

PUBLIC USE VERSION

**Technical Description of the
Health and Retirement Survey Sample Design**

**Steven G. Heeringa
Judith H. Connor**

**Sampling Section
Institute for Social Research
University of Michigan
Ann Arbor, MI**

May 1995

Table of Contents

1. Introduction	2
2. Sample Design Overview	3
2.A. Study Population.....	3
2.B. Multi-stage Area Probability Sample Design.....	3
2.C. Oversamples of Special Populations	4
2.D. Integrated Design and Procedures: Core Sample and Supplements	5
3. Sample Design And Procedures: Multi-Stage Area Probability Sample Design	6
3.A. Primary Stage Selection	6
3.B. Secondary-Stage Selection of Area Segments.....	13
3.C. Third-Stage Selection of Housing Units.....	18
3.D. Fourth-Stage: Respondent Selection.....	19
3.E. HRS Sample Release and Survey Monitoring	19
4. Sample Outcomes	22
4.A. Occupancy Rate, HU Update Rate	22
4.B. Household Eligibility and Subsampling Respondents Within Households	23
4.C. Household-level and Person-level Response Rates.....	26
5. Wave 1 Health and Retirement Study Weights for Data Analysis.....	27
5.A. Household Selection Weight.....	27
5.B. Adjustment Factor for Non-Listed SSUs	28
5.C. Adjustment Factor for Subsampled SSUs	28
5.D. Household Nonresponse Adjustment Factor	29
5.E. Household Post-Stratification Factor	35
5.F. Person Level Weight - Respondent Selection Factor.....	37
5.G. Person Level Post-Stratification Weight	39
5.H. Summary of Household and Person-level Analysis Weights	44
6. Health and Retirement Survey: Procedures for Sampling Error Estimation.....	45
6.A Overview of Sampling Error Analysis of HRS Sample Data	45
6.B Sampling Error Computation Methods and Programs	45
Appendix: Glossary.....	55
References	59

Technical Description: Health and Retirement Study Sample Design

The following technical memorandum describes the sample design, sampling procedures, and sample outcomes for Wave 1 of the Health and Retirement Study (HRS). This document is divided into six sections. The introduction describes the purpose and organization of the HRS. Sections 2 and 3 provide an overview and a detailed description of the multi-stage area probability sample design. The fourth section reports the HRS Wave 1 sample outcomes -- a comparison of the expected versus observed occupancy, eligibility, and response rates. Sections 5 and 6 contain descriptions of the construction and use of the analysis weights and the codes and procedures for computation of sampling errors for the HRS data.

1. Introduction

The HRS is funded by the National Institute on Aging (NIA) through a special Congressional appropriation. Although the initial HRS funding was for five years beginning in March 1991, the study is expected to continue for at least 10-12 years and possibly longer. The initial five year funding included a planning year and two data collections, April - December 1992 (Wave 1) and April - December 1994 (Wave 2).

Dr. F. Thomas Juster at the Institute for Social Research (University of Michigan) is the Principal Investigator for this national program of research. In addition, more than thirty researchers and professionals from the ISR and other universities and government agencies have collaborated on the HRS study design and content.

As the proportion of the population living to retirement and beyond increases, it is important for policy makers to understand the changing needs of that population in order to guide planning and policy decisions. There has been no extensive research on factors influencing or resulting from retirement since the Longitudinal Retirement History Survey conducted by the Bureau of the Census and the Social Security Administration during the period of 1969 - 1979. The HRS is intended to provide policy-makers with up-to-date information on changes in retirement and disability patterns, and to provide scientists with data to generate more accurate and realistic models of the retirement decision and the economic and health causes and consequences of retirement and aging.

HRS is designed to collect information on persons from pre-retirement into retirement. Wave 1 questionnaire content concentrated on the economic, health, and other factors that influence retirement decisions. As the HRS panel ages, future waves of data collection will emphasize health status and economic well-being.

2. Sample Design Overview

2.A. Study Population

The target population for Wave 1 of the HRS includes all adults in the contiguous United States, aged 51 - 61 (born during the years 1931 - 1941), who reside in households. Following conventional practice for population surveys, institutionalized persons (prisons, jails, nursing homes, long-term or dependent care facilities) are excluded from the survey population.

