, which contains 102 PSU's ($r = 102$). Because the 1980 NMCUES had been designed to be optimal with respect to the number of selections per segment, the number of responding OBRU's per segment was set to the value that the 1980 NMCUES achieved, or $\bar{t} = 8$. Therefore, the total number of segments in the OBRU design with 6,000 responding would be 750 ($r\bar{s} = 750$) and 1,250 for the OBRU design with 10,000 responding ($r\bar{s} = 1{,}250$).

These estimated variances were used as precision criteria for the other designs investigated in this study. Table 3 presents the results of this variance modeling activity for the 5 domains of interest and the 10 outcome measures. For convenience, percent relative standard errors are used rather than the variances. The percent relative standard error is 100 times the standard error (the square root of the variance) divided by the parameter being estimated. The percent relative standard errors achieved by the OBRU design with 6,000 responding are sufficient for the estimates based upon the total domain, but the increased precision that the OBRU design with 10,000 responding achieves for the small domain estimates is desirable.

Cost modeling

To establish cost comparisons between the unlinked and the linked designs, a systematic method was developed to generate the costs for all designs. The approach used was to develop unit costs by task for each design. The NMES tasks included in the modeling were the basic sampling and weighting tasks and the data collecting and processing tasks:

- Survey sampling.
- Instrument and materials development.
- Field preparations.
- Survey training.
- Data collection.
- Control system development and production.
- Data receipt, editing, and document control.
- Data coding operations.
- Data entry operations.
- Control card development, maintenance, and production.
- Summary development, maintenance, and production.
- Other data processing operations.
- Database construction.
- Counting and listing.
- Project administration.

The unit costs that were developed for each task were fixed costs, PSU-level costs, segment-level costs, and reporting-unit-level costs.

The first step in the process was to document the RTI cost experience for the 1980 NMCUES. Because of insufficient data for other contractors' costs, modeling was conducted with only RTI data. Only direct costs were included in the modeling because indirect costs, such as the costs for administration and building maintenance, vary among contractors as do accounting procedures used to recover these costs. Another step in documenting RTI costs for NMCUES was to separate the National Household Survey (HHS) costs from the costs associated with the four State Medicaid Household Surveys (SMHS). In most cases, SMHS activity was conducted under task numbers different from the HHS. In situations where HHS data and SMHS data were processed simultaneously, the additional costs added by SMHS were removed.

The next step was to use the 1980 NMCUES cost experience to develop unit costs for each task. Derivation of the unit costs by NMES task was a time-consuming process. The appendix includes a discussion of this process. The results are summarized in tables 4 and 5. Table 4 presents the costs for the OBRU design with 6,000 responding by category of cost for each of the 15 NMES tasks. Table 5 presents the costs for the OBRU design with 10,000 responding. For the OBRU design with 6,000 responding, direct costs are $4,963,013. For the OBRU design with 10,000 responding, direct costs are $7,209,409.

Other design considerations

Data for the 1980 NMCUES were collected by two contractors: RTI and the National Opinion Research Center (NORC). The cost modeling presented in this chapter was based on data from one contractor, however. There are advantages and disadvantages associated with using more than one contractor in data collection. These differences include quality, timeliness, and cost considerations.

Whether the OBRU design with 10,000 responding is chosen over the OBRU design with 6,000 responding, NMES will have time constraints on data collecting and processing, because data collection rounds are approximately 3 months apart. In the time between rounds 2 and 3, for instance, the data for round 2 must be collected, keyed, edited, coded, and entered into the database. The database is then used to generate a cumulative summary of household health care utilization and expenditures. This summary must be mailed to each household and interviewer before round 3. The volume of data collecting and processing required in this limited timeframe is beyond the capability of all but the largest firms. Hence, many firms would need to work together to accomplish the task.

Another advantage of using more than one contractor is the potential for improvements in work quality. Access to experienced interviewing and supervisory staff is limited to the volume of work performed. The inhouse staff needed to monitor data collection, to edit and to key the data, and to produce the final database is also limited. Merging the resources of more than one contractor enlarges the pool of experienced staff who can be assigned to a task.

The disadvantage of using more than one contractor is the inevitable duplication of effort. Each organization incurs the fixed costs associated with sampling, data collection, and data processing. To determine the cost penalty of using two contractors, the cost model that had been developed to determine costs for the 1980 NMCUES if only RTI had done the survey was used. The sample sizes of the 1980 NMCUES were used with one exception. Although the survey included 135 PSU's, only 108 were unique. Because overlapping of PSU's between the general purpose samples of the contractors was a duplication of effort, RTI-only 1980 NMCUES costs were modeled using 108 PSU's.

Table 6 summarizes the results of this comparison. RTI and NORC tasks were consolidated so that they correspond closely; therefore, the costs presented in this comparison are estimated costs. For example, many of the NORC tasks involved HHS and SMHS. Because the data collection instrument was the same for the surveys, both contractors combined the data entry and data processing tasks for HHS and SMHS. These tasks were adjusted by the number of the total that were HHS. RTI was responsible for the development of many procedures and materials used by both contractors. These development costs as well as the maintenance and production costs are contained in the RTI costs for the control system, control card, and summary. RTI keyed much of the data that NORC collected. Because this activity was performed under a separate charge number, the costs for RTI keying of NORC data are entered in the NORC column. Both contractors used their general purpose half-samples, so there were minimal costs for counting and listing. If RTI had done the full NMCUES, additional counting and listing would have been required for the portion of the RTI half-sample not in routine use. These costs have been included under the data collection task. Finally, database construction was performed exclusively by RTI and

printing by NORC, so these tasks are listed as separate entries with zero costs for the other contractor.

Examination of table 6 suggests that there is indeed a substantial cost penalty associated with the use of two contractors for NMCUES. This examination estimates the cost of using two contractors for the 1980 NMCUES as a $1,157,658 increase in direct costs for the study or an 18-percent increase over the costs for one contractor. The primary reason for the cost increase is that both contractors must incur fixed costs for sampling, data collection, and data processing. However, the *capability* of a single contractor to achieve results equivalent to NMCUES must be considered in weighing the advantages and disadvantages of using one versus two contractors.

Table 1. Completed reporting unit interviews by round for the unlinked designs with 6,000- and 10,000-respondent originating base reporting units (OBRU's)

Round	*1980 NMCUES*	*6,000 respondent OBRU's*	*10,000-respondent OBRU's*
1	6,603	6,319	10,531
2	6,519	6,238	10,397
3	6,528	6,247	10,411
4	4,559	4,363	7,271
5	6,561	6,278	10,464

Table 2. Proportions of National Medical Care Utilization and Expenditure Survey (NMCUES) expenditures and utilization variation by domain and type of service

Domain and outcome measure	Proportion of variation[1]		
	Δ(*PSU*)	Δ(*SEG*)	Δ(*OBRU*)
Total			
Visits:			
Hospital	0.0061	0.0007	0.9932
Facility	0.0134	0.0517	0.9349
Office	0.0066	0.0202	0.9732
Charges:			
Hospital	0.0002	0.0028	0.9970
Facility	0.0059	0.0338	0.9603
Office	0.0003	0.0328	0.9669
Expenses:			
Hospital, out of pocket (OOP)	0.0002	0.0065	0.9933
Facility, OOP	0.0048	0.0092	0.9860
Office, OOP	0.0002	0.0631	0.9367
Proportion with large OOP expenses	0.0002	0.0593	0.9405
150 percent of poverty population			
Visits:			
Hospital	0.0002	0.0117	0.9881
Facility	0.0002	0.0557	0.9441
Office	0.0038	0.0279	0.9683
Charges:			
Hospital	0.0002	0.0131	0.9867
Facility	0.0003	0.0456	0.9541
Office	0.0052	0.0262	0.9686
Expenses:			
Hospital, OOP	0.0002	0.0002	0.9996
Facility, OOP	0.0002	0.0113	0.9885
Office, OOP	0.0002	0.0277	0.9721
Proportion with large OOP expenses	0.0002	0.0248	0.9750
Medicare recipients			
Visits:			
Hospital	0.0039	0.0002	0.9959
Facility	0.0003	0.0003	0.9994
Office	0.0114	0.0003	0.9883
Charges:			
Hospital	0.0035	0.0005	0.9960
Facility	0.0003	0.0003	0.9994
Office	0.0081	0.0033	0.9886
Expenses:			
Hospital, OOP	0.0002	0.0002	0.9996
Facility, OOP	0.0008	0.0003	0.9989
Office, OOP	0.0095	0.0198	0.9707
Proportion with large OOP expenses	0.0002	0.0137	0.9861
Medicaid recipients			
Visits:			
Hospital	0.0007	0.0073	0.9920
Facility	0.0041	0.0360	0.9599
Office	0.0049	0.0056	0.9895
Charges:			
Hospital	0.0002	0.0083	0.9915
Facility	0.0003	0.0153	0.9844
Office	0.0050	0.0002	0.9948
Expenses:			
Hospital, OOP	0.0019	0.0003	0.9978
Facility, OOP	0.0003	0.0003	0.9994
Office, OOP	0.0002	0.0020	0.9978
Proportion with large OOP expenses	0.0025	0.0206	0.9769

[1]PSU = primary sampling unit; SEG = area segment; OBRU = originating base reporting unit.

Table 2. Proportions of National Medical Care Utilization and Expenditure Survey (NMCUES) expenditures and utilization variation by domain and type of service—Con.

Domain and outcome measure	*Proportion of variation*[1]		
	Δ(*PSU*)	Δ(*SEG*)	Δ(*OBRU*)
College head of household population			
Visits:			
Hospital	0.0017	0.0020	0.9963
Facility	0.0056	0.0333	0.9611
Office	0.0002	0.0155	0.9843
Charges:			
Hospital	0.0008	0.0075	0.9917
Facility	0.0053	0.0003	0.9944
Office	0.0002	0.0175	0.9822
Expenses:			
Hospital, OOP	0.0001	0.0119	0.9880
Facility, OOP	0.0003	0.0266	0.9731
Office, OOP	0.0002	0.0329	0.9669
Proportion with large OOP expenses	0.0012	0.0150	0.9838

[1] PSU = primary sampling unit; SEG = area segment; OBRU = originating base reporting unit.

Table 3. Estimated means and relative standard errors for the unlinked National Medical Expenditure Survey (NMES) design with 6,000- and 10,000-respondent originating base reporting units (OBRU's)

Domain and outcome measure	Y_k(*NMES*)	*Relative standard error*	
		6,000-respondent OBRU's	*10,000-respondent OBRU's*
Total			
Visits:			
Hospital	0.18	3.11	2.61
Facility	0.86	4.92	4.25
Office	4.18	2.02	1.69
Charges:			
Hospital	362.04	6.22	4.84
Facility	50.56	4.95	4.11
Office	117.71	2.42	1.88
Expenses:			
Hospital, out of pocket (OOP)	33.10	12.08	9.39
Facility, OOP	9.77	4.82	3.99
Office, OOP	53.70	2.43	1.89
Proportion with large OOP expenses	0.24	7.03	5.47
150 percent of poverty population			
Visits:			
Hospital	0.24	5.29	4.11
Facility	1.22	8.33	6.47
Office	4.23	4.10	3.34
Charges:			
Hospital	516.93	13.04	10.14
Facility	66.65	10.87	8.45
Office	108.82	4.79	3.95
Expenses:			
Hospital, OOP	40.40	15.31	11.91
Facility, OOP	9.70	8.50	6.61
Office, OOP	38.82	5.46	4.24
Proportion with large OOP expenses	0.20	13.55	10.53
Medicare recipients			
Visits:			
Hospital	0.40	5.74	4.72
Facility	1.45	9.97	7.76
Office	7.27	4.38	3.83
Charges:			
Hospital	1,164.15	11.18	9.14
Facility	88.14	12.81	9.97
Office	212.31	7.17	6.11
Expenses:			
Hospital, OOP	79.02	17.82	13.87
Facility, OOP	13.47	10.47	8.23
Office, OOP	79.38	5.50	4.70
Proportion with large OOP expenses	0.43	4.82	3.75
Medicaid recipients			
Visits:			
Hospital	0.33	6.63	5.20
Facility	1.36	7.70	6.27
Office	5.21	5.59	4.63
Charges:			
Hospital	691.56	13.56	10.55
Facility	78.09	7.45	5.80
Office	139.60	7.27	6.04
Expenses:			
Hospital, OOP	36.18	29.97	23.98
Facility, OOP	7.39	20.80	16.19
Office, OOP	23.10	9.57	7.44
Proportion with large OOP expenses	0.11	22.79	18.32

Table 3. Estimated means and relative standard errors for the unlinked National Medical Expenditure Survey (NMES) design with 6,000 and 10,000 respondent originating base reporting units (OBRU's)—Con.

Domain and outcome measure	Y_k(*NMES*)	*Relative standard errors*	
		6,000-respondent OBRU's	*10,000-respondent OBRU's*
College head of household population			
Visits:			
Hospital	0.14	7.17	5.72
Facility	0.75	9.91	8.20
Office	4.80	4.33	3.37
Charges:			
Hospital	287.87	19.18	15.06
Facility	45.17	8.66	7.22
Office	141.41	4.84	3.76
Expenses:			
Hospital, OOP	40.34	42.30	32.84
Facility, OOP	8.85	11.22	8.73
Office, OOP	75.15	5.71	4.43
Proportion with large OOP expenses	0.30	14.48	11.45

Table 4. Summary of estimated costs of project tasks for the 6,000-respondent originating base reporting unit unlinked design

	Cost category	Total	Project task[1] 1	2	3	4	5
01	Total	$4,963,013	$56,781	$185,500	$59,566	$515,553	$1,618,746
	Direct technical labor						
02	On-site	1,242,967	52,732	20,078	11,943	30,144	228,215
03	Off-site	292,583	-	-	23,669	50,291	197,350
	Other direct cost						
04	Total	3,427,463	4,049	165,422	23,954	435,118	1,193,181
05	Materials and supplies	58,565	147	1,034	839	473	24,222
06	Services	183,871	311	1,087	2,163	24,449	20,779
07	Shipping and communications	162,204	305	646	6,161	11,289	74,541
	Travel:						
08	On-site	52,365	842	1,869	1,015	10,479	8,872
09	Off-site	219,079	-	139	7,695	148,441	48,649
10	Consultants	27,825	-	-	-	-	-
11	Computer services	681,529	-	-	-	-	-
12	Reports and reproductions	166,369	-	159,748	38	-	1,406
13	Interviewer services	684,042	-	-	1,604	139,607	502,782
14	Interviewer expenses	439,080	-	-	3,718	95,608	331,716
15	Respondent incentives	124,805	-	-	-	-	124,805
16	Clerical labor	379,626	458	561	28	1,893	27,984
17	Clerical labor surcharge	197,264	2	249	10	1,088	15,827
18	Miscellaneous	14,441	-	60	85	152	1,367
19	Overtime expenses	36,398	1,984	29	598	1,639	10,231

[1]Legend for project tasks:
1 = Survey sampling.
2 = Instrument and materials development.
3 = Field preparations.
4 = Survey training.
5 = Data collection.
6 = Control system development and production.
7 = Data receipt, editing, and document control.
8 = Data coding operations.
9 = Data entry operations.
10 = Control card development, maintenance, and production.
11 = Summary development, maintenance, and production.
12 = Other data processing operations.
13 = Database construction.
14 = Counting and listing (costs not incurred on the National Medical Care Utilization and Expenditure Survey).
15 = Project administration.

Table 4. Summary of estimated costs of project tasks for the 6,000-respondent originating base reporting unit unlinked design—Con.

Project task[1]*—Con.*										
6	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	
$217,061	$280,462	$72,417	$388,378	$104,271	$167,509	$613,673	$401,874	$57,842	$223,380	01
81,099	42,188	12,925	89	40,089	60,378	302,596	163,058	7,559	189,873	02
-	-	-	-	-	-	-	-	21,273	-	03
135,962	238,274	59,492	388,289	64,182	107,131	311,077	238,816	29,009	33,507	04
952	4,663	1,494	255	5,174	6,854	10,244	65	473	1,675	05
16	6,467	65	126,173	-	23	2,135	-	203	-	06
3	56,677	99	18	225	126	2,885	845	1,683	6,701	07
863	1,490	293	2	839	1,098	4,449	150	-	20,104	08
-	-	-	-	-	-	-	-	14,155	-	09
1,419	-	-	-	3,971	819	21,380	236	-	-	10
119,932	-	-	-	49,067	88,360	186,789	237,381	-	-	11
-	-	-	-	-	-	-	-	151	5,026	12
-	-	-	-	-	-	33,436	-	6,613	-	13
-	-	-	-	-	2,307	-	-	5,731	-	14
-	-	-	-	-	-	-	-	-	-	15
38	127,612	44,693	140,645	13	72	35,574	55	-	-	16
-	40,072	12,179	115,406	3	35	12,364	29	-	-	17
12,329	108	8	169	-	149	14	-	-	-	18
410	1,185	661	5,621	4,890	7,288	1,807	55	-	-	19

Table 5. Summary of estimated costs of project tasks for the 10,000-respondent originating base reporting unlinked design

	Cost category	Total	Project task[1] 1	2	3	4	5
01	Total	$7,209,409	$75,137	$293,470	$59,566	$715,400	$2,396,714
	Direct technical labor						
02	On-site	1,591,977	69,974	21,294	11,943	36,747	288,800
03	Off-site	370,071	-	-	23,669	61,415	249,532
	Other direct cost						
04	Total	5,247,360	5,163	272,176	23,954	617,238	1,858,382
05	Materials and supplies	78,334	166	1,097	839	579	30,806
06	Services	285,138	383	1,153	2,163	30,013	28,417
07	Shipping and communications	223,165	421	685	6,161	14,319	94,459
	Travel:						
08	On-site	57,606	1,177	1,983	1,015	14,253	8,872
09	Off-site	254,534	-	147	7,695	161,462	61,639
10	Consultants	27,919	-	-	-	-	-
11	Computer services	1,004,795	-	-	-	-	-
12	Reports and reproductions	273,604	-	266,158	38	-	1,891
13	Interviewer services	1,113,807	-	-	1,604	231,701	818,041
14	Interviewer expenses	708,756	-	-	3,718	159,134	532,686
15	Respondent incentives	207,938	-	-	-	-	207,938
16	Clerical labor	616,264	517	595	28	2,273	37,662
17	Clerical labor surcharge	321,134	2	264	10	1,324	21,305
18	Miscellaneous	22,038	-	64	85	182	1,733
19	Overtime expenses	52,328	2,497	30	598	1,998	12,933

[1]Legend for project tasks:
1 = Survey sampling.
2 = Instrument and materials development.
3 = Field preparations.
4 = Survey training.
5 = Data collection.
6 = Control system development and production.
7 = Data receipt, editing, and document control.
8 = Data coding operations.
9 = Data entry operations.
10 = Control card development, maintenance, and production.
11 = Summary development, maintenance, and production.
12 = Other data processing operations.
13 = Database construction.
14 = Counting and listing (costs not incurred on the National Medical Care Utilization and Expenditure Survey).
15 = Project administration.

Table 5. Summary of estimated costs of project tasks for the 10,000-respondent originating base reporting unit unlinked design—Con.

Project task[1]—Con.										
6	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	
$316,284	$438,640	$115,142	$646,941	$146,186	$251,632	$861,801	$562,075	$96,403	$234,018	01
117,295	52,116	16,785	147	56,189	87,929	393,203	228,041	12,599	198,915	02
-	-	-	-	-	-	-	-	35,455	-	03
198,989	386,524	98,357	646,794	89,997	163,703	468,598	334,034	48,349	35,103	04
1,203	5,809	1,940	417	7,252	9,802	15,790	90	789	1,755	05
26	8,992	91	210,189	-	36	3,336	-	339	-	06
3	92,681	164	30	225	126	2,885	1,181	2,804	7,021	07
863	1,490	293	3	839	1,098	4,449	209	-	21,062	08
-	-	-	-	-	-	-	-	23,591	-	09
1,419	-	-	-	3,971	819	21,380	330	-	-	10
175,591	-	-	-	70,169	136,238	290,764	332,033	-	-	11
-	-	-	-	-	-	-	-	252	5,265	12
-	-	-	-	-	-	51,440	-	11,021	-	13
-	-	-	-	-	3,666	-	-	9,552	-	14
-	-	-	-	-	-	-	-	-	-	15
49	209,926	74,462	234,351	17	90	56,219	75	-	-	16
-	65,992	20,293	192,302	4	46	19,552	40	-	-	17
19,319	134	13	279	-	208	21	-	-	-	18
516	1,500	1,101	9,223	7,520	11,574	2,762	76	-	-	19

Table 6. Overview of Research Triangle Institute (RTI) and National Opinion Research Center (NORC) actual National Medical Care Utilization and Expenditure Survey (NMCUES) Household Survey direct cost experience compared with a 1980 NMCUES RTI-only design

Task description	*NORC direct cost*	*RTI direct cost*[1]	*Consolidation of RTI and NORC direct cost experience*	*Estimated costs to conduct 1980 RTI-only design*	*Difference between RTI and NORC actual versus RTI-only design*	*Percent difference*
Total	$3,194,209	$3,184,396	$6,378,605	$5,220,947	−$1,157,658	−19
Instrument development	116,106	24,644	140,750	25,857	−114,893	−82
GPO printing (NORC only)	133,565	-	133,565	166,883	33,318	−25
Sampling	61,822	44,291	106,113	58,147	−47,966	−45
HHS data collection	1,163,065	1,006,363	2,169,428	1,814,496	−354,932	−16
HHS training	444,678	433,958	878,636	602,922	−275,714	−31
Receipt and editing	156,057	160,852	316,909	290,655	−26,254	−8
Coding	64,368	42,066	106,434	75,280	−31,154	−29
Data entry	198,105	204,731	402,836	405,725	2,889	1
Control system production	135,147	146,581	281,728	223,711	−58,017	−21
Control card production	96,507	74,502	171,009	107,080	−63,929	−37
Summary production	80,797	107,851	188,648	173,175	−15,473	−8
Other data processing	408,940	437,529	846,469	630,352	−216,117	−26
Database construction (RTI only)	-	288,285	288,285	412,646	124,361	43
Project management	135,052	212,743	347,795	234,018	−113,777	−33

[1]RTI task cost experience already ratio adjusted for the National Household Survey.

Chapter 3
The linked dwelling unit design

The first National Health Interview Survey (NHIS) linked design investigated was a linked dwelling unit design. Using this design, the National Medical Expenditure Survey (NMES) is selected from a frame of NHIS sample listings. For comparison, four design options were developed based on two primary sampling unit (PSU) counts and two sample sizes. The variances achieved by the linked dwelling unit design were modeled and compared with those achieved by the unlinked designs. The sample sizes for the 100 and 200 PSU designs were set so that the resulting samples have the same precision as that of the unlinked originating base reporting unit (OBRU) design with 6,000 and 10,000 responding. Costs were developed for these four design options.

Definition

Linkage of NMES to NHIS makes available a list frame of names and addresses for NMES sample selection. The sample units in this design are the addresses included in NHIS rather than NHIS sample persons living at the addresses. After selecting a sample of addresses from the NHIS frame, NMES interviews the occupants of the sample dwelling units in round 1. NHIS sample members who move before round 1 of NMES are not followed; instead, any new occupants of the dwelling are included in NMES. Except for the selection process of the round 1 sample, the linked dwelling unit design follows the same procedures and definitions as those of the unlinked NMES. That is, the first, second, and fifth data collection rounds are conducted by personal interview; the third and fourth rounds, by telephone. Family members who are college students living away from home are interviewed at their temporary addresses. The round 1 sample individuals have data collected for them for the remaining four rounds of the survey whether or not they continue living in the same dwelling.

Using the NHIS listings for NMES sample selection, it was considered whether units that were nonresidential or nonresponding should be excluded before selection of the NMES sample. Units used for nonresidential purposes only would likely be nonresidential at the time of NMES. However, during the time between NHIS and NMES, the use of a nonresidential structure could change or residential spaces could be added. Also, the NHIS interviewer might fail to note a residential apartment attached to a nonresidential unit. These examples suggest that undercoverage in the NMES sample is likely if NHIS-identified nonresidential structures are omitted.

The second consideration for NMES sample selection is whether to exclude residential listings for which NHIS could not obtain a response. Although the NHIS refusal rate is very low, approximately 2.5 percent, the short data collection period (2 weeks) results in more nonresponse due to absence than in NMES collection (2.5 percent versus 0.6 percent of the 1980 NMCUES). Also, some of these nonresponding households may move before round 1 of NMES and be replaced by more cooperative households. The response rate from new occupants is assumed to be the same as that of the general population. If all nonresponding units were removed from the NMES frame, NMES would start with a 5.0 percent nonresponse rate before data collection and with the associated nonresponse bias.

Because nonresponding and ineligible NHIS listings are likely to yield few responding NMES cases, but excluding them would result in undercoverage of the NMES sample, the best approach is to include them in the frame but sample them at a lower rate. The low cost of identifying a nonresidential unit makes it feasible to include all nonresidential addresses in the frame to avoid undercoverage of the NMES frame. Nonresponding units are also included but the NHIS experience is used to determine the extent of followup for nonresponding units.

Therefore, the frame for NMES should include all of the NHIS sample addresses associated with the NMES sample PSU's and segments. After selection of the round 1 sample addresses, the collection procedures are the same as those of the unlinked design. These include the use of the half-open interval procedure for new construction to be included in NMES.

Sample size determination

To compare the linked designs with the unlinked designs, the sample size for the linked designs was set to the size yielding the same precision as the unlinked design. To determine the sample size for the linked dwelling unit design, the variance for the design was modeled.

The redesigned NHIS has the same target population as NMES. To represent this target population, NHIS includes 200 sample PSU's and 8,750 segments from these PSU's. The segments contain an average of 40 addresses, 6 of which are selected for inclusion in NHIS. The sample segments are separated into 52 weekly sets, so that each weekly sample is a valid national sample. A feature of NHIS is that the black population is oversampled at a rate 1.4 times that of all other races.

To model the variance of NMES sample estimates, it is assumed that NHIS oversamples black persons by increasing selection of high concentration black segments. To produce a self-weighting NMES, the effect of this oversampling is removed by subsampling these segments. The estimation procedures are similar to those presented for the unlinked design. That is, the sample estimate of mean utilization or expenditure per person-year is estimated by means of equation (1) as

$$\bar{Y}_k(\text{NMES}) = \frac{\sum_{i \in S} W(i)\delta_k(i)Y(i)}{\sum_{i \in S} W(i)T(i)\delta_k(i)} \qquad (11)$$

and the proportion burdened with large out-of-pocket expenditures by means of equation (2) as

$$\bar{Y}_k(\text{NMES}) = \frac{\sum_{i \in S} W(i)T(i)\delta_k(i)Y(i)}{\sum_{i \in S} W(i)T(i)\delta_k(i)} \qquad (12)$$

Using this approach, the variance of $\bar{Y}_k$(NMES) can again be expressed as

$$\text{Var}\,[\bar{Y}_k(\text{NMES})] = \frac{\sigma_k^2(\text{PSU})}{r} + \frac{\sigma_k^2(\text{SEG})}{r\bar{s}} + \frac{\sigma_k^2(\text{OBRU})}{r\bar{s}\bar{t}} \qquad (13)$$

where σ_k^2(PSU) = between NHIS PSU, within NHIS segment variance component for domain k

r = number of NHIS PSU's from which NMES is selected

σ_k^2(SEG) = between NHIS segment, within NHIS PSU variance component for domain k

$\bar{s}$ = average number of NHIS segments selected for NMES per sampled PSU

σ_k^2(OBRU) = between NMES OBRU, within NHIS segment variance component for domain k

$\bar{t}$ = average number of NHIS addresses selected for NMES per sampled segment

The specifications for the redesigned NHIS indicate that the NHIS PSU's and segments are similar in definition and size to those of the 1980 NMCUES. For this reason, the 1980 NMCUES variance component estimates described earlier were used to model the NHIS variance components.

The parameters remaining to be specified are r, $\bar{s}$, and $\bar{t}$. Depending on the design being modeled, the number of PSU's or r is 100 or 200. The NHIS samples 6 addresses out of 40 in a segment. NMCUES data were used to determine the number of responding OBRU's that could be derived from these six addresses. On the average, NMCUES obtained 1.045 responding OBRU's per address. With the same response and attrition rates for the linked design, six responding OBRU's is the maximum that could be obtained per sample segment. Because this is smaller than the optimal number of OBRU's to select per segment, it is assumed that all NHIS sample addresses within NMES-subsampled segments are included in NMES so that $\bar{t} = 6$.

The total sample size is $r\bar{s}\bar{t}$; the term remaining to be specified is $\bar{s}$. This process is illustrated for the 100-PSU design set to achieve the same precision as that of the unlinked OBRU design with 6,000 responding. The variance for the unlinked NMES OBRU design with 6,000 responding is modeled as

$$\frac{\sigma_k^2(\text{PSU})}{102} + \frac{\sigma_k^2(\text{SEG})}{750} + \frac{\sigma_k^2(\text{OBRU})}{6{,}000}$$

and the variance for the 100-PSU 6,000-OBRU-equivalent linked design is modeled as

$$\frac{\sigma_k^2(\text{PSU})}{100} + \frac{\sigma_k^2(\text{SEG})}{100\bar{s}} + \frac{\sigma_k^2(\text{OBRU})}{600\bar{s}}$$

These two expressions can be set equal for a specific domain k and a specific statistic, and the value of $\bar{s}$ derived will result in the linked design achieving the same precision as that of the unlinked design. The required number of segments vary depending on the domain and the outcome measure. Therefore, an average over the 50 statistics formed by the 5 domains and 10 outcome measures was used to determine the number of segments to be costed. Table 7 presents the number of segments required to obtain the precision of the unlinked design for each of the 5 domains and 10 outcome measures.

Cost modeling

The difference between the linked dwelling unit design and the unlinked design is the selection procedure for sample dwelling units which may affect the response rates for the survey. For example, interviewing the occupants of the sample dwelling units (except for new occupants), who have already been interviewed once, might have a negative effect on response. However, lead letters can be sent before the NMES interview. Because the use of lead letters tends to improve response, the linked dwelling unit design should be able to achieve the same response rates as the unlinked design.

Costs were developed for four linked dwelling unit designs based on the two PSU size options and the two sample size options. These four designs are as follows:

- *Design A.* 100 PSU's and a sample size sufficient to yield estimates of the same precision as the unlinked design with 6,000 responding OBRU's.
- *Design B.* 200 PSU's and a sample size sufficient to yield estimates of the same precision as the unlinked design with 6,000 responding OBRU's.
- *Design C.* 100 PSU's and a sample size sufficient to yield estimates of the same precision as the unlinked design with 10,000 responding OBRU's.
- *Design D.* 200 PSU's and a sample size sufficient to yield estimates of the same precision as the unlinked design with 10,000 responding OBRU's.

Based on the procedures discussed in the previous section, the sample sizes for the four designs were determined. Design A has 100 PSU's, 976 segments, and 5,856 responding OBRU's; design B has 200 PSU's, 921 segments, and 5,526 responding OBRU's; design C has 100 PSU's, 1,629 segments, and 9,774 responding OBRU's; and design D has 200 PSU's, 1,489 segments, and 8,934 responding OBRU's.

For each of these designs, all sample addresses are visited regardless of their classification by NHIS. Because the response rates are assumed to be the same as those of the 1980 NMCUES, the unit costs for the linked dwelling unit design are similar to those of the unlinked design. Costs for lead letters were added to the model, and the costs for counting and listing were deleted from the model.

Using these unit costs, the direct costs were estimated for the four designs. These costs are summarized in tables 8–11. The total costs for all tasks and all data collection rounds were $4,871,106 for design A and $4,947,848 for design B. For the equivalent 6,000-OBRU unlinked design, the total cost was $4,963,013. The costs for design A are less due to not having counting and listing costs and sampling 100 instead of the 102 PSU's in the unlinked design. Design B is more costly because it samples 200 PSU's. The direct cost estimate for designs C and D are $7,147,752 and $6,930,673, respectively, compared with $7,209,409 for the equivalent OBRU unlinked design with 10,000 responding. Both designs have costs lower than those of the unlinked design, and the 200-PSU design has the lowest total cost. This suggests that increased precision constraints make it cost effective to increase the number of PSU's in the design to 200. For reasons described in chapter 5, these results, instead, appear to be an indication of instability in the variance component estimates.

Other design considerations

The linked dwelling unit design, as described in this chapter, makes little use of the information collected for NHIS respondents. An alternative approach is to stratify NHIS dwelling units based on the characteristics of the occupants. Strata are also developed for the units that were unoccupied, nonresidential, and nonresponding. This stratification might improve the efficiency of the designs described earlier. Such an approach involves an optimization to determine the appropriate sample sizes. Optimization requires modeling the effect of movement on stratification. Depending on the amount of movement, there may be no advantage in stratifying the NHIS addresses before the NMES sample selection. Because of the complexity of the variance modeling and the assumption that the advantage of stratification is small as a result of movement, the stratification approach was not investigated in this study.

Table 7. Required segment size for the linked design to obtain the precision of the unlinked design by domain and type of service

Domain and outcome measure	Precision			
	6,000-respondent OBRU's		10,000-respondent OBRU's	
	100 PSU's	200 PSU's	100 PSU's	200 PSU's
Total				
Visits:				
Hospital	1,006	849	1,684	1,287
Facility	934	718	1,569	1,041
Office	971	826	1,626	1,257
Charges:				
Hospital	995	988	1,658	1,640
Facility	950	831	1,590	1,282
Office	947	941	1,578	1,562
Expenses:				
Hospital, out-of-pocket (OOP)	988	982	1,646	1,630
Facility, OOP	988	868	1,653	1,342
Office, OOP	913	908	1,521	1,510
Proportion with large OOP expenses	916	912	1,528	1,515
150 percent of poverty population				
Visits:				
Hospital	979	973	1,631	1,615
Facility	920	916	1,533	1,522
Office	953	949	1,589	1,576
Charges:				
Hospital	976	971	1,627	1,612
Facility	931	926	1,552	1,537
Office	960	848	1,606	1,316
Expenses:				
Hospital, OOP	1,000	994	1,667	1,650
Facility, OOP	979	973	1,632	1,614
Office, OOP	954	949	1,590	1,576
Proportion with large OOP expenses	958	953	1,597	1,583
Medicare recipients				
Visits:				
Hospital	1,004	898	1,679	1,402
Facility	1,000	992	1,667	1,644
Office	1,013	750	1,704	1,071
Charges:				
Hospital	1,003	907	1,677	1,424
Facility	1,000	992	1,667	1,644
Office	1,003	807	1,682	1,196
Expenses:				
Hospital, OOP	1,000	993	1,667	1,648
Facility, OOP	1,000	976	1,668	1,603
Office, OOP	975	777	1,635	1,146
Proportion with large OOP expenses	975	969	1,626	1,609
Medicaid recipients				
Visits:				
Hospital	987	968	1,646	1,594
Facility	946	861	1,581	1,356
Office	995	870	1,664	1,341
Charges:				
Hospital	985	978	1,641	1,624
Facility	973	966	1,621	1,603
Office	1,005	873	1,682	1,343
Expenses:				
Hospital, OOP	1,002	947	1,672	1,526
Facility, OOP	1,000	992	1,667	1,644
Office, OOP	996	991	1,661	1,645
Proportion with large OOP Expenses	966	906	1,614	1,451

See note at end of table.

Table 7. Required segment size for the linked design to obtain the precision of the unlinked design by domain and type of service—Con.

Domain and outcome measure	Precision			
	6,000-respondent OBRU's		10,000-respondent OBRU's	
	100 PSU's	200 PSU's	100 PSU's	200 PSU's
College head of household population				
Visits:				
Hospital	998	950	1,666	1,535
Facility	951	836	1,590	1,293
Office	972	967	1,621	1,606
Charges:				
Hospital	987	966	1,645	1,588
Facility	1,006	866	1,683	1,324
Office	969	963	1,615	1,599
Expenses:				
Hospital, OOP	978	975	1,630	1,621
Facility, OOP	955	949	1,593	1,576
Office, OOP	947	942	1,578	1,566
Proportion with large OOP expenses	974	943	1,625	1,539
Average				
All outcome measures	976	921	1,629	1,489

NOTE: OBRU's = originating base reporting units; PSU's = primary sampling units.