HRS uses a national area probability sample of U.S. households with supplemental oversamples of Blacks, Hispanics and residents of the state of Florida. The majority of the sample population is approaching retirement or already retired, but the sample also includes individuals who are not currently working or who have never worked outside the home.

The HRS observational unit is an eligible **household financial unit**. The HRS household financial unit must include at least one age-eligible member from the 1931-1941 birth year cohorts: 1) a single unmarried age-eligible person; 2) a married couple in which both persons are age eligible; or 3) a married couple in which only one spouse is age eligible. Throughout this document, the convenient term "household" will be used interchangeably with the more precise "household financial unit" definition. For most HRS-eligible households, the terms are interchangeable. However, the reader should note that some households may contain multiple household financial units. If a sample housing unit (HU) contains more than one unrelated age-eligible person (i.e., financial unit), one of these persons is randomly selected as the financial unit to be observed. If an age-eligible person has a spouse, the spouse is automatically selected for HRS even if he or she is not age-eligible. Based on the 1991 Current Population Survey, about 19.2% of U.S. households were expected to be eligible for HRS. Of these about 35.9% were expected to be single-person household financial units and 64.1% were expected to be married-couple household financial units (including households in which a respondent is living with a partner in a marriage-like relationship).

Both partners were expected to be age-eligible in 49.6% of the eligible households with a married couple; one partner would be less than age 51 in 25.2% of the eligible married couple households; and one partner would be older than 61 in 25.2% of the eligible married couple households.

2.B. Multi-stage Area Probability Sample Design

The HRS sample is selected under a multi-stage area probability sample design. The sample includes four distinct selection stages. An overview of these selection stages is given here. For a more detailed discussion, see Section 3. The primary stage of sampling involves probability proportionate to size (PPS) selection of U.S. Metropolitan Statistical Areas (MSAs) and non-MSA counties. This stage is followed by a second stage sampling of area segments (SSUs) within sampled primary stage units (PSUs). The third stage of sample selection is preceded by a complete listing (enumeration) of all housing units (HUs) that are physically located within the bounds of the selected SSU. The third sampling stage is a systematic selection of housing units from the HU listings for the sample SSUs. The fourth and final stage in the multi-stage design is the selection of the household financial unit within a sample HU.

2.C. Oversamples of Special Populations

In addition to the nationally-representative, multi-stage area probability sample (the **core** sample), the HRS design includes three **oversamples**. The oversamples are introduced as supplements to the core national sample and are designed to increase the numbers of Black and Hispanic HRS respondents as well as the number of HRS respondents who are residents of the state of Florida. Sampling weights are provided on all HRS data sets to compensate for the unequal probabilities of selection between the core and oversample domains (see Section 5).

1990 Census data suggest that the expected total of completed interviews from an equal probability sample of U.S. households would contain approximately 10% age-eligible Black households. Within the 84 PSUs which comprise the first stage of the SRC National Sample Design, a supplemental sample of SSUs (area segments) was selected from second stage strata of Census block groups containing 10% or more 1990 Census households with a Black head. Thus, eligible persons in residential areas eligible for the second stage sample supplement (more than 10% Black households per block group) have a greater probability of selection than persons in areas which have less than 10% Black households. Through the use of this procedure, the representation of eligible Black household units was expected to increase from 10% to about 18.6% of the total HRS sample.

For an equal probability sample of U.S. households, estimates from the Current Population Survey would suggest that 5% of the HRS households would include a respondent of Hispanic origin. Approximately 58% of these Hispanic households are of Mexican ancestry. The design objective for the HRS was to obtain a two-fold oversampling of Mexican-American households. The Hispanic supplement required additions to the PSU sample, especially in the West and Southwest. In addition to expanding the primary stage of the sample, supplemental sampling of SSUs in areas with Hispanic household density of 10% or more was used to assure sufficient sample size to permit subgroup analysis. The Hispanic supplement was designed to increase the representation of Hispanics, including the Mexican-American subgroup, from 5% to 8.6% of the total HRS sample.

Table 1 shows the proportion of Black and Hispanic households expected from an equal probability sample of U.S. households and the proportion expected from the HRS special allocation.

Table 1: HRS Special Sample Allocation Compared to Proportionate Allocation (HHs)

Household Racial / Ethnic Group	% Households Proportionate Allocation	% Households HRS Allocation
Blacks	10.0%	18.6%
Hispanics	5.0%	8.6%
All Others	85.0%	72.8%
TOTAL	100.0%	100.0%

In addition to the oversamples of Black and Hispanic households, the HRS design incorporates a two-fold oversample of Florida households (across all race and ethnic groups). Supplemental funds were obtained to increase the number of Florida PSUs (from 5 to 12 Florida PSUs). This insured that there would be sufficient precision to allow separate state-level analysis of data from the HRS Florida respondents. The HRS multi-stage area probability design for the core sample and supplements is described in detail in Section 3.

2.D. Integrated Design and Procedures: Core Sample and Supplements

The HRS core sample and special supplemental samples are integrated within the general framework of the SRC National Sample design. In expanding the PSU samples for both the Florida and Hispanic supplemental samples, the 84 strata SRC design was used as the framework. In Florida, the five original National Sample strata were subdivided to form 12 new Florida strata -- six of which became self-representing for the HRS Florida sample. Similarly, the original National Sample stratification was reorganized and used in selecting additional Hispanic PSUs. These Hispanic PSUs are new or additional primary-stage selections from the original SRC strata which had significant Mexican-American population.

The HRS Black supplement sample is also selected within the SRC National Sample stratification. The Black supplement required no added PSU selections beyond those included in the full SRC National Sample. The Black supplement SSUs are selected from the original National Sample PSUs. The HRS primary stage sample does use the full set of National Sample PSUs (instead of the 2/3 set of PSUs) in the South, the Region which accounts for 52.8% of the U.S. Black population (34.4% of total U.S. population).

The use of sampling weights which compensate for the oversampling of the three domains allows the core and supplement samples to be combined in analyses. The sampling weights are incorporated into the analysis weights (described in Section 5).

3. Sample Design And Procedures: Multi-Stage Area Probability Sample Design

The HRS core sample and special supplements comprise an integrated sample of the U.S. household population. Each multi-stage component of the HRS area probability sample is consistent with the general sample design framework and sampling procedures of the SRC National Sample (Heeringa, Connor, and Darrah, 1984).

The HRS sample was selected at a time when 1990 Census data were just becoming available. For this reason some features of the design (e.g., PSU definitions) are consistent with 1980 Census definitions. However, other features such as the geographic definitions of SSUs and the measures of size (MOS) for SSUs were updated to take best advantage of newly released Census mapping materials (TIGER) and 1990 Census counts of population and housing.

3.A. Primary Stage Selection

3.A.1. Core Sample

The selection of core SRC National Sample primary stage sampling units (PSUs), which depending on the sample stratum are either SMSAs (MSAs),¹ single counties or groups of small counties, was based on the county-level 1980 Census Reports of Population and Housing and the 1980 SMSA definitions. National Sample PSUs were assigned to 84 explicit strata based on MSA/non-MSA status, PSU size and geographic location. Sixteen of the 84 National Sample strata contain only a single self-representing (SR) PSU, each of which is included with certainty in the primary stage of sample selection. The remaining 68 nonself-representing (NSR) strata contain more than one PSU. From each of these nonself-representing strata, one PSU was sampled with probability proportionate to its size (PPS) measured in 1980 Census occupied housing units.

The full 1980 SRC National Sample design of 84 primary stage selections was designed to be optimal for very large studies. To permit the flexibility needed for optimal design of smaller survey samples, the primary stage of the SRC National Sample can be partitioned into smaller subsamples of PSUs. Each of the partitions represents a stratified subselection from the full 84 PSU design (Heeringa, Connor, Darrah; 1984).