Table 8. Summary of estimated costs of project tasks for linked dwelling unit design A

	Cost category	Total	Project task[1] 1	2	3	4	5
01	Total	$4,871,106	$55,462	$182,510	$52,723	$560,811	$1,587,592
	Direct technical labor						
02	On-site	1,230,433	49,575	20,076	13,164	30,411	232,589
03	Off-site	274,965	-	-	21,278	50,741	202,946
	Other direct cost						
04	Total	3,365,708	5,887	162,434	18,281	479,659	1,152,057
05	Materials and supplies	58,681	161	1,051	658	475	25,175
06	Services	180,106	327	1,076	1,582	24,673	20,858
07	Shipping and communications	160,572	308	645	4,971	10,245	77,561
	Travel:						
08	On-site	52,738	834	1,872	750	11,796	8,201
09	Off-site	242,726	-	139	6,586	186,203	49,798
10	Consultants	27,821	-	-	-	-	-
11	Computer services	669,623	-	-	-	-	-
12	Reports and reproductions	163,302	-	156,734	12	-	1,530
13	Interviewer services	653,241	-	-	608	143,303	476,550
14	Interviewer expenses	415,764	-	-	2,514	98,151	312,841
15	Respondent incentives	121,771	-	-	-	-	121,771
16	Clerical labor	374,985	1,931	581	20	1,908	29,442
17	Clerical labor surcharge	194,182	361	248	7	1,098	16,544
18	Miscellaneous	14,166	-	60	67	153	1,374
19	Overtime expenses	36,029	1,965	28	506	1,654	10,412

[1]Legend for project tasks:
1 = Survey sampling.
2 = Instrument and materials development.
3 = Field preparations.
4 = Survey training.
5 = Data collection.
6 = Control system development and production.
7 = Data receipt, editing, and document control.
8 = Data coding operations.
9 = Data entry operations.
10 = Control card development, maintenance, and production.
11 = Summary development, maintenance, and production.
12 = Other data processing operations.
13 = Database construction.
14 = Project administration.

Table 8. Summary of estimated costs of project tasks for linked dwelling unit design A—Con.

Project task[1]—Con.									
6	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	
$213,374	$278,007	$70,829	$378,794	$102,712	$164,423	$604,526	$395,963	$223,380	01
79,741	42,383	12,782	87	39,491	59,363	299,240	160,658	189,873	02
0	-	-	-	-	-	-	-	-	03
133,633	234,624	58,047	378,707	63,221	105,060	305,286	235,305	33,507	04
944	4,876	1,476	247	5,092	6,745	10,043	63	1,675	05
16	6,369	63	123,031	-	22	2,089	-	-	06
3	55,956	96	18	225	126	2,885	832	6,701	07
863	1,490	293	2	839	1,098	4,449	147	20,104	08
-	-	-	-	-	-	-	-	-	09
1,419	-	-	-	3,971	819	21,380	232	-	10
117,871	-	-	-	48,282	86,609	182,966	233,895	-	11
-	-	-	-	-	-	-	-	5,026	12
-	-	-	-	-	-	32,780	-	-	13
-	-	-	-	-	2,258	-	-	-	14
-	-	-	-	-	-	-	-	-	15
38	125,347	43,588	137,183	13	70	34,811	53	-	16
-	39,307	11,879	112,571	4	35	12,099	29	-	17
12,074	107	7	165	-	146	13	-	-	18
405	1,172	645	5,490	4,795	7,132	1,771	54	-	19

Table 9. Summary of estimated costs of project tasks for linked dwelling unit design B

	Cost category	Total	Project task[1] 1	2	3	4	5
01	Total	$4,947,848	$54,010	$173,550	$93,672	$535,022	$1,742,799
	Direct technical labor						
02	On-site	1,268,244	48,311	19,974	22,397	29,796	281,442
03	Off-site	334,853	-	-	37,922	49,707	247,224
	Other direct cost						
04	Total	3,344,751	5,699	153,576	33,353	455,519	1,214,133
05	Materials and supplies	62,026	154	1,045	1,152	465	28,895
06	Services	176,378	316	1,071	3,163	24,160	23,146
07	Shipping and communications	177,169	297	642	8,742	9,857	92,367
	Travel:						
08	On-site	57,969	816	1,862	1,302	11,558	13,151
09	Off-site	248,748	-	138	11,659	177,414	59,537
10	Consultants	27,814	-	-	-	-	-
11	Computer services	642,969	-	-	-	-	-
12	Reports and reproductions	155,062	-	147,906	24	-	2,106
13	Interviewer services	644,907	-	-	1,217	134,931	477,463
14	Interviewer expenses	423,965	-	-	5,027	92,416	324,376
15	Respondent incentives	114,913	-	-	-	-	114,913
16	Clerical labor	369,841	1,848	577	40	1,872	40,883
17	Clerical labor surcharge	191,442	345	247	14	1,076	22,944
18	Miscellaneous	13,892	-	60	118	150	1,640
19	Overtime expenses	37,655	1,923	28	895	1,620	12,712

[1]Legend for project tasks:
1 = Survey sampling.
2 = Instrument and materials development.
3 = Field preparations.
4 = Survey training.
5 = Data collection.
6 = Control system development and production.
7 = Data receipt, editing, and document control.
8 = Data coding operations.
9 = Data entry operations.
10 = Control card development, maintenance, and production.
11 = Summary development, maintenance, and production.
12 = Other data processing operations.
13 = Database construction.
14 = Project administration.

Table 9. Summary of estimated costs of project tasks for linked dwelling unit design B—Con.

Project task[1]*—Con.*									
6	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	
$205,192	$271,883	$67,306	$357,472	$99,255	$157,488	$584,065	$382,754	$223,380	01
76,755	44,828	12,464	83	38,163	57,092	291,767	155,299	189,873	02
-	-	-	-	-	-	-	-	-	03
128,437	227,055	54,842	357,389	61,092	100,396	292,298	227,455	33,507	04
923	4,975	1,439	233	4,921	6,502	9,586	61	1,675	05
16	6,332	61	116,102	-	21	1,990	-	-	06
3	54,412	91	17	225	126	2,885	804	6,701	07
863	1,490	293	2	839	1,098	4,449	142	20,104	08
-	-	-	-	-	-	-	-	-	09
1,419	-	-	-	3,971	819	21,380	225	-	10
113,281	-	-	-	46,541	82,662	174,394	226,091	-	11
-	-	-	-	-	-	-	-	5,026	12
-	-	-	-	-	-	31,296	-	-	13
-	-	-	-	-	2,146	-	-	-	14
-	-	-	-	-	-	-	-	-	15
37	120,753	41,133	129,456	13	69	33,108	52	-	16
-	37,804	11,210	106,230	4	34	11,506	28	-	17
11,498	110	7	156	-	141	12	-	-	18
397	1,179	608	5,193	4,578	6,778	1,692	52	-	19

Table 10. Summary of estimated costs of project tasks for linked dwelling unit design C

	Cost category	Total	Project task[1] 1	2	3	4	5
01	Total	$7,147,752	$72,697	$288,961	$52,723	$856,020	$2,359,208
	Direct technical labor						
02	On-site	1,574,037	64,592	21,296	13,164	37,460	298,543
03	Off-site	344,486	-	-	21,278	62,579	260,529
	Other direct cost						
04	Total	5,229,229	8,105	267,665	18,281	755,981	1,800,036
05	Materials and supplies	79,277	241	1,127	658	587	32,799
06	Services	280,203	455	1,134	1,582	30,541	28,798
07	Shipping and communications	225,072	440	684	4,971	14,679	100,307
	Travel:						
08	On-site	56,813	1,043	1,986	750	14,530	8,201
09	Off-site	357,644	-	147	6,586	286,792	64,119
10	Consultants	27,914	-	-	-	-	-
11	Computer services	986,252	-	-	-	-	-
12	Reports and reproductions	269,012	-	261,601	12	-	2,134
13	Interviewer services	1,067,987	-	-	608	239,148	777,819
14	Interviewer expenses	673,587	-	-	2,514	163,797	503,687
15	Respondent incentives	203,245	-	-	-	-	203,245
16	Clerical labor	611,365	2,914	629	20	2,326	40,843
17	Clerical labor surcharge	317,242	544	263	7	1,356	22,969
18	Miscellaneous	21,642	-	64	67	187	1,762
19	Overtime expenses	51,974	2,468	30	506	2,038	13,353

[1]Legend for project tasks:
1 = Survey sampling.
2 = Instrument and materials development.
3 = Field preparations.
4 = Survey training.
5 = Data collection.
6 = Control system development and production.
7 = Data receipt, editing, and document control.
8 = Data coding operations.
9 = Data entry operations.
10 = Control card development, maintenance, and production.
11 = Summary development, maintenance, and production.
12 = Other data processing operations.
13 = Database construction.
14 = Project administration.

Table 10. Summary of estimated costs of project tasks for linked dwelling unit design C—Con.

Project task[1]*—Con.*									
6	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	
$310,576	$437,744	$112,686	$632,080	$143,776	$246,811	$847,568	$552,884	$234,018	01
115,205	54,234	16,564	143	55,263	86,349	387,998	224,311	$198,915	02
-	-	-	-	-	-	-	-	-	03
195,371	383,510	96,122	631,937	88,513	160,462	459,570	328,573	35,103	04
1,190	6,277	1,913	407	7,131	9,631	15,473	88	1,755	05
26	8,929	89	205,347	-	35	3,267	-	-	06
3	92,378	161	30	225	126	2,885	1,162	7,021	07
863	1,490	293	3	839	1,098	4,449	206	21,062	08
-	-	-	-	-	-	-	-	-	09
1,419	-	-	-	3,971	819	21,380	325	-	10
172,394	-	-	-	68,955	113,497	284,804	326,602	-	11
-	-	-	-	-	-	-	-	5,265	12
-	-	-	-	-	-	50,412	-	-	13
-	-	-	-	-	3,589	-	-	-	14
-	-	-	-	-	-	-	-	-	15
48	207,650	72,751	228,970	17	88	55,034	75	-	16
-	65,155	19,827	187,891	5	46	19,139	40	-	17
18,919	135	12	272	-	204	20	-	-	18
509	1,496	1,076	9,017	7,370	11,329	2,707	75	-	19

Table 11. Summary of estimated costs of project tasks for linked dwelling unit design D

	Cost category	Total	Project task[1] 1	2	3	4	5
01	Total	$6,930,673	$69,003	$266,142	$93,672	$792,966	$2,413,978
	Direct technical labor						
02	On-site	1,568,321	61,373	21,034	22,397	35,954	338,811
03	Off-site	395,372	-	-	37,922	60,050	297,400
	Other direct cost						
04	Total	4,966,980	7,630	245,108	33,353	696,962	1,777,767
05	Materials and supplies	79,954	224	1,111	1,152	563	35,527
06	Services	263,471	428	1,122	3,163	29,288	30,054
07	Shipping and communications	233,331	412	676	8,742	13,732	112,152
	Travel:						
08	On-site	61,649	998	1,962	1,382	13,946	13,151
09	Off-site	349,105	-	145	11,659	265,307	71,994
10	Consultants	27,894	-	-	-	-	-
11	Computer services	918,373	-	-	-	-	-
12	Reports and reproductions	247,043	-	239,122	24	-	2,632
13	Interviewer services	1,006,041	-	-	1,217	218,676	739,516
14	Interviewer expenses	648,487	-	-	5,027	149,776	490,381
15	Respondent incentives	185,781	-	-	-	-	185,781
16	Clerical labor	575,451	2,703	618	40	2,237	50,800
17	Clerical labor surcharge	298,481	505	260	14	1,301	28,532
18	Miscellaneous	20,394	-	63	118	180	1,977
19	Overtime expenses	51,525	2,360	29	895	1,956	15,270

[1]Legend for project tasks:
1 = Survey sampling.
2 = Instrument and materials development.
3 = Field preparations.
4 = Survey training.
5 = Data collection.
6 = Control system development and production.
7 = Data receipt, editing, and document control.
8 = Data coding operations.
9 = Data entry operations.
10 = Control card development, maintenance, and production.
11 = Summary development, maintenance, and production.
12 = Other data processing operations.
13 = Database construction.
14 = Project administration.

Table 11. Summary of estimated costs of project tasks for linked dwelling unit design D—Con.

Project task[1]—Con.									
6	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	
$289,740	$410,830	$103,712	$577,786	$134,972	$229,146	$795,467	$519,241	$234,018	01
107,604	54,267	15,753	131	51,881	80,563	368,971	210,057	198,915	02
-	-	-	-	-	-	-	-	-	03
182,136	356,563	87,959	577,655	83,091	148,583	426,496	308,574	35,103	04
1,137	6,194	1,819	373	6,694	9,013	14,309	83	1,755	05
24	8,559	83	187,704	-	32	3,014	-	-	06
3	86,092	147	27	225	126	2,885	1,091	7,021	07
863	1,490	293	3	839	1,098	4,449	193	21,062	08
-	-	-	-	-	-	-	-	-	09
1,419	-	-	-	3,971	819	21,380	305	-	10
160,706	-	-	-	64,524	123,444	262,975	306,724	-	11
-	-	-	-	-	-	-	-	5,265	12
-	-	-	-	-	-	46,632	-	-	13
-	-	-	-	-	3,303	-	-	-	14
-	-	-	-	-	-	-	-	-	15
46	192,344	66,500	209,294	16	84	50,699	70	-	16
-	60,288	18,123	171,744	4	43	17,629	38	-	17
17,451	135	11	249	-	192	18	-	-	18
487	1,461	983	8,261	6,818	10,429	2,506	70	-	19

Chapter 4
The linked household design

Another approach to linking the National Medical Expenditure Survey (NMES) to the National Health Interview Survey (NHIS) is to designate as sampling units the NHIS sample households rather than the sample addresses. This approach facilitates data collection because sample members are known in advance. However, some sample members will move before round 1 and will have to be located. This approach was investigated using the two primary sampling unit (PSU) size options and the two precision constraint sets of the originating base reporting unit (OBRU) unlinked designs with 6,000 and 10,000 responding.

Definition

The linked household design selects NHIS households rather than dwelling units. However, the sampling units are the individual members of these subsampled NHIS households. These individuals are key members of the NMES sample. These key individuals are interviewed in round 1 of NMES whether or not they live at the same NHIS address. Thus, tracing and followup of movers is needed in the first round of data collection. Because family-level analyses are conducted in NMES, the members of families formed by the sample individuals need to be interviewed. Most households remain the same in the time period between NHIS and NMES. Because individuals within NHIS households are selected as a group, stable households are entirely composed of NMES key individuals.

Movement into and out of established families is not uncommon, however. The guidelines for handling this movement in round 1 are similar to those used in later rounds of NMES under all design options. That is, individuals who join families formed by key individuals through birth or return from the military, an institution, or overseas residence are included as key individuals in NMES. Other individuals joining the families of key individuals are classified as nonkey. The distinction between key and nonkey sample members is that only key individuals are included in person-level analyses. Data for nonkey persons are only used in developing family-level aggregates. Key individuals are followed through all five rounds of data collection. Nonkey individuals have data collected only for the time period in which they belong to a family containing a key individual.

The frame for the linked household design is a list of NHIS sample households with names, addresses, and information needed for tracing. NHIS not-at-home cases are also included but not NHIS refusals. The frame is stratified based on characteristics related to NHIS oversampling to produce a self-weighting sample.

Because the short NHIS data collection period results in a large percent of nonresponse due to failure to find someone at home, excluding these cases would adversely affect the NMES response rate. Including these addresses presents a problem, however, because residents present at the time of the NHIS interview may move prior to the NMES round 1 interview and be replaced by new tenants. The movement problem can be handled by including special screening procedures for NHIS not-at-home cases. However, the problems associated with movement from NHIS refusals led to their exclusion from the frame for this design.

Sample size determination

In a procedure similar to that discussed in the previous chapter, sample sizes were developed for the four designs resulting from the two PSU size options and the two sets of variance constraints. First the design variance was modeled. The intent was not to build an optimal design so only NHIS oversampling was removed and the design was not stratified prior to selection. Therefore, the variance modeling and sample size determination are the same as those described for the linked dwelling unit design. However, converting responding OBRU's into the required number of reporting unit interviews is different from the linked dwelling unit design.

Cost modeling

The target population for NMES is the civilian noninstitutionalized residents of the United States during the data collection year. Sample individuals are eligible for NMES data collection only during the time they are civilian, noninstitutionalized, and residing in the United States. Determining the costs for NMES required modeling the rate at which NHIS individuals leave the NMES target population through death, institutionalization, or emigration, before the NMES data collection period.

Response and attrition rates differ for the linked household design. Loss occurs due to movement before NMES as well as attrition effects associated with the previous NHIS interview. Tracing is needed in round 1, and more interviews need to be conducted outside the sample clusters, due to the additional movement occurring before round 1.

The first step in the costing process was to model the 1980 NMCUES experience. Movement could only be detected for NMCUES when there was a change of ZIP code. First the

ZIP codes associated with the original clustered addresses were determined. In each data collection round, the reporting units (RU's) were classified as to whether the interview occurred within the ZIP-code-defined clustered areas. Additional interviewer travel time and expenses are incurred for interviews outside clustered areas. The only interviews occurring outside the sample clusters in round 1 were for college students living away from home.

When a household moves, there is a one-time only tracing cost to determine the new address. To model this event, a move was defined as when the ZIP code in a round differs from that of the previous round. Both movement outside the clusters and tracing are expected to be greater for the linked household design.

Table 12 presents the results of this modeling of the 1980 NMCUES. Because NMCUES costs occurred to the reporting unit level, these sample sizes are given for RU's. Because the 1980 NMCUES was a clustered area sample of addresses, many of the selections were ineligible units (vacant, nonresident, and so forth), which accounts for the large number of ineligible RU's in round 1. College students living away from home require a separate interview and, thus, are assigned a separate RU number. These college students living away from home account for the 92 RU interviews conducted outside the sample clusters in round 1. By definition, no tracing was needed in round 1. After round 1, there were costs associated with following up sample members who were ineligible or lost to the survey population due to death, institutionalization, entrance into the military, or migration out of the country. There were also costs associated with attempting interviews with nonrespondents. In round 2, for instance, 6,727 RU's were fielded. Of these, 14 were ineligible for the study, 199 failed to respond, and 6,514 completed interviews. Of the 6,514 completing interviews, 395 had moved since round 1, requiring tracing and perhaps a reassignment of the RU to another interviewer. The 6,514 completed interviews had 6,352 conducted within the ZIP code areas associated with the initial sample selections and 162 outside these areas. The 395 RU's requiring tracing may or may not have moved outside the sample clustered ZIP codes. After round 2, these cases did not require additional tracing unless they moved again. However, those of the 395 RU's who moved outside the sample clusters required more interviewer traveltime and expenses to complete their interviews.

The expected sample sizes needed to yield the required number of completed OBRU interviews are given in table 13 for the four linked household designs. Assumptions were made in deriving these sample sizes. First, the required number of responding OBRU's were converted into RU costing units by assuming that the ratio of the number of completed interviews in a round and the number of responding OBRU's would be the same for all designs. With this assumption, the number of completed interviews in each round was estimated as the product of the number of responding OBRU's times each round's ratio of completed RU interviews to responding OBRU's.