In complex sample designs, the precision of sample estimates is related to a number of factors, an important one being the number of PSUs which contribute data to the estimate. The basic

¹SMSAs or Standard Metropolitan Statistical Areas are now called MSAs (Metropolitan Statistical Areas) or PMSAs (Primary Metropolitan Statistical Areas). PMSAs are part of larger CMSAs (Consolidated Metropolitan Statistical Areas) while MSAs are not part of CMSAs. The PSUs in the 1980 SRC National Sample used 1980 SMSA definitions. These definitions can be found in the publication, 1980 Census of Population. Standard Metropolitan Statistical Areas: 1980 (PC80-S1-5; issued October 1981). The following definition is found on page 4 of the above mentioned publication: SMSAs are "designated as Federal statistical standards by the Office of Management and Budget (OMB) to maintain geographic consistency in the presentation of data issued by Federal agencies. The general concept of an SMSA is one of a large population nucleus, together with adjacent communities which have a high degree of economic and social integration with that nucleus." In this document, the current term, MSA, will be used to refer to both MSAs and PMSAs.

sample for the HRS study is selected from the 2/3 partition of the full 84 strata of the 1980 SRC National Sample. The 2/3 partition includes the 16 self-representing MSA PSUs and a stratified subsampling of 45 of the 68 nonself-representing PSUs for a total of 61 PSUs. To increase the precision for estimates based on Black respondent data, the primary stage of the HRS national sample design includes all Census South Region MSA and non-MSA PSUs (nine additional PSUs). The Census South Region includes about 34% of the total U.S. population but almost 53% of Black population.

In addition, the full set of 23 non-MSA PSUs in the SRC National Sample was used for HRS. The purpose for including the full set of 23 non-MSA PSUs in the HRS design was to achieve improved precision of HRS analyses for rural populations. Since the selection of National Sample PSUs is performed independently within Census regions, the use of the full sample in the South and non-MSA strata and the 2/3 sample in the Northeast, Midwest, and West nonself-representing MSA strata does not bias the sample for non-Black households. Under the standard multi-stage sample procedure, an adjustment for the larger PSU sample in the South and non-MSA strata -- i.e., smaller samples of HUs per PSU -- enters at a subsequent stage of the selection process. Including the added PSU selections for the Hispanic Supplement and Florida sample, the HRS sample has 93 primary stage selections: 27 self-representing and 66 nonself-representing.

3.A.2. Black Supplement

Although no additional PSU selections were made for the HRS Black supplement, the decision to use the full instead of the 2/3 set of National Sample PSUs in the South was made in order to increase the precision of survey estimates from the subsample of Black HRS respondents.

3.A.3. Hispanic Supplement

The HRS Hispanic supplement sample required additions to both the primary and secondary stages of the basic SRC National Sample design. At the primary stage, the supplement involved a re-stratification of the 84 strata of the 1980 SRC National Sample to reflect the distribution of the U.S. Mexican-American Hispanic population. The re-stratification was performed through simple recombinations of previously defined SRC National Sample strata. As shown in Table 2, the 84 1980 National Sample strata were reorganized to create 34 collapsed primary stage strata for the HRS Hispanic supplement. A total of a=23 Hispanic supplement PSU selections were allocated to these 34 collapsed strata based on 1990 Census counts of Mexican-American Hispanic households for PSUs assigned to the redefined strata. Column 4 of Table 2 shows the 1990 Census measures of size (MOS) for each of the recombined strata. Many of the recombined strata such as stratum 1, the New York, NY MSA, contain very few Mexican-American households, and no supplemental PSU selections were added to these strata. Other strata (e.g., Medium California MSAs) contain large Mexican-American populations and therefore multiple supplemental Hispanic PSUs are allocated to such strata. The majority of Hispanic PSUs are in the Southwest and West. Five of the 16 SRC National Sample self-representing PSUs were included with certainty in the Hispanic supplement: Los Angeles CA; Chicago IL; San Francisco CA; Dallas TX; and Houston TX.

Eight of the 23 Hispanic supplement PSUs are NSR PSUs in the SRC National Sample design. The remaining 10 Hispanic supplement NSR PSUs are new PSU selections not previously selected as part of the SRC National Sample.

By definition, the Hispanic supplement SR PSUs were the only PSUs in their stratum. Therefore, the five SR PSUs which had significant Mexican-American Hispanic population were automatically included in the Hispanic supplement.

In the Hispanic supplement NSR strata with sufficient Mexican-American Hispanic population, the core PSUs were not automatically selected for the Hispanic supplement. The Kish-Scott procedure (Kish, 1963) was used to maximize the probability of reselection of the core PSUs in the Hispanic supplement. In some cases, a new Hispanic PSU replaced the National Sample PSU in the Hispanic supplement. In other cases, the National Sample PSU was retained for the supplement. Additional new Hispanic supplement PSUs were also selected in strata which had a proportionately high Mexican-American population.

Table 2: Allocation of Hispanic PSUs and SSUs to SRC National Sample Strata and Definition of Mexican-American Strata

Hisp. Supp. Str. No.	Natl. Smpl. Str. No.	National Sample Stratum	Stratum MOS (1990 Mex.-Amer. population)	No. 1st Stage Selectns.	No. 2nd Stage Selectns.
		<i>Self-Representing Strata</i>			
1	1	New York, NY	73,529	0	
2	2	Los Angeles, CA	2,527,160	1	28
3	3	Chicago, IL	574,847	1	7
4	4	Philadelphia, PA	11,973	0	
5	5	Detroit, MI	50,801	0	
6	6	San Francisco, CA	298,895	1	4
7	7	Washington, DC	28,008	0	
8	8	Dallas, TX	449,218	1	5
9	9	Houston, TX	599,115	1	7
10	10	Boston, MA	8,226	0	
11	11	Nassau-Suffolk, NY	5,561	0	
12	12	St. Louis, MO	13,004	0	
13	13	Pittsburgh, PA	3,963	0	
14	14	Baltimore, MD	5,965	0	
15	15	Minneapolis, MN	23,026	0	
16	16	Atlanta, GA	22,654	0	
		<i>Nonself-Representing MSA Strata</i>			
17	17-24	MSAs in EAST	59,944	0	
18	25-35	MSAs in MIDWEST	335,944	0	
19	36-43	MSAs in AL,FL,GA, LA,MS,SC	158,155	0	
20	44	Large TX MSAs	1,579,046	3	18

Table 2, continued

Hisp. Supp. Str. No.	Natl. Smpl. Str. No.	National Sample Stratum	Stratum MOS (1990 Mex.-Amer. population)	No. 1st Stage Selectns.	No. 2nd Stage Selectns.
21	45	Small TX MSAs	617,233	1	7
22	46-51	MSAs in AR,DE,KY, MD,NC,OK,TN,TX, VA,WV	108,153	0	
23	52	San Diego, CA	449,541	1	5
24	53-54	Large MSAs in WA, OR,North CA	320,861	1	4
25	55	Sacramento, CA and Denver, CO	280,792	1	3
26	56-57	Medium California MSAs	1,427,032	3	18
27	58	Small CA MSAs	774,697	2	12
28	59-61	Non-California in WEST (except Seattle WA, Portland OR, Denver CO, Honolulu HI, Anchorage AK	937,721	2	12
		<i>Nonself-Representing Non-MSA Strata</i>			
29	62-64	Non-MSAs in NORTHEAST	8,461	0	
30	65-71	Non-MSAs in MIDWEST	155,878	0	
31	72-75	Non-MSA counties in AL,FL,GA,LA,MS, SC	158,384	0	
32	76	TX & OK Non-MSA Counties	570,451	1	6
33	77-81	Non-MSA counties in AR,DE,KY,MD,NC, OK,TN,VA,WV	47,072	0	

Table 2, continued

Hisp. Supp. Str. No.	Nat. Smpl. Str. No.	National Sample Stratum	Stratum MOS (1990 Mex.-Amer. population)	No. 1st Stage Selectns.	No. 2nd Stage Selectns.
34	82-84	Non-MSA counties in WEST	806,783	3	14
		TOTAL:	13,492,093	23	150

3.A.4. Florida Oversample

Five of the 84 strata in the SRC National Sample include only Florida MSAs or non-MSA counties. In order to allow sufficient precision for separate analysis of data from Florida respondents, more Florida PSUs were required for HRS. To accomplish this, the five Florida National Sample strata were subdivided to form 12 strata. Six of these new strata include a single self-representing PSU. Five of the 12 new strata retained the PSU used in the 1980 SRC National Sample. Retaining the original National Sample PSU selections in five of 12 new Florida strata greatly reduced the cost of relocating or training new field staff. Table 3 shows the definition of the 12 Florida strata.