Because the linked household design will encounter movement in round 1, the percent of interviews outside the sample clusters should be greater than that in round 1 of the unlinked design. To estimate the extent of the movement, it was assumed that the linked household design encounters similar movement outside the clusters in round 1 to that of the unlinked design in round 2; that round 2 movement outside the clusters is simliar to that encountered by the unlinked design in round 3; and so forth. These projected rates were modified to account for less interviewing outside the clusters in round 4 when college students have returned home for the summer. The percent of the completed interviews where tracing is required should be similar in the linked and unlinked designs, except for round 1 of the unlinked design, which does not encounter movement. The round 2 tracing rate for the unlinked design was used to model the round 1 tracing rate for the linked household design.

Modeling the response rate was the next step. The cumulative responses and attrition rates that the 1980 NMCUES encountered were 91.1 percent in round 1; 90.7 percent in round 2; 89.7 percent in round 3; 89.3 percent in round 4; and 89.0 percent in round 5. Excluding the 2.5 percent NHIS refusals from the NMES frame allows the linked household survey better roundwise response rate than that of the unlinked design. The fact that the sample would have been interviewed once already would have a negative effect. Balancing these two factors, the cumulative attrition and response rate expected in the field is 92.5 percent in round 1; 91.5 percent in round 2; 91.1 percent in round 3; 90.8 percent in round 4; and 90.5 percent in round 5. An additional 2.5 percent of the NMES sample would be lost due to NHIS refusal and exclusion from the frame, resulting in effective cumulative response and attrition rates of 90.2, 89.2, 88.8, 88.5, and 88.2 percent in rounds 1 through 5, respectively.

The rate at which sample members become ineligible was modeled in a procedure similar to that of the tracing rate model. That is, it was assumed that in every round after the first the percent ineligible of the total sample fielded is the same for the linked household design as for the 1980 NMCUES. The round 1 ineligible rate for the linked household design was based on the rate in round 2 of the 1980 NMCUES.

Unit costs were developed by round to include identifying ineligible RU's, attempting to interview nonresponding RU's, completing interviews within the sample clusters, completing interviews outside the sample clusters, and tracing movers. These unit costs were used in modeling the costs for the four linked household designs. These costs are presented in tables 14–17. The 6,000-OBRU-equivalent linked household design has direct costs of $4,891,831 with 100 PSU's and $4,967,406 with 200 PSU's, compared with $4,963,013 for the unlinked 6,000-OBRU design. The 10,000-OBRU-equivalent linked household design has direct costs of $7,182,341 with 100 PSU's and $6,962,291 with 200 PSU's, compared with $7,209,409 for the unlinked 10,000-OBRU design. These results suggest that 200 PSU's are more cost efficient for the 10,000-OBRU precision constraints than 100 PSU's, but are more likely a reflection of instability of the variance constraints. (See chapter 5.)

The cost savings associated with linkage are not substantial. Savings for the design, a slightly larger response rate, and no counting and listing costs, are partly offset by added costs associated with tracing movers.

Other design considerations

Between the time of the NHIS interview and the beginning of the NMES data collection year, individuals enter the target population through birth or through return from the military, an institution, or overseas. The unlinked household design updates the sample in round 1 using the same procedure as that of all NMES designs. That is, individuals who joined families formed by NMES subsampled individuals enter the survey as key individuals if they were born or returned from an ineligible state after the NHIS interview. This procedure results in undercoverage of the individuals entering the target population who do not join preexisting families. All NMES designs encounter this type of undercoverage in rounds 2–5 of the study, but only the linked household design encounters this in round 1. This undercoverage is not substantial enough to preclude the use of the linked household design, but the dwelling unit design is preferable for optimum population coverage.

By restricting attention to self-weighting designs, thus far, many of the advantages associated with the linkage of NMES to NHIS have been eliminated. The next chapter departs from the self-weighting constraint to investigate optimal versions of the linked household design.

Table 12. Sample sizes for the 1980 National Medical Care Utilization and Expenditure Survey (NMCUES) design

Round	Reporting units (RU's) ineligible	RU's nonresponding	RU's completing interviews			
			Total	Traced	Inside sample clusters	Outside sample clusters
1	1,115	643	6,601	-	6,509	92
2	14	199	6,514	395	6,352	162
3	24	94	6,525	248	6,355	170
4	3	72	4,558	114	4,482	76
5	26	57	6,559	183	6,418	141

Table 13. Sample sizes for the National Medical Expenditure Survey (NMES) linked household design

Design type and round	Reporting units (RU's) ineligible	RU's nonresponding	RU's completing interviews			
			Total	Traced	Inside sample clusters	Outside sample clusters
Design A						
Round 1	14	498	6,165	172	6,012	153
Round 2	23	184	6,084	369	5,925	159
Round 3	23	86	6,094	232	5,935	159
Round 4	3	66	4,257	106	4,186	71
Round 5	24	52	6,126	171	5,981	145
Design B						
Round 1	13	470	5,818	162	5,674	144
Round 2	22	174	5,741	348	5,591	150
Round 3	22	81	5,751	219	5,601	150
Round 4	3	62	4,017	100	3,950	67
Round 5	23	49	5,781	161	5,644	137
Design C						
Round 1	23	831	10,290	287	10,035	255
Round 2	38	307	10,154	616	9,889	265
Round 3	38	144	10,172	387	9,907	265
Round 4	5	110	7,105	177	6,986	119
Round 5	40	87	10,225	285	9,983	242
Design D						
Round 1	21	760	9,406	262	9,173	233
Round 2	35	281	9,282	563	9,039	243
Round 3	35	131	9,297	354	9,054	243
Round 4	5	101	6,495	162	6,387	108
Round 5	37	79	9,346	261	9,125	221

Table 14. Summary of estimated costs of project tasks for linked household design A

	Cost category	Project task[1]					
		Total	*1*	*2*	*3*	*4*	*5*
01	Total	$4,891,831	$55,462	$182,510	$52,723	$560,811	$1,608,317
	Direct technical labor						
02	On-site	1,230,862	49,575	20,076	13,164	30,411	233,018
03	Off-site	275,026	-	-	21,278	50,741	203,007
	Other direct cost						
04	Total	3,385,943	5,887	162,434	18,281	479,659	1,172,292
05	Materials and supplies	58,620	161	1,051	658	475	25,114
06	Services	180,229	327	1,076	1,582	24,673	20,981
07	Shipping and communications	161,436	308	645	4,971	10,245	78,425
	Travel:						
08	On-site	52,738	834	1,872	750	11,796	8,201
09	Off-site	243,404	-	139	6,586	186,203	50,476
10	Consultants	27,821	-	-	-	-	-
11	Computer services	669,623	-	-	-	-	-
12	Reports and reproductions	163,302	-	156,734	12	-	1,530
13	Interviewer services	662,362	-	-	608	143,303	485,671
14	Interviewer expenses	424,103	-	-	2,514	98,151	321,180
15	Respondent incentives	121,771	-	-	-	-	121,771
16	Clerical labor	375,848	1,931	581	20	1,908	30,305
17	Clerical labor surcharge	194,613	361	248	7	1,098	16,975
18	Miscellaneous	14,166	-	60	67	153	1,374
19	Overtime expenses	35,906	1,965	28	506	1,654	10,289

[1]Legend for project tasks:
1 = Survey sampling.
2 = Instrument and materials development.
3 = Field preparations.
4 = Survey training.
5 = Data collection.
6 = Control system development and production.
7 = Data receipt, editing, and document control.
8 = Data coding operations.
9 = Data entry operations.
10 = Control card development, maintenance, and production.
11 = Summary development, maintenance, and production.
12 = Other data processing operations.
13 = Database construction.
14 = Project administration.

Table 14. Summary of estimated costs of project tasks for linked household design A—Con.

Project task[1]*—Con.*									
6	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	
$213,374	$278,007	$70,829	$378,794	$102,712	$164,423	$604,526	$395,963	$223,380	01
79,741	42,383	12,782	87	39,491	59,363	299,240	160,658	189,873	02
0	-	-	-	-	-	-	-	-	03
133,633	234,624	58,047	378,707	63,221	105,060	305,286	235,305	33,507	04
944	4,876	1,476	247	5,092	6,745	10,043	63	1,675	05
16	6,369	63	123,031	-	22	2,089	-	-	06
3	55,956	96	18	225	126	2,885	832	6,701	07
863	1,490	293	2	839	1,098	4,449	147	20,104	08
-	-	-	-	-	-	-	-	-	09
1,419	-	-	-	3,971	819	21,380	232	-	10
117,871	-	-	-	48,282	86,609	182,966	233,895	-	11
-	-	-	-	-	-	-	-	5,026	12
-	-	-	-	-	-	32,780	-	-	13
-	-	-	-	-	2,258	-	-	-	14
-	-	-	-	-	-	-	-	-	15
38	125,347	43,588	137,183	13	70	34,811	53	-	16
-	39,307	11,879	112,571	4	35	12,099	29	-	17
12,074	107	7	165	-	146	13	-	-	18
405	1,172	645	5,490	4,795	7,132	1,771	54	-	19

Table 15. Summary of estimated costs of project tasks for linked household design B

	Cost category	Total	Project task[1] 1	2	3	4	5
01	Total	$4,967,406	$54,010	$173,550	$93,672	$535,022	$1,762,357
	Direct technical labor						
02	On-site	1,268,649	48,311	19,974	22,397	29,796	281,847
03	Off-site	334,910	-	-	37,922	49,707	247,281
	Other direct cost						
04	Total	3,363,847	5,699	153,576	33,353	455,519	1,233,229
05	Materials and supplies	61,968	154	1,045	1,152	465	28,837
06	Services	176,495	316	1,071	3,163	24,160	23,263
07	Shipping and communications	177,983	297	642	8,742	9,857	93,181
	Travel:						
08	On-site	57,969	816	1,862	1,302	11,558	13,151
09	Off-site	249,388	-	138	11,659	177,414	60,177
10	Consultants	27,814	-	-	-	-	-
11	Computer services	642,969	-	-	-	-	-
12	Reports and reproductions	155,062	-	147,906	24	-	2,106
13	Interviewer services	653,515	-	-	1,217	134,931	486,071
14	Interviewer expenses	431,835	-	-	5,027	92,416	332,246
15	Respondent incentives	114,913	-	-	-	-	114,913
16	Clerical labor	370,655	1,848	577	40	1,872	41,697
17	Clerical labor surcharge	191,849	345	247	14	1,076	23,351
18	Miscellaneous	13,892	-	60	118	150	1,640
19	Overtime expenses	37,539	1,923	28	895	1,620	12,596

[1]Legend for project tasks:
1 = Survey sampling.
2 = Instrument and materials development.
3 = Field preparations.
4 = Survey training.
5 = Data collection.
6 = Control system development and production.
7 = Data receipt, editing, and document control.
8 = Data coding operations.
9 = Data entry operations.
10 = Control card development, maintenance, and production.
11 = Summary development, maintenance, and production.
12 = Other data processing operations.
13 = Database construction.
14 = Project administration.

Table 15. Summary of estimated costs of project tasks for linked household design B—Con.

Project task[1]*—Con.*									
6	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	
$205,192	$271,883	$67,306	$357,472	$99,255	$157,488	$584,065	$382,754	$223,380	01
76,755	44,828	12,464	83	38,163	57,092	291,767	155,299	189,873	02
-	-	-	-	-	-	-	-	-	03
128,437	227,055	54,842	357,389	61,092	100,396	292,298	227,455	33,507	04
923	4,975	1,439	233	4,921	6,502	9,586	61	1,675	05
16	6,332	61	116,102	-	21	1,990	-	-	06
3	54,412	91	17	225	126	2,885	804	6,701	07
863	1,490	293	2	839	1,098	4,449	142	20,104	08
-	-	-	-	-	-	-	-	-	09
1,419	-	-	-	3,971	819	21,380	225	-	10
113,281	-	-	-	46,541	82,662	174,394	226,091	-	11
-	-	-	-	-	-	-	-	5,026	12
-	-	-	-	-	-	31,296	-	-	13
-	-	-	-	-	2,146	-	-	-	14
-	-	-	-	-	-	-	-	-	15
37	120,753	41,133	129,456	13	69	33,108	52	-	16
-	37,804	11,210	106,230	4	34	11,506	28	-	17
11,498	110	7	156	-	141	12	-	-	18
397	1,179	608	5,193	4,578	6,778	1,692	52	-	19

Table 16. Summary of estimated costs of project tasks for linked household design C

	Cost category	Total	Project task[1] 1	2	3	4	5
01	Total	$7,182,341	$72,697	$288,961	$52,723	$856,020	$2,393,797
	Direct technical labor						
02	On-site	1,574,753	64,592	21,296	13,164	37,460	299,259
03	Off-site	344,587	-	-	21,278	62,579	260,730
	Other direct cost						
04	Total	5,263,001	8,105	267,665	18,281	755,981	1,833,808
05	Materials and supplies	79,174	241	1,127	658	587	32,696
06	Services	280,409	455	1,134	1,582	30,541	29,004
07	Shipping and communications	226,513	440	684	4,971	14,679	101,748
	Travel:						
08	On-site	56,813	1,043	1,986	750	14,530	8,201
09	Off-site	358,776	-	147	6,586	286,792	65,251
10	Consultants	27,914	-	-	-	-	-
11	Computer services	986,252	-	-	-	-	-
12	Reports and reproductions	269,012	-	261,601	12	-	2,134
13	Interviewer services	1,083,210	-	-	608	239,148	793,042
14	Interviewer expenses	687,505	-	-	2,514	163,797	517,605
15	Respondent incentives	203,245	-	-	-	-	203,245
16	Clerical labor	612,805	2,914	629	20	2,326	42,283
17	Clerical labor surcharge	317,962	544	263	7	1,356	23,689
18	Miscellaneous	21,642	-	64	67	187	1,762
19	Overtime expenses	51,769	2,468	30	506	2,038	13,148

[1]Legend for project tasks:
1 = Survey sampling.
2 = Instrument and materials development.
3 = Field preparations.
4 = Survey training.
5 = Data collection.
6 = Control system development and production.
7 = Data receipt, editing, and document control.
8 = Data coding operations.
9 = Data entry operations.
10 = Control card development, maintenance, and production.
11 = Summary development, maintenance, and production.
12 = Other data processing operations.
13 = Database construction.
14 = Project administration.

Table 16. Summary of estimated costs of project tasks for linked household design C—Con.

Project task[1]—Con.									
6	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	
$310,576	$437,744	$112,686	$632,080	$143,776	$246,811	$847,568	$552,884	$234,018	01
115,205	54,234	16,564	143	55,263	86,349	387,998	224,311	$198,915	02
-	-	-	-	-	-	-	-	-	03
195,371	383,510	96,122	631,937	88,513	160,462	459,570	328,573	35,103	04
1,190	6,277	1,913	407	7,131	9,631	15,473	88	1,755	05
26	8,929	89	205,347	-	35	3,267	-	-	06
3	92,378	161	30	225	126	2,885	1,162	7,021	07
863	1,490	293	3	839	1,098	4,449	206	21,062	08
-	-	-	-	-	-	-	-	-	09
1,419	-	-	-	3,971	819	21,380	325	-	10
172,394	-	-	-	68,955	113,497	284,804	326,602	-	11
-	-	-	-	-	-	-	-	5,265	12
-	-	-	-	-	-	50,412	-	-	13
-	-	-	-	-	3,589	-	-	-	14
-	-	-	-	-	-	-	-	-	15
48	207,650	72,751	228,970	17	88	55,034	75	-	16
-	65,155	19,827	187,891	5	46	19,139	40	-	17
18,919	135	12	272	-	204	20	-	-	18
509	1,496	1,076	9,017	7,370	11,329	2,707	75	-	19

Table 17. Summary of estimated costs of project tasks for linked household design D

	Cost category	Total	Project task[1] 1	2	3	4	5
01	Total	$6,962,291	$69,003	$266,142	$93,672	$792,966	$2,445,596
	Direct technical labor						
02	On-site	1,568,976	61,373	21,034	22,397	35,954	339,466
03	Off-site	395,464	-	-	37,922	60,050	297,492
	Other direct cost						
04	Total	4,997,851	7,630	245,108	33,353	696,962	1,808,638
05	Materials and supplies	79,859	224	1,111	1,152	563	35,432
06	Services	263,659	428	1,122	3,163	29,288	30,242
07	Shipping and communications	234,648	412	676	8,742	13,732	113,469
	Travel:						
08	On-site	61,649	998	1,962	1,302	13,946	13,151
09	Off-site	350,140	-	145	11,659	265,307	73,029
10	Consultants	27,894	-	-	-	-	-
11	Computer services	918,373	-	-	-	-	-
12	Reports and reproductions	247,043	-	239,122	24	-	2,632
13	Interviewer services	1,019,956	-	-	1,217	218,676	753,431
14	Interviewer expenses	661,210	-	-	5,027	149,776	503,104
15	Respondent incentives	185,781	-	-	-	-	185,781
16	Clerical labor	576,768	2,703	618	40	2,237	52,117
17	Clerical labor surcharge	299,140	505	260	14	1,301	29,191
18	Miscellaneous	20,394	-	63	118	180	1,977
19	Overtime expenses	51,337	2,360	29	895	1,956	15,082

[1]Legend for project tasks:
1 = Survey sampling.
2 = Instrument and materials development.
3 = Field preparations.
4 = Survey training.
5 = Data collection.
6 = Control system development and production.
7 = Data receipt, editing, and document control.
8 = Data coding operations.
9 = Data entry operations.
10 = Control card development, maintenance, and production.
11 = Summary development, maintenance, and production.
12 = Other data processing operations.
13 = Database construction.
14 = Project administration.

Table 17. Summary of estimated costs of project tasks for linked household design D—Con.

Project task[1]*—Con.*									
6	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	
$289,740	$410,830	$103,712	$577,786	$134,972	$229,146	$795,467	$519,241	$234,018	01
107,604	54,267	15,753	131	51,881	80,563	368,971	210,667	198,915	02
-	-	-	-	-	-	-	-	-	03
182,136	356,563	87,959	577,655	83,091	148,583	426,496	308,574	35,103	04
1,137	6,194	1,819	373	6,694	9,013	14,309	83	1,755	05
24	8,559	83	187,704	-	32	3,014	-	-	06
3	86,092	147	27	225	126	2,885	1,091	7,021	07
863	1,490	293	3	839	1,098	4,449	193	21,062	08
-	-	-	-	-	-	-	-	-	09
1,419	-	-	-	3,971	819	21,380	305	-	10
160,706	-	-	-	64,524	123,444	262,975	306,724	-	11
-	-	-	-	-	-	-	-	5,265	12
-	-	-	-	-	-	46,632	-	-	13
-	-	-	-	-	3,303	-	-	-	14
-	-	-	-	-	-	-	-	-	15
46	192,344	66,500	209,294	16	84	50,699	70	-	16
-	60,288	18,123	171,744	4	43	17,629	38	-	17
17,451	135	11	249	-	192	18	-	-	18
487	1,461	983	8,261	6,818	10,429	2,506	70	-	19

Chapter 5
An optimally allocated design

The designs previously described are self-weighting and selected by aggregating the National Health Interview Survey (NHIS) sample over a short time period. Cost savings result from linking these designs to NHIS, but they are not substantial. One reason for the lack of substantial cost savings is that these designs include little of the available NHIS information. Using the characteristics of NHIS respondents, greater savings are possible by stratification and optimal allocation of the sample.