As seen in Table 3, Florida strata 1 - 6 were created from the SRC National Sample strata 40, 41, and 42. In order to determine the size of the six new Florida NSR strata, the total housing units in the six Florida SR strata were subtracted from the total housing units in the state, and the remainder was divided by six. The result of this calculation was 404,129 -- the target number of housing units for the remaining NSR strata. Table 3 shows that the Florida NSR stratum sizes vary about this target -- from a low of 359,814 to a high of 466,391.

Florida strata 7 - 10 were created from the SRC National Sample stratum 43. The MSAs in this stratum were grouped together by geographic area into four strata of roughly equivalent numbers of housing units (as shown in Table 3). The original National Sample PSU for stratum 43 was retained. In addition, three new PSUs were selected with PPS from the remaining three Florida strata.

Florida strata 11 and 12 were created from National Sample stratum 75. Stratum 75 was divided geographically into Florida stratum 11 (in the north) and Florida stratum 12 (in the south). Each stratum contained four counties which had at least 40 percent of their population aged 55 or older. One PSU was selected by PPS from the NSR PSUs in Florida stratum 11. Another was selected by PPS from the NSR PSUs in Florida stratum 12.

Table 3: Florida Supplement Restratification

FL Str. No.	National Sample Str. No.	National Sample Stratum	Stratum MOS (1990 HUs)
<i>Self-Representing MSAs</i>			
1.	40-41	Large Florida MSA	975,046
2.	40-41	Large Florida MSA	771,288
3.	40-41	Large Florida MSA	628,660
4.	42	Medium Florida MSAs	461,665
5.	42	Medium Florida MSAs	448,490
6.	42	Medium Florida MSAs	390,335
<i>Nonsel-Representing MSAs</i>			
7.	43	Small Florida MSAs	366,122
8.	43	Small Florida MSAs	461,351
9.	43	Small Florida MSAs	359,814
10.	43	Small Florida MSAs	361,541
<i>Nonsel-Representing Non-MSAs</i>			
11.	75	Florida non-MSA counties in southern part of state	409,559
12.	75	Florida non-MSA counties in northern part of state	466,391

3.B. Secondary-Stage Selection of Area Segments

3.B.1. Core Sample

3.B.1.a. SSU Stratification and Selection

The second stage of the HRS core sample component was selected directly from computerized files that were prepared from the 1990 Census PL 94-171 CD-ROM file. The designated second-stage sampling units (SSUs) or "area segments" are comprised of Census blocks or groups of blocks. Each SSU was assigned a measure of size equal to the total 1990 housing unit count for the area. A minimum of 72 housing units was required for core sample SSUs. If a block had no housing units or fewer than 72 housing units, it was linked with adjacent blocks to form SSUs of sufficient size.

Prior to selection, Census blocks within each PSU were implicitly stratified by geography. Counties within MSA PSUs having more than one county were ordered by size and distance from the center of the MSA. This ordering was accomplished by placing the county with the central city first, suburban counties next, and remaining counties last in a circular pattern. In non-MSA PSUs comprised of more than one county, the Census blocks were ordered by county according to geographic location and population size of the county. Within counties, the Census blocks were sorted in Census tract order and within tract by Census block number. The numerical ordering of Census tracts and blocks corresponds closely to the geographic location within the county,

SSU selection was performed with probabilities proportionate to the assigned housing unit measures of size. A computer program developed at SRC was used to group the ordered file of Census blocks into SSUs of minimum measure of size (72 housing units) and to perform a systematic selection of the SSUs.

3.B.1.b. SSU Allocation

The number of SSUs allocated to sample PSUs depends on the population size of the stratum which the PSU represents. The number of SSUs in the self-representing PSUs is proportional to the size of the PSU (stratum) and ranges from a high of 61 in New York to a low of 16 in the six smallest SR PSUs. Table 4 shows the number and type of core sample SSUs in each PSU. In addition to showing the core allocation, the table shows the allocation of Black and Hispanic supplement SSUs (described in the following sections).

Table 4: HRS SSU Allocation by National Sample Stratum

National Sample Str. No.	Total HRS SSUs	Core Sample SSUs	Black Suppl. SSUs	Hispanic Suppl. SSUs
1	75	61	14	---
2	85	50	7	28
3	60	43	10	7
4	35	29	6	---
5	34	27	7	---
6	31	24	3	4
7	27	20	7	---
8	31	23	3	5
9	35	25	3	7
10	19	18	1	---
11	17	16	1	---
12	19	16	3	---
13	17	16	1	---
14	19	16	3	---
15	17	16	1	---
16	19	16	3	---
17	27	24	3	---
18	29	24	5	---
21	27	24	3	---
23	28	24	4	---
24	24	24	---	---
26	27	24	---	---
27	28	24	4	---
28	27	24	3	---
29	24	24	---	---
31	24	24	---	---
32	25	24	1	---

Table 4, continued

National Sample Str. No.	Total HRS SSUs	Core Sample SSUs	Black Suppl. SSUs	Hispanic Suppl. SSUs
33	24	24	---	---
34	28	24	4	---
36	21	18	3	---
37	18	12	6	---
38	16	12	4	---
39	24	18	6	---
40	27	24	3	---
41	25	24	1	---
42	27	24	3	---
43	27	24	3	---
44	24	18	---	6
45	21	18	3	---
46	12	12	---	---
47	18	18	---	---
48	13	12	1	---
49	19	18	1	---
50	22	18	4	---
51	16	12	4	---
52	5	---	---	5
53	24	24	---	---
55	27	24	---	3
56	30	24	---	6
57	30	24	---	6
58	30	24	---	6
59	24	24	---	---
60	30	24	---	6
62	6	6	---	---

Table 4, continued

National Sample Str. No.	Total HRS SSUs	Core Sample SSUs	Black Suppl. SSUs	Hispanic Suppl. SSUs
63	12	12	---	---
64	12	12	---	---
65	12	12	---	---
66	12	12	---	---
67	6	6	---	---
68	12	12	---	---
69	6	6	---	---
70	12	12	---	---
71	6	6	---	---
72	10	6	4	---
73	16	12	4	---
74	15	12	3	---
75	12	12	---	---
76	12	12	---	---
77	18	12	6	---
78	12	12	---	---
79	6	6	---	---
80	12	12	---	---
81	16	12	4	---
82	12	12	---	---
83	8	6	---	2
84	12	12	---	---
85	12	12	---	---
86	12	12	---	---
87	12	12	---	---
88	18	18	---	---
89	12	12	---	---

Table 4, continued

National Sample Str. No.	Total HRS SSUs	Core Sample SSUs	Black Suppl. SSUs	Hispanic Suppl. SSUs
90	12	12	---	---
91	12	12	---	---
92	6	---	---	6
93	6	---	---	6
94	7	---	---	7
95	4	---	---	4
96	6	---	---	6
97	6	---	---	6
98	6	---	---	6
99	6	---	---	6
100	6	---	---	6
101	6	---	---	6
Total	1818	1502	166	150

3.B.2. Black Supplement

At the primary stage of sampling, the Black supplement is fully integrated with the core National Sample design -- both the core HRS sample and the Black supplement share the same set of primary stage sample locations. The Black supplement to the HRS consists of 166 additional SSU selections. However, within each PSU location, the selection of Black Supplement SSUs was independent of the core SSU selection.

The first step in the sampling process was to allocate the 166 Black supplement SSUs to the National Sample PSUs. Since the purpose of the Black supplement is to improve the precision of survey estimates for the Black population, the supplemental sample of SSUs was allocated to the sample PSUs in proportion to the total Black population of the stratum which each sample PSU represents. (In a standard national household sample -- such as the HRS core sample -- this allocation would be proportional to total population or housing counts.) Table 4 shows the SSU allocation by PSU for the Black supplement.