To investigate this, five optimally allocated linked household designs were studied. Two designs are optimally allocated self-weighting designs, one with the precision of the 6,000 originating base reporting unit (OBRU) unlinked design, the other with the precision of the 10,000-OBRU design. Next, the self-weighting constraint was removed for two optimally allocated designs, one using the 6,000-OBRU constraints, the second using the 10,000-OBRU constraints. Because increasing the sample size to 10,000 OBRU's improves precision for smaller domains such as medicaid recipients, a fifth design was developed using the 6,000-OBRU constraints for the total population and the 10,000-OBRU constraints for the medicaid subpopulation.

Definition

Stratification of the sample is usually proportional to stratum size, except when oversampling of certain population subgroups is specified. However, because data collection costs and variances differ among strata, optimal allocation of the sample may result in substantial cost savings. For the National Medical Expenditure Survey (NMES), a multipurpose survey with many outcome measures and reporting domains, the preferred optimization strategy is one that minimizes total survey cost subject to multiple variance constraints. Separate variance constraints are set to control the precision of key survey statistics for the total population and for important reporting domains.

To optimally allocate the sample among strata, cost and variance models are needed. The following linear function is used to model survey costs for a sample design with L sample size levels, $m(l)$:

$$C = C_0 + \sum_{l=1}^{L} C(l)m(l) \qquad (14)$$

where C = total survey cost

C_0 = fixed administrative cost of the survey

$C(l)$ = cost of surveying a unit from the lth design level where l may index a combination of design stages, phases, and strata

$m(l)$ = sample size for the lth design level

The corresponding variance model for a particular statistic and domain k is

$$V_k = \sum_{l=1}^{L} \frac{V_k(l)}{m(l)} \qquad (15)$$

where V_k = variance of the domain k statistic

$V_k(l)$ = variance component associated with the kth domain and sampling from the lth design level

These cost and variance models illustrate that as the sample size for each stratum increases, the variance decreases as the total cost of the survey increases.

To determine the optimum sample sizes for the L design levels, the maximum variances (V_k^*) allowed for the designated domain k estimates must be specified. This may be represented mathematically as the set of level-specific sample sizes $m(l)$ that minimize the total survey cost C subject to $V_k \leq V_k^*$ and $m(l) \geq 0$ for all l. For a single variance constraint problem, the optimal allocation to level l is

$$m(l) = \left[\frac{V(l)}{C(l)}\right]^{1/2} \sum_{l=1}^{L} \frac{[V(l)/C(l)]^{1/2}}{V^*} \qquad (16)$$

With optimum allocation, these level-specific sampling rates tend to increase as the associated variance increases or the data collection cost decreases.

Few surveys are conducted to obtain a single estimate. For sample allocation based on the single variance constraint solution, several estimates would be considered and the design would be optimized for only one. The preferred strategy simultaneously considers several estimates chosen by classifying the survey statistics according to their variance properties and selecting a typical variance model from each class. Unlike the single constraint case, optimization for multiple variance con-

straints does not have a closed form solution; Cochran (pp. 119–123)[3] reviews a number of approaches to obtain solutions for these problems.

The NMES optimization was obtained using an optimization approach developed by Chromy, described in reference 4. Chromy's optimization algorithm is an iterative approach that provides an optimal solution when the convergence criteria are met.

NHIS household sampling units provide useful information for NMES. This information is generally person-level such as age, race, sex, relationship to head of household, limitation of activity, bed disability days, perceived health status, medical conditions, education level, marital status, and employment. Because NMES samples entire households to facilitate family-level analysis, these data must be aggregated to the household level for stratification.

Stratification of the NHIS sample before selection of the NMES sample provides control over the distribution of the sample while increasing the precision of survey estimates. The variance of estimates is reduced and the precision increased by sampling stratified to maximize the between-stratum variation and minimize the within-stratum variation. Variables used for stratification should result in homogeneity of the units within strata and heterogeneity between strata.

Time constraints prevented the examination of 1980 National Medical Care Utilization and Expenditure Survey (NMCUES) data to determine which variables should be used for stratification of the NHIS sample before NMES sample selection. Instead, variables that are considered good predictors of health care utilization and expenditures were used for stratification. These variables are black and all other races, aged and not aged, poor and not poor, and self-perceived health status (healthy and not healthy). Sample size limitations of the 1980 NMCUES database used to estimate variance components required collapsing of the black strata over the poverty variable, resulting in eight all-other-race strata and four black strata.

To demonstrate the advantages of an optimum allocation approach, five optimal designs were developed. The domains that were included in the optimization are the total population and medicaid recipients. For use in stratification, dichotomous OBRU-level variables denoted race (black versus nonblack), poverty status (more or less than 150 percent of the official poverty index), age status (containing no person greater than or equal to 65 years versus containing at least one), and health status (containing no person with poor or fair health versus containing at least one). The optimization was conducted for nine utilization and expenditure rates and for the subpopulation with large out-of-pocket expenses. First, variance modeling for a stratified, linked household design drawn from the first phase NHIS sample was conducted. Second, the cost component for each second phase stratum and each stage of the first phase NHIS design was modeled. Finally, optimization was conducted and its results assessed. The optimization program computes the total survey costs for the optimal design based on the unit costs. Because the total cost was available, full scale costing to evaluate the design was not necessary. Therefore, this step was eliminated for all the optimally allocated designs.

Variance modeling

Using a stratified sampling approach, NMES would estimate the mean for domain k as

$$\bar{Y}_k(\text{NMES}) = \sum_{h=1}^{H} \hat{\pi}_k(h)\bar{Y}_k(h) \tag{17}$$

where $\bar{Y}_k(h)$ = NMES estimated mean for stratum h

$\hat{\pi}_k(h)$ = NHIS-estimated fraction of the kth subpopulation total person-years associated with the hth stratum

H = number of sample strata

For the nine utilization and expenditure measures, the stratum mean is estimated as

$$\bar{Y}_k(h) = \frac{\sum_{i \in h} W(i)\delta_k(i)Y(i)}{\sum_{i \in h} W(i)\delta_k(i)T(i)} \tag{18}$$

where $W(i)$ = sampling weight of the ith person

$\delta_k(i)$ = 1 if the ith person belongs to the kth domain and 0 if not

$Y(i)$ = response of the ith person

$T(i)$ = fraction of the year that the ith person was eligible for NMES

For the proportion burdened with large out-of-pocket expenses, the stratum mean is estimated as

$$\bar{Y}_k(h) = \frac{\sum_{i \in h} W(i)\delta_k(i)T(i)Y(i)}{\sum_{i \in h} W(i)\delta_k(i)T(i)} \tag{19}$$

where $Y(i) = 1$ if the annualized out-of-pocket expenses are large (more than $200) and 0 if not.

To simplify modeling the variance, it is assumed that NHIS oversampling of black persons is at the last stage and that black and all other races is a stratification variable. Therefore, the variance of the stratified estimate is modeled as

$$\begin{aligned}\text{Var}\,[\bar{Y}_k(\text{NMES})] &= \text{Var}_{\text{NHIS}}\,\{E[\bar{Y}_k(\text{NHIS})]\} \\ &\quad + E_{\text{NHIS}}\{\text{Var}\,[\bar{Y}_k(\text{NHIS})]\} \\ &= \text{Var}_{\text{NHIS}}\,[\bar{Y}_k(\text{NHIS})] \\ &\quad + E_{\text{NHIS}} \sum_{h=1}^{H} \frac{\pi_k^2(h)S_k^2(h)[1 - f(h)]}{m(h)}\end{aligned}$$

$$\doteq D_w(k)$$

$$\cdot \left[\frac{\sigma_k^2(\text{PSU})}{r} + \frac{\sigma_k^2(\text{SEG})}{r\bar{s}} + \frac{\sigma_k^2(\text{OBRU})}{r\bar{s}\bar{t}} \right]$$

$$+ \sum_{h=1}^{H} \frac{\pi_k^2(h) S_k^2(h)[1 - f(h)]}{E[m(h)]} \tag{20}$$

where $D_w(k)$ = design effect for NHIS unequal weighting for the kth domain

$\sigma_k^2(\text{PSU})$ = between NHIS primary sampling unit (PSU) variance component for domain k

$\sigma_k^2(\text{SEG})$ = between NHIS segment, within NHIS PSU variance component for domain k

$\sigma_k^2(\text{OBRU})$ = between NHIS OBRU, within NHIS segment variance component for domain k

$S_k^2(h)$ = stratum h variance for domain k

$f(h)$ = NMES subsampling rate for stratum h or $m(h)/n(h)$

$m(h)$ = NMES stratum h OBRU sample size

$n(h)$ = NHIS stratum h OBRU sample size

The variance components computed from the 1980 NMCUES were used to estimate the NHIS components. A Taylor series approximation for the simple random sampling variance of a combined ratio estimator was used to estimate $S_k^2(h)$.

The expected NMES sample size from the hth stratum can be expressed as

$$E[m(h)] = r\bar{s}\bar{t}f(h)\pi'(h) \tag{21}$$

where $\pi'(h)$ = expected fraction of the NHIS sample from the hth strata or

$$\pi'(h) = \frac{M(h)o(h)}{\sum_{h=1}^{H} M(h)o(h)} \tag{22}$$

and $M(h)$ is the population count of OBRU's in stratum h.

Assuming that black and all other races is used as a stratification variable with equal probability sampling within strata, the design effect for unequal weighting in domain k estimation is modeled as

$$D_w(k) = \frac{\pi_B^2}{\theta_B} + \frac{\pi_{\text{AOR}}^2}{\theta_{\text{AOR}}} \tag{23}$$

where π_B = proportion of black persons in the population

π_{AOR} = proportion of all other races in the population

θ_B = proportion of black persons in the NHIS sample

θ_{AOR} = proportion of all other races in the NHIS sample

Because

$$\theta_B = \frac{1.4\pi_B}{1.4\pi_B + \pi_{\text{AOR}}} \tag{24}$$

and

$$\theta_{\text{AOR}} = \frac{\pi_{\text{AOR}}}{1.4\pi_B + \pi_{\text{AOR}}} \tag{25}$$

$D_w(k)$ may also be expressed as

$$D_w(k) = 1 + \frac{0.16\pi_B\pi_{\text{AOR}}}{1.4} \tag{26}$$

For convenience, relative variance components are used in the optimization. To model the relative variances,

$$RV_k(\text{NMES}) = \frac{\text{Var}\,[\bar{Y}_k(\text{NMES})]}{\bar{Y}_k^2(\text{NMES})} \tag{27}$$

For domain k, the relative variance of a mean estimated using the linked household design can be expressed as

$$RV_k(\text{NMES}) = \sum_{l=1}^{H} \frac{RV_k(l)}{m(l)} + \sum_{l=H+1}^{H+2} \frac{RV_k(l)}{m(l)} \tag{28}$$

where $l = 1, 2, \ldots, H$ are the second phase strata used in selecting the NMES subsample, and $H + 1$ and $H + 2$ are the first phase segment and PSU sampling stages.

Cost modeling

If $C(l)$ represents the variable unit cost for a selection from level l, then the optimization problem may be stated as follows: Minimize

$$CV(\text{NMES}) = \sum_{l=1}^{H+2} m(l)C(l) \tag{29}$$

subject to

1. $\sum_{l=1}^{H+2} \frac{RV_k(l)}{m(l)} \leq RV_k^*$ for $k = 1, 2, \ldots, K$
2. $m(l) \geq 0$ for $l = 1, 2, \ldots, H + 2$
3. $200 \leq m(H + 2) \leq m(H + 1)$
4. $m(l) \leq m(H + 1)$ for $l = 1, 2, \ldots, H$

where $CV(\text{NMES})$ = total variable cost for NMES

RV_k^* = relative variance constraint for the kth domain

The variable costs for the PSU stage of sampling $[C(H+2)]$ and the segment level of sampling $[C(H+1)]$ were obtained by aggregating the task-level unit costs determined by the cost modeling of the self-weighting linked household design cost modeling (chapter 4). The unit costs for the subsampled OBRU's within NHIS-defined strata vary depending on the response and movement rates within the strata. In a procedure similar to that described in chapter 4 for the total population, the 1980 NMCUES experience was used to estimate the rates at which ineligibles, nonrespondents, and movers are encountered and to develop the OBRU-level cost component for each of the 12 strata. The unit costs developed for the self-weighting linked household design for tracing movers, interviewing ineligibles, and interviewing outside and inside the clusters were used in forming the total unit costs for each stratum.

Optimization results

The first design investigated is a stratified, self-weighting linked household design. Using this design, the variance is expressed as in equation (20) where $f(h) = f/o(h)$. The factor f is the subsampling rate desired for the NMES subsample of NHIS after NHIS oversampling is removed. The Chromy optimization procedure was used to obtain optimum values for the number of PSU's, the average number of segments to sample per PSU, and the NMES subsampling rate used within the sample segments (r, $\bar{s}$, and f). For use in the optimization, the simplified variance function is recast in the form of equation (15) as

$$\text{Var}\,[\bar{Y}_k(\text{NMES})] = \frac{[D_w(k)\sigma_k^2(\text{PSU})]}{r} + \frac{D_w(k)\sigma_k^2(\text{SEG}) + D_w(k)\sigma_k^2(\text{OBRU})/\bar{t}}{r\bar{s}} - \frac{\sum_{h=1}^{H}\pi_k^2(h)S_k^2(h)/\pi'(h)\bar{t}}{r\bar{s}} + \frac{\sum_{h=1}^{H}\pi_k^2(h)S_k^2(h)o(h)/\bar{t}\pi'(h)}{r\bar{s}f} \qquad (30)$$

Correspondingly recasting the linear cost model leads to H second phase stratum cost parameters of the form

$$C'(l) = \frac{C(l)t\pi'(l)}{o(l)} \qquad (31)$$

The optimization was performed twice. When the variance constraints associated with the 6,000-OBRU unlinked design were used, the optimal solution was 102 PSU's, 1,258 segments, and 5,980 responding OBRU's. With a subsampling rate f of 83 percent, black strata are subsampled at a 59-percent rate ($f/1.4$) and all-other-race strata at the 83-percent rate. The total cost for the design is \$4,844,013 compared with \$4,963,013 for the unlinked design with the same precision.

When the variance constraints associated with the 10,000-OBRU unlinked design are used, the optimal stratified linked household design has 103 PSU's, 2,117 segments, 9,960 responding OBRU's, and a subsampling rate f of 82 percent. Allowing for the NMES oversampling, black strata are subsampled at a 58-percent rate and all-other-race strata at the 82-percent rate. The total cost for this design is \$6,931,233 compared with \$7,209,409 for the unlinked design with the same precision.

The stratified household design, with 10,000-OBRU precision, incorporates 103 PSU's. The unstratified design, previously described in chapter 3, is most cost efficient with 200 PSU's. This difference is the result of instability of the estimated variance components used to obtain the sample sizes for the unstratified designs.

The next set of designs investigated are the stratified linked household designs without the self-weighting constraint. The advantage of this type of design is that heavy utilizers of health care services can be identified and oversampled. For use in the optimization, the variance given in equation (20) was recast following equation (15).

$$\text{Var}\,[\bar{Y}_k(\text{NMES})] = \frac{D_w(k)\sigma_k^2(\text{PSU})}{r} + \frac{D_w(k)\sigma_k^2(\text{SEG}) + D_w(k)\sigma_k^2(\text{OBRU})/\bar{t}}{r\bar{s}} - \frac{\sum_{h=1}^{H}\pi_k^2(h)S_k^2(h)/\pi'(h)\bar{t}}{r\bar{s}} + \sum_{h=1}^{H}\frac{\pi_k^2(h)S_k^2(h)/t\pi'(h)}{r\bar{s}f(h)} \qquad (32)$$

To optimize over PSU's (r), segments ($r\bar{s}$), and NMES strata ($h = 1, 2, \ldots, H$), the stratified linked sample has $H+2$ design levels. Using expression (32) for the variance, revised unit costs are computed for each of the H second phase strata or

$$C'(l) = C(l)t\pi'(l) \qquad (33)$$

The total population and medicaid recipients are used in the optimization. Medicare recipients, the poor, and those in families with college educated heads of households were not included because an instability of the variance components was observed with negative segment-level variance components for some domain estimates. Due to time constraints, examination and correction of the negative components were not possible.

First, an optimally allocated design with the precision constraints of the unlinked 6,000-OBRU design for the total and medicaid domains was investigated. The optimal solution

used 98 PSU's, 1,152 segments, and 5,880 responding OBRU's with subsampling rates ranging from 57–100 percent. In general, the not healthy and all-other-race groups are sampled at a higher rate than is the black group. Greater percents of NHIS all other race persons are selected than black persons because the number of black persons occurs at a rate 1.4 times greater than that for persons of all other races in the NHIS sample. The total cost for this design is $4,770,353 compared with $4,963,013 for the unlinked 6,000-OBRU design and $4,844,013 for the self-weighting optimally allocated design.

Next, an optimally allocated design with the precision of the 10,000-OBRU unlinked design for the total and the medicaid domains was investigated. The optimal solution used 106 PSU's, 1,811 segments, and 9,717 responding OBRU's with subsampling rates ranging from 59–100 percent. The total cost for the design is $6,758,063 compared with $7,209,409 for the 10,000-OBRU unlinked design and $6,931,233 for the optimally allocated self-weighting design.

For household samples drawn from area frames, there is little information available for use in sample stratification. To obtain the required sample sizes for small domains, a sample size larger than usual is frequently used. With household-level stratification information, these small domains can be oversampled without increasing the size of the total sample.

To illustrate this advantage, an optimally allocated design, with the precision of the unlinked 10,000-OBRU design for the medicaid domain and of the 6,000-OBRU design for total population estimates, was developed. These constraints result in an optimal design with 95 PSU's, 2,092 segments, and 7,228 responding OBRU's with NMES subsampling rates ranging from 32–100 percent. The total cost for the design with 6,000 and 10,000 OBRU's is $5,601,533, which compares well with the $6,758,063 cost for the comparable not-self-weighting design with 10,000-OBRU constraints for both the total and medicaid domain statistics. Tables 18–20 summarize the results of these comparisons.

Other design considerations

NMES will have many small analysis domains including the medicaid, the medicare, the aged, the poor, and the black populations. In the past, separate analyses have been made possible by selecting self-weighting samples large enough to obtain adequate precision for these domains. This approach results in precision greater than necessary for large domains such as the not-aged or white domains. Without linkage, however, this is the best approach because household characteristics are not available for use in sampling.

Although beyond the scope of this report, precision constraints for the NMES should be set for a large group of policy-relevant domains. With linkage to NHIS, there is much information about households that can be used to create an optimally allocated design with increased precision for selected domains. The stability of the variance components and the accuracy of the cost components should also be considered. Finally, cost modeling should include the effect of the aggregation length of the NHIS sample.

The reporting domains to be included in the optimization need careful attention. Precision is assured for statistics and domains included in the optimization. The precision for other statistics and domains will depend on their relation to the statistics and domains included in the optimization.

The optimizations were designed for total utilization and expenditure statistics for the total population and for the medicaid population. The stratified self-weighting linked household design insures precision for these domains and statistics by selecting a self-weighting design with a sufficient sample size. In the stratified linked household designs without the self-weighting constraint, the precision for these statistics was maintained and the cost decreased by oversampling the poor and the not healthy and undersampling the not poor and the healthy. For domains and statistics not included in the optimization, neither of these optimal designs may yield statistics of the desired precision.

Examples from the optimizations described in this chapter demonstrate this point. The stratified self-weighting linked design, optimized for the variance constraints of the 6,000-OBRU unlinked design, may not produce estimates of the desired precision for small domains such as newborns. Using the variance constraints for the 10,000-OBRU unlinked design, the sample size for newborns still may not be sufficient to support detailed analyses. Increasing the sample size of the self-weighting design yields increased precision for such small domains and greater precision than necessary for large domains.

Without the self-weighting constraint, an optimally allocated design can be created that obtains the desired precision for a small domain by oversampling from strata where domain members are concentrated. If the 10,000-OBRU unlinked design yields the required variance constraints for the medicaid domain, the self-weighting linked design to use is that which yields the variance constraints of the 10,000-OBRU unlinked design for all domains. If the 6,000-OBRU unlinked design yields variance constraints acceptable for the total population, the not-self-weighting optimally allocated linked design can achieve both sets of variance constraints by oversampling strata with a high concentration of medicaid recipients. The survey costs with the not-self-weighting approach (the not-self-weighting design with 6,000 total and 10,000 medicaid precision constraints in table 19 are $5,601,533 compared with $6,931,233 for the self-weighting design (the self-weighting design with 10,000 and 10,000 respondents in table 19).

The disadvantage of the optimally allocated not-self-weighting approach is that it may not yield estimates of the desired precision for domains and statistics not included in the optimization. The not-self-weighting design with 6,000 total and 10,000 medicaid precision constraints produces estimates of the desired precision for the total utilization and total expenditure statistics by oversampling from the not healthy strata. If total income is being estimated instead, estimates of the desired precision can not be assured because the design does not control for the precision of income estimates. Alternatively, if total utilization or total expenditures are being estimated for a domain not included in the optimization, such as the medicare domain, the design may not yield estimates of the desired precision. The precision of estimates for domains and statistics

not included in the optimization depends on their relation to the statistics and domains included in the optimization.

Although most surveys include many domains and statistics, this does not preclude use of a not-self-weighting optimally allocated design. A strategy using this design is to consider several estimates chosen by classifying their variance properties and selecting a typical variance model from each class. Similarly, the domains to include in the optimization can be chosen by listing the important domains and selecting those that represent diverse groups of the population.

Because extreme groups are usually rare, they must be represented in the set of domains subject to optimization to obtain an adequate sample size. For example, a survey comparing health expenditures for different income groups should include the poor and the wealthy as domains in the optimization. It may not be necessary to include the large middle income portion of the population as a domain, particularly if the total population is included as a domain in the optimization.

Linkage of NMES to NHIS makes available the names, addresses, and personal characteristics of sample households before data collection. The design with the most potential for using this information is the stratified not-self-weighting optimally allocated design. Research to produce this design would determine the domains and statistics of interest to the survey and the appropriate set to include in the optimization. The 1980 NMCUES data could be used in constructing variance and cost models. The advantages of implementing an optimally allocated design should far exceed the costs of its development.

Table 18. Sample sizes for the alternate optimally allocated designs

Design type	Primary sampling units	Segments	Originating base reporting units (OBRU's)	Cost
Self-weighting, precision of 6,000 OBRU design	102	1,258	5,980	$4,844,013
Self-weighting, precision of 10,000 OBRU design	103	2,117	9,960	6,931,233
Not-self-weighting, precision of 6,000 OBRU design	98	1,152	5,880	4,770,353
Not-self-weighting, precision of 10,000 OBRU design	106	1,811	9,717	6,758,063
Not-self-weighting, precision of 6,000 total OBRU and 10,000 medicaid OBRU designs	95	2,092	7,228	5,601,533

Table 19. Stratum sampling rates for the alternate optimally allocated designs

Strata	Design type				
	Self-weighting, precison of 6,000 OBRU design	Self-weighting, precision of 10,000 OBRU design	Not self-weighting, precision of 6,000 OBRU design	Not self-weighting, precision of 10,000 OBRU design	Not self-weighting, precision of 6,000 total OBRU and 10,000 medicaid OBRU designs
All other races, not aged, not poor, healthy	83	82	86	94	41
All other races, not aged, not poor, not healthy	83	82	99	99	95
All other races, not aged, poor, healthy	83	82	76	79	63
All other races, not aged, poor, not healthy	83	82	100	100	100
All other races, aged, not poor, healthy	83	82	83	84	32
All other races, aged, not poor, not healthy	83	82	100	100	93
All other races, aged, poor, healthy	83	82	88	97	72
All other races, aged, poor, not healthy	83	82	87	77	72
Black, not aged, healthy	59	58	61	67	59
Black, not aged, not healthy	59	58	76	79	76
Black, aged, healthy	59	58	57	59	35
Black, aged, not healthy	59	58	100	100	100

OBRU = originating base reporting unit.

Table 20. Stratum originating base reporting unit (OBRU) sample sizes for the alternate optimally allocated designs

Strata	Design type				
	Self-weighting, precison of 6,000 OBRU design	Self-weighting, precision of 10,000 OBRU design	Not self-weighting, precision of 6,000 OBRU design	Not self-weighting, precision of 10,000 OBRU design	Not self-weighting, precision of 6,000 total OBRU and 10,000 medicaid OBRU designs
All strata	5,980	9,960	5,880	9,717	7,228
All other races, not aged, not poor, healthy	2,826	4,707	2,697	4,622	2,328
All other races, not aged, not poor, not healthy	556	927	612	957	1,069
All other races, not aged, poor, healthy	451	751	380	625	574
All other races, not aged, poor, not healthy	250	416	277	435	503
All other races, aged, not poor, healthy	461	768	422	674	298
All other races, aged, not poor, not healthy	279	464	309	486	524
All other races, aged, poor, healthy	268	446	262	454	390
All other races, aged, poor, not healthy	265	441	256	356	383
Black, not aged, healthy	351	585	332	573	586
Black, not aged, not healthy	152	254	179	293	328
Black, aged, healthy	52	87	47	75	52
Black, aged, not healthy	69	114	107	167	193

OBRU = originating base reporting unit.

Chapter 6
Comparison of the designs and recommendations

The National Medical Expenditure Survey (NMES) design types investigated in this study have similar features. Regardless of how the sample is selected, all of the designs assume that each sample household is interviewed personally in rounds 1, 2, and 5, and that the telephone is used whenever possible in rounds 3 and 4.

Each design defines key persons to be followed for all rounds of data collection. The designs also define key persons as those who, in rounds 2–5, are either born or return from the military, overseas, or a long-term care institution and enter an existing family. All other persons who are members of families formed by key persons are classified as nonkey. Nonkey persons have data collected for them only as long as they belong to families with members who are key persons. The data for key persons are used for person-level analyses; nonkey person data are only used to construct aggregated data used in family-level analyses.

In round 1, a household roster is obtained, and health care data are collected for all household members including college students living away from home. During the first interview, the household is given a calendar diary and instructed as to its use. An incentive of $5 is paid to the household and its members are advised that another $5 will be paid to them at the end of the survey. The household is advised that a summary of the reported health care data will be mailed to its members before each interview so that erroneous or missing information can be corrected.

Round 2 is also conducted by personal interview for the design types investigated in this study. The advantages of a second personal interview round are that the interviewer can review the summary with the respondent; and, because the bulk of survey attrition occurs at round 2, a personal interview should reduce the level of attrition early in the survey and commit the respondent to the survey.

The next two rounds of data collection use the telephone whenever possible. Because round 4 is at the end of the year, not all respondents are included. Because December 31 is the end of the survey reference period, approximately 30 percent of the sample is not interviewed in round 4 but, instead, early in round 5 (that is, shortly after January 1 of the next year).

The fifth and final round of data collection is conducted by personal interview. In addition to obtaining the health care data through December 31 of the past year, the round 5 interview obtains annual income and other data that are not available until after the end of the reference period.

The same target population definition is used by the National Health Interview Survey (NHIS) and NMES, which facilitates using the NHIS sample as a frame for NMES. Both surveys define their target populations as the civilian noninstitutionalized residents of the United States. NHIS is based on a national area sample of housing units and group quarters and is similar to the 1980 National Medical Care Utilization and Expenditure Survey (NMCUES) design except for the sampling of college students. NHIS includes college students in the sample when their college residence is sampled. Because of its interest in family-level analyses, NMES links college students who are single, 17–22 years of age, and living away from home to their parents' residence. Only when the parents' residence is selected is the college student included in the sample. The difference between the definitions does not present problems for linkage of NMES to NHIS provided that NHIS identifies all college students who are single, 17–22 years of age, and living away from home and asks sample NHIS families to provide name and address information for these college students.

Four types of sample designs were investigated in this study, including two unlinked designs, four linked NHIS and NMES dwelling unit designs, four linked NHIS and NMES household designs, and five optimally allocated linked household designs. Table 21 summarizes the sample size and cost for the 1980 NMCUES and for the 14 designs investigated for use in the 1987 NMES. The cost of the five optimally allocated designs compares well with that of the other designs. These costs were constructed from the 1980 NMCUES experience and are not adjusted for inflation.

Table 21 includes the months that the NHIS sample must be aggregated to obtain the required number of sample segments from the specified number of primary sampling units (PSU's). These estimates of aggregation time are based on the assumptions that NHIS includes 8,750 segments and 200 PSU's for an average of 43.75 segments per PSU in a year and that NMES is selected from the 90 percent consisting of personal interviews. The aggregation times range from 1.5–6.7 months; the longer periods of aggregation are required for the optimally allocated designs. Modeling of movement is only approximate, so the costs associated with movement may be understated, particularly for designs that aggregate over a longer period of time. More attention needs to be given to cost modeling of movement as the time between NHIS and NMES increases.

In modeling the costs for the designs it is assumed that the NMES contractor selects the sample. The NHIS interviewer in the NMES-subsampled segments is given a three-part tearsheet on which to record the information needed in the NMES

sample selection. This information includes names and addresses, NHIS-identifiers, and person characteristics needed for stratification. The tearsheet is completed at the time of NHIS data collection. The tearsheets are distributed on a flow basis, one copy to the contractor, one copy to the U.S. Bureau of the Census field office, and one copy to the interviewer's records. With this approach, the contractor constructs the frame on a flow basis. The Census field office also reviews the documents on a flow basis and advises the contractor of any discrepancies. With the tearsheet approach, the NMES sample can also be selected by the U.S. Bureau of the Census or the National Center for Health Statistics.

For costing the sampling effort, it is assumed that the contractor does the frame construction and sampling. An advantage of selection by the contractor is quality control. NMES is a complex study that requires integration of the effort of sampling statisticians, survey operations specialists, and computer programmers. To coordinate NMES activities and ensure the quality of the product, the contractor should have direct control over all project activities.

The cost savings demonstrated by the optimally allocated designs, particularly the not-self-weighting designs, indicate that there are signfiicant savings possible with NHIS linkage. Further study would be needed to construct such a design for NMES. It is recommended that a full scale design study be conducted before the 1987 NMES to determine the sample size parameters of the design. This study should identify potential high expenditure respondents from NHIS data and use this information to improve the precision of survey estimates to reduce the data collection costs for the survey.

Proposed NMES design parameters should be tested in a pilot study before implementation. This pilot study should test linkage methods, data collection alternatives, and questionnaire changes since the 1980 NMCUES. The use of NHIS-derived information should be considered as a means to reduce the data collection costs of NMES. In this investigation the data collection pattern of the 1980 NMCUES was followed. However, this approach may not be necessary when an NHIS-based list frame is available.

It appears possible that one or more of the personal interview rounds could be replaced by a telephone interview round without adversely affecting response rates. The first round should use personal interviews whenever possible. Personal contact is necessary to establish the creditability of the study, to persuade the respondent to participate, and to instruct the respondent in the use of the calendar diary and the summary. Telephone numbers available from NHIS may be used to make appointments, reducing data collection costs. Before implementing this, the procedure should be tested in a pilot study to determine its impact on response.

Another strategy that could be tested is using NHIS to obtain round 1 data for NMES. Using this approach, NHIS families to be included in NMES would have the NHIS instrument administered along with a supplement to obtain the required NMES round 1 data not normally obtained by NHIS. For example, NHIS obtains health care expenditures and utilization data for the week before data collection. The NMES supplement would collect additional data for the period since January 1. If this combined NHIS and NMES interview approach were effective, one round of data collection could be eliminated. If this strategy is considered for NMES, a pilot study should be conducted to determine whether adding a NMES supplement to selected NHIS family interviews would contaminate either NHIS or NMES data. This question of NHIS contamination could be tested by comparing NHIS data collected in the usual manner with NHIS data collected when a NMES supplement was used. The question of the effect on NMES could be tested by comparing NMES data obtained by NHIS interviewers with an NMES supplement with NMES data obtained in an independent NMES interview.

Table 21. Sample size summary for the alternate National Medical Expenditure Survey (NMES) design

Design	Sample size			Aggregation time	Direct cost
	Primary sampling units	*Segments*	*Originating base reporting units (OBRU's)*		
Unlinked designs					
6,000-respondent OBRU's	102	750	6,000	...	$4,963,013
10,000-respondent OBRU's	102	1,250	10,000	...	7,209,409
Linked dwelling unit designs					
Design A (6,000-respondent OBRU's)	100	976	5,856	3.0	4,871,106
Design B (6,000-respondent OBRU's)	200	921	5,526	1.4	4,947,848
Design C (10,000-respondent OBRU's)	100	1,629	9,774	5.0	7,147,752
Design D (10,000-respondent OBRU's)	200	1,489	8,934	2.3	6,930,673
Linked household designs					
Design A (6,000-respondent OBRU's)	100	976	5,856	3.0	4,891,831
Design B (6,000-respondent OBRU's)	200	921	5,526	1.4	4,967,406
Design C (10,000-respondent OBRU's)	100	1,629	9,774	5.0	7,182,341
Design D (10,000-respondent OBRU's)	200	1,489	8,934	2.3	7,209,409
Linked stratified optimally allocated household designs					
Self-weighting, precision of 6,000 OBRU design	102	1,258	5,980	3.8	4,844,013
Self-weighting, precision of 10,000 OBRU design	103	2,117	9,960	6.3	6,931,233
Not-self-weighting, precision of 6,000 OBRU design	98	1,152	5,880	3.6	4,770,353
Not-self-weighting, precision of 10,000 OBRU design	106	1,811	9,717	5.2	6,758,063
Not-self-weighting, precision of 6,000 total OBRU and 10,000 medicaid OBRU designs	95	2,092	7,228	6.7	5,601,533

References

[1]B. V. Shah: *VMCPNLS: Program To Compute Variance Components.* Research Triangle Institute. In-house report, 1979.

[2]G. B. Gray: Component of variance model in multi-stage stratified samples. *Survey Methodology*1:27–43, 1975.

[3]W. G. Cochran: *Sampling Techniques.* New York. John Wiley and Sons, 1977.

[4]National Center for Health Statistics: R. E. Folsom, Jr., R. L. Williams, and J. R. Chromy: *Optimum Design of a Medical Care Expenditure and Utilization Survey Involving a Provider Record Check.* Report No. 1725/01–06S. Research Triangle Park, N.C. Research Triangle Institute, 1980.

Appendix
Description of cost modeling process

This appendix describes the steps required to perform the various cost modeling steps completed for the alternative designs. Examples provided in tables I–XII for this discussion are for the survey sampling operations task.

Table	Description of activity
I	*Step 1.* Research Triangle Institute monthly cost experience for each of the direct cost budget categories was abstracted from accounting records during the life of the project. The project activity spanned the period October 1979 through the fall of 1981.
II	*Step 2.* Using the monthly breakdown of project spending, monthly costs were collapsed to correspond to presurvey setup activity, rounds 1–5, and postsurvey wrapup activity periods of time.
III	*Step 3.* Professional staff, providing the 1980 National Medical Care Utilization and Expenditure Survey project with fiscal leadership, reviewed the round-by-round cost experience to determine the level of expenditures to be associated with fixed and variable cost units of primary sampling units, segments, and reporting units (RU's). Table III shows the percents used to distribute the costs over the fixed and variable categories.
IV	*Step 4.* Once percent allocations were determined, these percents were applied to the actual dollars expended for each of the budget cost categories. Table IV shows actual dollar allocations for the fixed and variable modeling categories.
V	*Step 5.* Using various combinations of numbers expected for completed RU's, numbers of primary sampling units, and numbers of segments, the estimated costs of alternative designs were generated. Table V presents the estimated direct costs to have had only Research Triangle Institute conduct the 1980 National Medical Care Utilization and Expenditure Survey design.
VI	Procedure designed in step 5 was repeated for the 6,000-OBRU design.
VII	Procedure described in step 5 was repeated for the 10,000-OBRU design.
VIII	*Step 6.* In preparation for modeling the linked household unweighted design, staff reviewed the fixed and variable percent allocations used in the modeling to determine whether any refinements were to be made based on operational differences of the designs. The allocation rates for fixed and variable cost components were generated. Presented in table VIII are the dollar allocations for the fixed and variable cost categories.
IX	*Step 7.* Using the information prepared during step 6, staff generated the estimated costs to perform activities for the linked household unweighted design A.
X	Procedure described in step 7 was repeated for design B.
XI	Procedure described in step 7 was repeated for design C.
XII	Procedure described in step 7 was repeated for design D.

Table I. Summary of Research Triangle Institute (RTI) cost experience for survey sampling for the National Medical Care Utilization and Expenditure Survey Household Survey, by month

	Cost category	Total	1979	1980			
			Prior 3 months	Jan.	Feb.	Mar.	Apr.
01	Total	...	...	...	...	...	...
	Direct technical labor						
02	On-site	$41,138	$7,086	$637	$663	$245	$304
03	Off-site	-	-	-	-	-	-
	Other direct cost						
04	Total	3,152	387	55	77	18	81
05	Materials and supplies	98	44	-	46	-	-
06	Services	228	48	55	7	-	-
07	Shipping and communications	213	-	-	24	18	81
	Travel:						
08	On-site	690	-	-	-	-	-
09	Off-site	-	-	-	-	-	-
10	Consultants	-	-	-	-	-	-
11	Computer services	-	-	-	-	-	-
12	Reports and reproductions	-	-	-	-	-	-
13	Interviewer services	-	-	-	-	-	-
14	Interviewer expenses	-	-	-	-	-	-
15	Respondent incentives	-	-	-	-	-	-
16	Clerical labor	301	295	-	-	-	-
17	Clerical labor surcharge	2	-	-	-	-	-
18	Miscellaneous	-	-	-	-	-	-
19	Overtime expenses	1,620	-	-	-	-	-

NOTES: National Household Survey portion = 1.00; RTI portion = 1.00. Number of primary sampling units = 59; number of segments = 404.

Item	Round 1	Round 2	Round 3	Round 4	Round 5
Completed personal interviews	3,322	3,293	558	279	3,306
Completed telephone interviews	-	-	2,722	2,047	

Table I. Summary of Research Triangle Institute (RTI) cost experience for survey sampling for the National Medical Care Utilization and Expenditure Survey Household Survey, by month—Con.

1980—Con.								1981						
May	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*Other months*	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	01
-	$666	$130	$290	$1,645	$1,358	$2,158	$3,055	$239	$564	$1,404	$621	$3,999	$16,074	02
-	-	-	-	-	-	-	-	-	-	-	-	-	-	03
$50	10	168	15	-	6	-	58	168	-	8	311	31	1,709	04
-	-	-	-	-	-	-	-	-	-	8	-	-	-	05
-	-	-	-	-	6	-	18	30	-	-	-	-	64	06
50	10	-	15	-	-	-	-	-	-	-	-	-	15	07
-	-	168	-	-	-	-	40	138	-	-	311	31	2	08
-	-	-	-	-	-	-	-	-	-	-	-	-	-	09
-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
-	-	-	-	-	-	-	-	-	-	-	-	-	-	11
-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
-	-	-	-	-	-	-	-	-	-	-	-	-	6	16
-	-	-	-	-	-	-	-	-	-	-	-	-	2	17
-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
-	-	-	-	-	-	-	-	-	-	-	-	-	1,620	19

Table II. Summary of Research Triangle Institute (RTI) cost experience for survey sampling for the National Medical Care Utilization and Expenditure Survey Household Survey, rounds 1–5

Cost category	*Total*	*Setup activity*	*Round 1*	*Round 2*	*Round 3*	*Round 4*	*Round 5*	*Wrapup activity*
Total	...	...	...	...	...	...	...	...
Direct technical labor								
On-site	$41,138	$6,732	$1,899	$970	$3,423	$5,213	$6,827	$16,074
Off-site	-	-	-	-	-	-	-	-
Other direct costs								
Total	3,152	368	169	141	189	58	518	1,709
Materials and supplies	98	42	48	-	-	-	8	-
Services	228	46	64	-	6	18	30	64
Shipping and communications	213	0	42	141	15	0	0	15
Travel:								
On-site	690	-	-	-	168	40	480	2
Off-site	-	-	-	-	-	-	-	-
Consultants	-	-	-	-	-	-	-	-
Computer services	-	-	-	-	-	-	-	-
Reports and reproductions	-	-	-	-	-	-	-	-
Interviewer services	-	-	-	-	-	-	-	-
Interviewer expenses	-	-	-	-	-	-	-	-
Respondent incentives	-	-	-	-	-	-	-	-
Clerical labor	301	280	15	-	-	-	-	6
Clerical labor surcharge	2	-	-	-	-	-	-	2
Miscellaneous	-	-	-	-	-	-	-	-
Overtime expenses	1,620	-	-	-	-	-	-	1,620

NOTE: See note to table I.

Table III. Summary of Research Triangle Institute cost experience in percent for survey sampling for the National Medical Care Utilization and Expenditure Survey Household Survey, rounds 1–5

	Cost category	Round 1				Round 2			
		Fixed cost	*PSU cost*	*Segment cost*	*RU cost*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*
		Percent[1]							
01	Total	...	...	...	...	...	...	...	...
	Direct technical labor								
02	On-site	40	...	30	30	50	...	...	50
03	Off-site	...	...	...	...	...	...	...	...
	Other direct costs								
04	Total	...	...	...	...	...	...	...	...
05	Materials and supplies	40	...	30	30	...	...	...	...
06	Services	40	...	30	30	...	...	...	...
07	Shipping and communications	40	...	30	30	50	...	...	50
	Travel:								
08	On-site	...	...	...	...	...	...	...	...
09	Off-site	...	...	...	...	...	...	...	...
10	Consultants	...	...	...	...	...	...	...	...
11	Computer services	...	...	...	...	...	...	...	...
12	Reports and reproductions	...	...	...	...	...	...	...	...
13	Interviewer services	...	...	...	...	...	...	...	...
14	Interviewer expenses	...	...	...	...	...	...	...	...
15	Respondent incentives	...	...	...	...	...	...	...	...
16	Clerical labor	40	...	30	30	...	...	...	...
17	Clerical labor surcharge	...	...	...	...	...	...	...	...
18	Miscellaneous	...	...	...	...	...	...	...	...
19	Overtime expenses	...	...	...	...	...	...	...	...

[1]Percents used to allocate fixed and per unit variable costs.

NOTE: PSU = primary sampling unit; RU = reporting unit.

Table III. Summary of Research Triangle Institute cost experience in percent for survey sampling for the National Medical Care Utilization and Expenditure Survey Household Survey, rounds 1–5—Con.

Round 3				Round 4				Round 5				
Fixed cost	*PSU cost*	*Segment cost*	*RU cost*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	
						Percent[1]						
...	...	...	...	...	...	...	...	...	...	...	...	01
75	...	...	25	85	...	...	15	75	...	...	25	02
...	...	...	...	...	...	...	...	...	...	...	...	03
...	...	...	...	...	...	...	...	...	...	...	...	04
...	...	...	...	...	...	...	...	75	...	...	25	05
75	...	...	25	85	...	...	15	75	...	...	25	06
75	...	...	25	...	...	...	...	75	...	...	25	07
75	...	...	25	85	...	...	15	75	...	...	25	08
...	...	...	...	...	...	...	...	...	...	...	...	09
...	...	...	...	...	...	...	...	...	...	...	...	10
...	...	...	...	...	...	...	...	...	...	...	...	11
...	...	...	...	...	...	...	...	...	...	...	...	12
...	...	...	...	...	...	...	...	...	...	...	...	13
...	...	...	...	...	...	...	...	...	...	...	...	14
...	...	...	...	...	...	...	...	...	...	...	...	15
...	...	...	...	...	...	...	...	75	...	...	25	16
...	...	...	...	...	...	...	...	75	...	...	25	17
...	...	...	...	...	...	...	...	...	...	...	...	18
...	...	...	...	...	...	...	...	...	...	...	...	19

Table IV. Summary of Research Triangle Institute cost experience for survey sampling for the National Medical Care Utilization and Expenditure Survey Household Survey, rounds 1–5, by type of cost

	Cost category	Round 1				Round 2			
		Fixed cost	*PSU cost*	*Segment cost*	*RU cost*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*
01	Total	$3,667.20	-	$6.81	$0.83	$555.50	-	-	$0.17
	Direct technical labor								
02	On-site	3,452.40	-	6.41	0.78	485.00	-	-	0.15
03	Off-site	-	-	-	-	-	-	-	-
	Other direct costs								
04	Total	214.80	-	0.40	0.50	70.50	-	-	0.02
05	Materials and supplies	36.00	-	0.07	0.01	-	-	-	-
06	Services	44.00	-	0.08	0.01	-	-	-	-
07	Shipping and communications	16.80	-	0.03	-	70.50	-	-	0.02
	Travel:								
08	On-site	-	-	-	-	-	-	-	-
09	Off-site	-	-	-	-	-	-	-	-
10	Consultants	-	-	-	-	-	-	-	-
11	Computer services	-	-	-	-	-	-	-	-
12	Reports and reproductions	-	-	-	-	-	-	-	-
13	Interviewer services	-	-	-	-	-	-	-	-
14	Interviewer expenses	-	-	-	-	-	-	-	-
15	Respondent incentives	-	-	-	-	-	-	-	-
16	Clerical labor	118.00	-	0.22	0.03	-	-	-	-
17	Clerical labor surcharge	-	-	-	-	-	-	-	-
18	Miscellaneous	-	-	-	-	-	-	-	-
19	Overtime expenses	-	-	-	-	-	-	-	-

NOTES: PSU = primary sampling unit; RU = reporting unit. Number of primary sampling units = 59; number of segments = 404.

Item	*Round 1*	*Round 2*	*Round 3*	*Round 4*	*Round 5*
Completed personal interviews	3,322	3,293	558	279	3,306
Completed telephone interviews	-	-	2,722	2,047	
Cost			Percent		
Total	100	100	100	100	100
Fixed	40	50	75	85	75
PSU	-	-	-	-	-
Segment	30	-	-	-	-
Case	30	50	25	15	25

Table IV. Summary of Research Triangle Institute cost experience for survey sampling for the National Medical Care Utilization and Expenditure Survey Household Survey, rounds 1–5, by type of cost—Con.

Round 3				*Round 4*				*Round 5*				
Fixed cost	*PSU cost*	*Segment cost*	*RU cost*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	
$2,709.00	-	-	$0.28	$4,480.35	-	-	$0.34	$18,846.00	-	-	$1.90	01
2,567.25	-	-	0.26	4,431.05	-	-	0.34	17,175.75	-	-	1.73	02
-	-	-	-	-	-	-	-	-	-	-	-	03
141.75	-	-	0.01	49.30	-	-	-	1,670.25	-	-	0.17	04
-	-	-	-	-	-	-	-	6.00	-	-	-	05
4.50	-	-	-	15.30	-	-	-	70.50	-	-	0.01	06
11.25	-	-	-	-	-	-	-	11.25	-	-	-	07
126.00	-	-	0.01	34.00	-	-	-	361.50	-	-	0.04	08
-	-	-	-	-	-	-	-	-	-	-	-	09
-	-	-	-	-	-	-	-	-	-	-	-	10
-	-	-	-	-	-	-	-	-	-	-	-	11
-	-	-	-	-	-	-	-	-	-	-	-	12
-	-	-	-	-	-	-	-	-	-	-	-	13
-	-	-	-	-	-	-	-	-	-	-	-	14
-	-	-	-	-	-	-	-	-	-	-	-	15
-	-	-	-	-	-	-	-	4.50	-	-	-	16
-	-	-	-	-	-	-	-	1.50	-	-	-	17
-	-	-	-	-	-	-	-	-	-	-	-	18
-	-	-	-	-	-	-	-	1,215.00	-	-	0.12	19

Table V. Summary of estimated costs for survey sampling with the Research Triangle Institute design component of the 1980 NMCUES

	Cost category	Total	Round 1					Round 2				
			Total	Fixed cost	PSU cost	Segment cost	RU cost	Total	Fixed cost	PSU cost	Segment cost	RU cost
01	Total	$58,147	$14,642	$3,667	-	$5,508	$5,467	$1,656	$556	-	-	$1,100
	Direct technical labor											
02	On-site	54,001	13,784	3,452	-	5,185	5,147	1,445	485	-	-	960
03	Off-site	-	-	-	-	-	-	-	-	-	-	-
	Other direct costs											
04	Total	4,154	858	215	-	323	320	219	71	-	-	140
05	Materials and supplies	154	144	36	-	54	54	-	-	-	-	-
06	Services	322	176	44	-	66	66	-	-	-	-	-
07	Shipping and communications	322	67	17	-	25	25	219	71	-	-	140
	Travel:											
08	On-site	857	-	-	-	-	-	-	-	-	-	-
09	Off-site	-	-	-	-	-	-	-	-	-	-	-
10	Consultants	-	-	-	-	-	-	-	-	-	-	-
11	Computer services	-	-	-	-	-	-	-	-	-	-	-
12	Reports and reproductions	-	-	-	-	-	-	-	-	-	-	-
13	Interviewer services	-	-	-	-	-	-	-	-	-	-	-
14	Interviewer expenses	-	-	-	-	-	-	-	-	-	-	-
15	Respondent incentives	-	-	-	-	-	-	-	-	-	-	-
16	Clerical labor	479	471	118	-	177	176	-	-	-	-	-
17	Clerical labor surcharge	3	-	-	-	-	-	-	-	-	-	-
18	Miscellaneous	-	-	-	-	-	-	-	-	-	-	-
19	Overtime expenses	2,019	-	-	-	-	-	-	-	-	-	-

NOTES: Number of primary sampling units (PSU's) = 108; number of segments = 809; RU = reporting unit. Data are based on NMCUES fixed and per unit allocations.

Item	Round 1	Round 2	Round 3	Round 4	Round 5
Completed personal interviews	6,603	6,519	1,110	547	6,561
Completed telephone interviews	-	-	5,418	4,012	-

Table V. Summary of estimated costs for survey sampling with the Research Triangle Institute design component of the 1980 NMCUES—Con.

Round 3					Round 4					Round 5					
Total	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	
$4,506	$2,709	-	-	$1,797	$6,030	$4,480	-	-	$1,550	$31,313	$18,846	-	-	$12,467	01
4,270	2,567	-	-	1,703	5,964	4,431	-	-	1,533	28,538	17,176	-	-	11,362	02
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	03
236	142	-	-	94	66	49	-	-	17	2,775	1,670	-	-	1,105	04
-	-	-	-	-	-	-	-	-	-	10	6	-	-	4	05
8	5	-	-	3	20	15	-	-	5	118	71	-	-	47	06
18	11	-	-	7	-	-	-	-	-	18	11	-	-	7	07
210	126	-	-	84	46	34	-	-	12	601	362	-	-	239	08
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	09
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
-	-	-	-	-	-	-	-	-	-	-	5	-	-	3	16
-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	17
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
-	-	-	-	-	-	-	-	-	-	2,019	1,215	-	-	804	19

Table VI. Summary of estimated costs for survey sampling with the 6,000-respondent originating base reporting unit unlinked design

	Cost category	Total	Round 1					Round 2				
			Total	Fixed cost	PSU cost	Segment cost	RU cost	Total	Fixed cost	PSU cost	Segment cost	RU cost
01	Total	$56,782	$14,005	$3,667	-	$5,106	$5,232	$1,610	$556	-	-	$1,054
	Direct technical labor											
02	On-site	52,732	13,184	3,452	-	4,807	4,925	1,405	485	-	-	920
03	Off-site	-	-	-	-	-	-	-	-	-	-	-
	Other direct costs											
04	Total	4,049	820	215	-	299	306	205	71	-	-	134
05	Materials and supplies	147	137	36	-	50	51	-	-	-	-	-
06	Services	312	168	44	-	61	63	-	-	-	-	-
07	Shipping and communications	305	64	17	-	23	24	205	71	-	-	134
	Travel:											
08	On-site	842	-	-	-	-	-	-	-	-	-	-
09	Off-site	-	-	-	-	-	-	-	-	-	-	-
10	Consultants	-	-	-	-	-	-	-	-	-	-	-
11	Computer services	-	-	-	-	-	-	-	-	-	-	-
12	Reports and reproductions	-	-	-	-	-	-	-	-	-	-	-
13	Interviewer services	-	-	-	-	-	-	-	-	-	-	-
14	Interviewer expenses	-	-	-	-	-	-	-	-	-	-	-
15	Respondent incentives	-	-	-	-	-	-	-	-	-	-	-
16	Clerical labor	458	450	118	-	164	168	-	-	-	-	-
17	Clerical labor surcharge	3	-	-	-	-	-	-	-	-	-	-
18	Miscellaneous	-	-	-	-	-	-	-	-	-	-	-
19	Overtime expenses	1,984	-	-	-	-	-	-	-	-	-	-

NOTES: Number of primary sampling units (PSU's) = 102; number of segments = 750; RU = reporting unit. Data are based on NMCUES fixed and per unit allocations.

Item	Round 1	Round 2	Round 3	Round 4	Round 5
Completed personal interviews	6,319	6,247	1,062	524	6,278
Completed telephone interviews	-	-	5,185	3,839	-

Table VI. Summary of estimated costs for survey sampling with the 6,000-respondent originating base reporting unit unlinked design—Con.

Round 3					Round 4					Round 5					
Total	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	
$4,429	$2,709	-	-	$1,720	$5,963	$4,480	-	-	$1,483	$30,775	$18,846	-	-	$11,929	01
4,197	2,567	-	-	1,630	5,898	4,431	-	-	1,467	28,048	17,176	-	-	10,872	02
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	03
232	142	-	-	90	65	49	-	-	16	2,727	1,670	-	-	1,057	04
-	-	-	-	-	-	-	-	-	-	10	6	-	-	4	05
8	5	-	-	3	20	15	-	-	5	116	71	-	-	45	06
18	11	-	-	7	-	-	-	-	-	18	11	-	-	7	07
206	126	-	-	80	45	34	-	-	11	591	362	-	-	229	08
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	09
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
-	-	-	-	-	-	-	-	-	-	-	5	-	-	3	16
-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	17
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
-	-	-	-	-	-	-	-	-	-	1,984	1,215	-	-	769	19

Table VII. Summary of estimated costs for survey sampling with the 10,000-respondent originating base reporting unit unlinked design

	Cost category	Total	Round 1					Round 2				
			Total	Fixed cost	PSU cost	Segment cost	RU cost	Total	Fixed cost	PSU cost	Segment cost	RU cost
01	Total	$74,462	$20,896	$3,667	-	$8,510	$8,719	$2,310	$556	-	-	$1,754
	Direct technical labor											
02	On-site	69,142	19,671	3,452	-	8,011	8,208	2,016	485	-	-	1,531
03	Off-site	-	-	-	-	-	-	-	-	-	-	-
	Other direct costs											
04	Total	5,318	1,224	215	-	498	511	294	71	-	-	223
05	Materials and supplies	218	206	36	-	84	86	-	-	-	-	-
06	Services	429	251	44	-	102	105	-	-	-	-	-
07	Shipping and communications	436	96	17	-	39	40	294	71	-	-	223
	Travel:											
08	On-site	1,055	-	-	-	-	-	-	-	-	-	-
09	Off-site	-	-	-	-	-	-	-	-	-	-	-
10	Consultants	-	-	-	-	-	-	-	-	-	-	-
11	Computer services	-	-	-	-	-	-	-	-	-	-	-
12	Reports and reproductions	-	-	-	-	-	-	-	-	-	-	-
13	Interviewer services	-	-	-	-	-	-	-	-	-	-	-
14	Interviewer expenses	-	-	-	-	-	-	-	-	-	-	-
15	Respondent incentives	-	-	-	-	-	-	-	-	-	-	-
16	Clerical labor	683	673	118	-	274	281	-	-	-	-	-
17	Clerical labor surcharge	4	-	-	-	-	-	-	-	-	-	-
18	Miscellaneous	-	-	-	-	-	-	-	-	-	-	-
19	Overtime expenses	2,497	-	-	-	-	-	-	-	-	-	-

NOTES: Number of primary sampling units (PSU's) = 102; number of segments = 1,250; RU = reporting unit. Data are based on NMCUES fixed and per unit allocations.

Item	Round 1	Round 2	Round 3	Round 4	Round 5
Completed personal interviews	10,531	10,397	1,770	873	10,464
Completed telephone interviews	-	-	8,641	6,398	-

Table VII. Summary of estimated costs for survey sampling with the 10,000-respondent originating base reporting unit unlinked design—Con.

Round 3					Round 4					Round 5					
Total	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	
$5,575	$2,709	-	-	$2,866	$6,952	$4,480	-	-	$2,472	$38,729	$18,846	-	-	$19,883	01
5,283	2,567	-	-	2,716	6,875	4,431	-	-	2,444	35,297	17,176	-	-	18,121	02
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	03
292	142	-	-	150	76	49	-	-	27	3,432	1,670	-	-	1,762	04
-	-	-	-	-	-	-	-	-	-	12	6	-	-	6	05
10	5	-	-	5	23	15	-	-	8	145	71	-	-	74	06
23	11	-	-	12	-	-	-	-	-	23	11	-	-	12	07
259	126	-	-	133	53	34	-	-	19	743	362	-	-	381	08
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	09
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
-	-	-	-	-	-	-	-	-	-	10	5	-	-	5	16
-	-	-	-	-	-	-	-	-	-	4	2	-	-	2	17
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
-	-	-	-	-	-	-	-	-	-	2,497	1,215	-	-	1,282	19

Table VIII. Summary of costs for survey sampling for the linked household design

	Cost category	Round 1				Round 2			
		Fixed cost	*PSU cost*	*Segment cost*	*RU cost*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*
01	Total	$3,111.20	-	$5.78	$0.70	$555.50	-	-	$0.17
	Direct technical labor								
02	On-site	2,471.60	-	4.59	0.56	485.00	-	-	0.15
03	Off-site	-	-	-	-	-	-	-	-
	Other direct costs								
04	Total	639.60	-	1.19	0.14	70.50	-	-	0.02
05	Materials and supplies	36.00	-	0.07	0.01	-	-	-	-
06	Services	44.00	-	0.08	0.01	-	-	-	-
07	Shipping and communications	16.80	-	0.03	-	70.50	-	-	0.02
	Travel:								
08	On-site	-	-	-	-	-	-	-	-
09	Off-site	-	-	-	-	-	-	-	-
10	Consultants	-	-	-	-	-	-	-	-
11	Computer services	-	-	-	-	-	-	-	-
12	Reports and reproductions	-	-	-	-	-	-	-	-
13	Interviewer services	-	-	-	-	-	-	-	-
14	Interviewer expenses	-	-	-	-	-	-	-	-
15	Respondent incentives	-	-	-	-	-	-	-	-
16	Clerical labor	457.60	-	0.85	0.10	-	-	-	-
17	Clerical labor surcharge	85.20	-	0.16	0.02	-	-	-	-
18	Miscellaneous	-	-	-	-	-	-	-	-
19	Overtime expenses	-	-	-	-	-	-	-	-

NOTES: PSU = primary sampling unit; RU = reporting unit. Number of primary sampling units = 59; number of segments = 404.

Item	*Round 1*	*Round 2*	*Round 3*	*Round 4*	*Round 5*
Completed personal interviews	3,322	3,293	558	279	3,306
Completed telephone interviews	-	-	2,722	2,047	-

Table VIII. Summary of costs for survey sampling for the linked household design—Con.

Round 3				Round 4				Round 5				
Fixed cost	*PSU cost*	*Segment cost*	*RU cost*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	
$2,709.00	-	-	$0.28	$4,480.35	-	-	$0.34	$18,846.00	-	-	$1.90	01
2,567.25	-	-	0.26	4,431.05	-	-	0.34	17,175.75	-	-	1.73	02
-	-	-	-	-	-	-	-	-	-	-	-	03
141.75	-	-	0.01	49.30	-	-	-	1,670.25	-	-	0.17	04
-	-	-	-	-	-	-	-	6.00	-	-	-	05
4.50	-	-	-	15.30	-	-	-	70.50	-	-	0.01	06
11.25	-	-	-	-	-	-	-	11.25	-	-	-	07
126.00	-	-	0.01	34.00	-	-	-	361.50	-	-	0.04	08
-	-	-	-	-	-	-	-	-	-	-	-	09
-	-	-	-	-	-	-	-	-	-	-	-	10
-	-	-	-	-	-	-	-	-	-	-	-	11
-	-	-	-	-	-	-	-	-	-	-	-	12
-	-	-	-	-	-	-	-	-	-	-	-	13
-	-	-	-	-	-	-	-	-	-	-	-	14
-	-	-	-	-	-	-	-	-	-	-	-	15
-	-	-	-	-	-	-	-	4.50	-	-	-	16
-	-	-	-	-	-	-	-	1.50	-	-	-	17
-	-	-	-	-	-	-	-	-	-	-	-	18
-	-	-	-	-	-	-	-	1,215.00	-	-	0.12	19

Table IX. Summary of estimated costs for survey sampling for the linked household design A

	Cost category	Total	Round 1					Round 2				
			Total	Fixed cost	PSU cost	Segment cost	RU cost	Total	Fixed cost	PSU cost	Segment cost	RU cost
01	Total	$55,461	$13,078	$3,111	-	$5,637	$4,330	$1,582	$556	-	-	$1,026
	Direct technical labor											
02	On-site	49,575	10,390	2,472	-	4,478	3,440	1,381	485	-	-	896
03	Off-site	-	-	-	-	-	-	-	-	-	-	-
	Other direct costs											
04	Total	5,887	2,689	640	-	1,159	890	201	71	-	-	130
05	Materials and supplies	161	151	36	-	65	50	-	-	-	-	-
06	Services	328	185	44	-	80	61	-	-	-	-	-
07	Shipping and communications	307	70	17	-	30	23	201	71	-	-	130
	Travel:											
08	On-site	834	-	-	-	-	-	-	-	-	-	-
09	Off-site	-	-	-	-	-	-	-	-	-	-	-
10	Consultants	-	-	-	-	-	-	-	-	-	-	-
11	Computer services	-	-	-	-	-	-	-	-	-	-	-
12	Reports and reproductions	-	-	-	-	-	-	-	-	-	-	-
13	Interviewer services	-	-	-	-	-	-	-	-	-	-	-
14	Interviewer expenses	-	-	-	-	-	-	-	-	-	-	-
15	Respondent incentives	-	-	-	-	-	-	-	-	-	-	-
16	Clerical labor	1,932	1,924	458	-	829	637	-	-	-	-	-
17	Clerical labor surcharge	361	358	85	-	154	119	-	-	-	-	-
18	Miscellaneous	-	-	-	-	-	-	-	-	-	-	-
19	Overtime expenses	1,965	-	-	-	-	-	-	-	-	-	-

NOTES: Number of primary sampling units (PSU's) = 100; number of segments = 976; RU = reporting unit.

Item	Round 1	Round 2	Round 3	Round 4	Round 5
Completed personal interviews	6,165	6,084	1,036	511	6,126
Completed telephone interviews	-	-	5,058	3,746	-

Table IX. Summary of estimated costs for survey sampling for the linked household design A—Con.

Round 3					Round 4					Round 5					
Total	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	
$4,387	$2,709	-	-	$1,678	$5,927	$4,480	-	-	$1,447	$30,487	$18,846	-	-	$11,641	01
4,157	2,567	-	-	1,590	5,862	4,431	-	-	1,431	27,785	17,176	-	-	10,609	02
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	03
230	142	-	-	88	65	49	-	-	16	2,702	1,670	-	-	1,032	04
-	-	-	-	-	-	-	-	-	-	10	6	-	-	4	05
8	5	-	-	3	20	15	-	-	5	115	71	-	-	44	06
18	11	-	-	7	-	-	-	-	-	18	11	-	-	7	07
204	126	-	-	78	45	34	-	-	11	585	362	-	-	223	08
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	09
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
-	-	-	-	-	-	-	-	-	-	-	5	-	-	3	16
-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	17
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
-	-	-	-	-	-	-	-	-	-	1,965	1,215	-	-	750	19

Table X. Summary of estimated costs for survey sampling for the linked household design B

	Cost category	Total	Round 1					Round 2				
			Total	Fixed cost	PSU cost	Segment cost	RU cost	Total	Fixed cost	PSU cost	Segment cost	RU cost
01	Total	$54,009	$12,517	$3,111	-	$5,319	$4,087	$1,524	$556	-	-	$968
	Direct technical labor											
02	On-site	48,310	9,944	2,472	-	4,226	3,246	1,331	485	-	-	846
03	Off-site	-	-	-	-	-	-	-	-	-	-	-
	Other direct costs											
04	Total	5,701	2,574	640	-	1,094	840	194	71	-	-	123
05	Materials and supplies	154	145	36	-	62	47	-	-	-	-	-
06	Services	317	177	44	-	75	58	-	-	-	-	-
07	Shipping and communications	298	68	17	-	29	22	194	71	-	-	123
	Travel:											
08	On-site	817	-	-	-	-	-	-	-	-	-	-
09	Off-site	-	-	-	-	-	-	-	-	-	-	-
10	Consultants	-	-	-	-	-	-	-	-	-	-	-
11	Computer services	-	-	-	-	-	-	-	-	-	-	-
12	Reports and reproductions	-	-	-	-	-	-	-	-	-	-	-
13	Interviewer services	-	-	-	-	-	-	-	-	-	-	-
14	Interviewer expenses	-	-	-	-	-	-	-	-	-	-	-
15	Respondent incentives	-	-	-	-	-	-	-	-	-	-	-
16	Clerical labor	1,849	1,841	458	-	782	601	-	-	-	-	-
17	Clerical labor surcharge	346	343	85	-	146	112	-	-	-	-	-
18	Miscellaneous	-	-	-	-	-	-	-	-	-	-	-
19	Overtime expenses	1,923	-	-	-	-	-	-	-	-	-	-

NOTES: Number of primary sampling units (PSU's) = 200; number of segments = 921; RU = reporting unit.

Item	Round 1	Round 2	Round 3	Round 4	Round 5
Completed personal interviews	5,818	5,741	978	482	5,781
Completed telephone interviews	-	-	4,773	3,535	

Table X. Summary of estimated costs for survey sampling for the linked household design B—Con.

Round 3					Round 4					Round 5					
Total	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	
$4,292	$2,709	-	-	$1,583	$5,845	$4,480	-	-	$1,365	$29,831	$18,846	-	-	$10,985	01
4,067	2,567	-	-	1,500	5,781	4,431	-	-	1,350	27,187	17,176	-	-	10,011	02
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	03
225	142	-	-	83	64	49	-	-	15	2,644	1,670	-	-	974	04
-	-	-	-	-	-	-	-	-	-	9	6	-	-	3	05
8	5	-	-	3	20	15	-	-	5	112	71	-	-	41	06
18	11	-	-	7	-	-	-	-	-	18	11	-	-	7	07
200	126	-	-	74	44	34	-	-	10	573	362	-	-	211	08
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	09
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
-	-	-	-	-	-	-	-	-	-	1,923	1,215	-	-	708	19

Table XI. Summary of estimated costs for survey sampling for the linked household design C

	Cost category	Total	Round 1					Round 2				
			Total	Fixed cost	PSU cost	Segment cost	RU cost	Total	Fixed cost	PSU cost	Segment cost	RU cost
01	Total	$72,690	$19,742	$3,111	-	$9,909	$7,228	$2,269	$556	-	-	$1,713
	Direct technical labor											
02	On-site	64,593	15,688	2,472	-	7,474	5,742	1,981	485	-	-	1,496
03	Off-site	-	-	-	-	-	-	-	-	-	-	-
	Other direct costs											
04	Total	8,105	4,060	640	-	1,934	1,486	288	71	-	-	217
05	Materials and supplies	241	229	-	-	109	84	-	-	-	-	-
06	Services	456	279	-	-	133	102	-	-	-	-	-
07	Shipping and communications	441	107	71	-	51	39	288	71	-	-	217
	Travel:											
08	On-site	1,043	-	-	-	-	-	-	-	-	-	-
09	Off-site	-	-	-	-	-	-	-	-	-	-	-
10	Consultants	-	-	-	-	-	-	-	-	-	-	-
11	Computer services	-	-	-	-	-	-	-	-	-	-	-
12	Reports and reproductions	-	-	-	-	-	-	-	-	-	-	-
13	Interviewer services	-	-	-	-	-	-	-	-	-	-	-
14	Interviewer expenses	-	-	-	-	-	-	-	-	-	-	-
15	Respondent incentives	-	-	-	-	-	-	-	-	-	-	-
16	Clerical labor	2,915	2,905	458	-	1,384	1,063	-	-	-	-	-
17	Clerical labor surcharge	545	541	85	-	258	198	-	-	-	-	-
18	Miscellaneous	-	-	-	-	-	-	-	-	-	-	-
19	Overtime expenses	2,468	-	-	-	-	-	-	-	-	-	-

NOTES: Number of primary sampling units (PSU's) = 100; number of segments = 1,629; RU = reporting unit.

Item	Round 1	Round 2	Round 3	Round 4	Round 5
Completed personal interviews	10,290	10,154	1,729	853	10,225
Completed telephone interviews	-	-	8,443	6,252	-

Table XI. Summary of estimated costs for survey sampling for the linked household design C—Con.

Round 3					Round 4					Round 5					
Total	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	
$5,509	$2,709	-	-	$2,800	$6,895	$4,480	-	-	$2,415	$38,275	$18,846	-	-	$19,429	01
5,221	2,567	-	-	2,654	6,820	4,431	-	-	2,389	34,883	17,176	-	-	17,707	02
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	03
289	142	-	-	147	76	49	-	-	27	3,392	1,670	-	-	1,722	04
-	-	-	-	-	-	-	-	-	-	12	6	-	-	6	05
10	5	-	-	5	23	15	-	-	8	144	71	-	-	73	06
23	11	-	-	12	-	-	-	-	-	23	11	-	-	12	07
256	126	-	-	130	52	34	-	-	18	735	362	-	-	373	08
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
-	-	-	-	-	-	-	-	-	-	2,468	1,215	-	-	1,253	19

Table XII. Summary of estimated costs for survey sampling for the linked household design D

	Cost category	Total	Round 1					Round 2				
			Total	Fixed cost	PSU cost	Segment cost	RU cost	Total	Fixed cost	PSU cost	Segment cost	RU cost
01	Total	$69,002	$18,318	$3,111	-	$8,600	$6,607	$2,122	$556	-	-	$1,566
	Direct technical labor											
02	On-site	61,373	14,553	2,472	-	6,832	5,249	1,852	485	-	-	1,367
03	Off-site	-	-	-	-	-	-	-	-	-	-	-
	Other direct costs											
04	Total	7,632	3,766	640	-	1,768	1,358	270	71	-	-	199
05	Materials and supplies	226	214	36	-	100	76	-	-	-	-	-
06	Services	428	259	44	-	122	93	-	-	-	-	-
07	Shipping and communications	413	99	17	-	46	36	270	71	-	-	199
	Travel:											
08	On-site	999	-	-	-	-	-	-	-	-	-	-
09	Off-site	-	-	-	-	-	-	-	-	-	-	-
10	Consultants	-	-	-	-	-	-	-	-	-	-	-
11	Computer services	-	-	-	-	-	-	-	-	-	-	-
12	Reports and reproductions	-	-	-	-	-	-	-	-	-	-	-
13	Interviewer services	-	-	-	-	-	-	-	-	-	-	-
14	Interviewer expenses	-	-	-	-	-	-	-	-	-	-	-
15	Respondent incentives	-	-	-	-	-	-	-	-	-	-	-
16	Clerical labor	2,704	2,695	458	-	1,265	972	-	-	-	-	-
17	Clerical labor surcharge	505	502	85	-	236	181	-	-	-	-	-
18	Miscellaneous	-	-	-	-	-	-	-	-	-	-	-
19	Overtime expenses	2,360	-	-	-	-	-	-	-	-	-	-

NOTES: Number of primary sampling units (PSU's) = 200; number of segments = 1,489; RU = reporting unit.

Item	Round 1	Round 2	Round 3	Round 4	Round 5
Completed personal interviews	9,406	9,282	1,580	779	9,346
Completed telephone interviews	-	-	7,717	5,716	-

Table XII. Summary of estimated costs for survey sampling for the linked household design D—Con.

Round 3					*Round 4*					*Round 5*					
Total	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	*Total*	*Fixed cost*	*PSU cost*	*Segment cost*	*RU cost*	
$5,269	$2,709	-	-	$2,560	$6,688	$4,480	-	-	$2,208	$36,605	$18,846	-	-	$17,759	01
4,993	2,567	-	-	2,426	6,614	4,431	-	-	2,183	33,361	17,176	-	-	16,185	02
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	03
276	142	-	-	134	76	49	-	-	24	3,244	1,670	-	-	1,574	04
-	-	-	-	-	-	-	-	-	-	12	6	-	-	6	05
9	5	-	-	4	23	15	-	-	8	137	71	-	-	66	06
22	11	-	-	11	-	-	-	-	-	22	11	-	-	11	07
245	126	-	-	119	51	34	-	-	17	703	362	-	-	341	08
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	09
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11
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-	-	-	-	-	-	-	-	-	-	-	2	-	-	1	17
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
-	-	-	-	-	-	-	-	-	-	2,360	1,215	-	-	1,145	19

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