A special Black supplement frame was then constructed for each PSU which had been allocated one or more supplemental SSUs. This frame consisted of SSUs having at least ten percent Black population. Through the use of appropriate weights in the analysis of the survey data, Black households not covered by the supplemental frame (but covered by the core National Sample frame) will receive unbiased representation in survey estimates. Excluding low density Black areas from the supplemental frame greatly increases the cost efficiency of the Black supplement.

Because the minimum measure of size for the Black supplement SSUs was based on Black households, the size of an individual SSU could vary depending on the density of Black households within its boundaries. Based on the predetermined allocation to the PSUs, the Black supplement SSUs were selected with probability proportionate to size measured in 1990 Census counts of Black households. Although the Black Supplement is intended primarily to increase the number of eligible Black HRS respondents, there is no race screening in the Black supplement SSUs. All households with at least one person born during the years 1931 - 1941 are eligible regardless of race. However, the average proportion of Black households in Black supplement SSUs is about 75 percent (compared to 10 percent in the core SSUs).

3.B.3. Hispanic Supplement

The Hispanic supplement SSUs were selected using the 1990 Census PL 94-171 file. For each PSU which is part of the Hispanic supplement (see Section 3.A.3), a file was constructed of all Census blocks which are part of the PSU definition. The file of Census blocks was ordered by geography (as described in Section 3.B.1.a). A computer program was used to cluster the Census blocks into SSUs with a minimum measure of size of 96 Hispanic persons. A sampling frame was then formed from only those SSUs having at least ten percent Hispanic population. From this frame the predetermined number of SSUs was selected from each Hispanic supplement PSU with probability proportional to the Hispanic population. The SSU allocation to Hispanic supplement PSUs is shown in Table 2.

In the Hispanic supplement SSUs, households were screened to include only those which had at least one eligible Hispanic person. The average proportion of Hispanics in the Hispanic supplement SSUs was expected to be about 20 percent (versus about 5 percent in the core SSUs). Although the allocation of the Hispanic supplement PSUs and SSUs was based on Mexican- American population, all self-reported Hispanic households were eligible for the Hispanic supplement. However, because the supplement was concentrated in areas with high Mexican-American population density, the Hispanic respondents in the supplement are more likely to be Mexican-Americans than other groups such as Puerto Ricans or Cuban-Americans.

3.B.4. Florida Sample

The HRS Florida sample is completely integrated with the core sample at both the PSU and SSU levels. Because of the way the additional Florida PSUs were selected, all twelve Florida PSUs and all Florida SSUs are part of both the core and special Florida samples. A sampling weight which compensates for the two-fold oversampling in Florida is required for HRS analyses. The sampling weights are described in Section 6. Table 4 shows the allocation of SSUs to the Florida PSUs.

3.C. Third-Stage Selection of Housing Units

For each SSU selected in the second sampling stage, a listing was made of all housing units located within the physical boundaries of the segment. For SSUs with a very large number of expected housing units or a very large geographic area, all housing units in a subselected part of the SSU were listed. Within each sample domain a final equal probability sample of housing units for the HRS survey was systematically selected from the housing unit listings for the sampled SSUs. The equal probability sample of households within each sample domain was achieved by using the standard multi-stage sampling technique of setting the sampling rate for selected housing units within SSUs to be inversely proportional to the PPS probabilities used to select the PSU and the SSU. The number of selected housing unit listings took into account the expected occupancy rate, the screening required to find age-eligible households, and the expected response rate. These sample design parameters are discussed in Section 4.

3.D. Fourth-Stage: Respondent Selection

Within each sampled housing unit, the SRC interviewer prepared a complete listing of all household members. The full name, sex, age, and relationship to informant was recorded for each member of the household. The informant was then asked the year of birth of any person in the housing unit aged 50 to 62. If the year of birth was 1931 - 1941 inclusive, the person was eligible to be interviewed for the HRS survey. If no one in the housing unit was born during that time period, the household was classified as having no eligible respondent (NER). The HRS area probability sample housing unit listings were also used to screen for persons born prior to 1924. These household members would be interviewed for a future SRC study, the Aging and Health in America (AHEAD) study. The National Institute on Aging sponsored both the HRS and the AHEAD studies.

If the HRS sample household contained only one age-eligible person or if there were two age-eligible persons who were married/partnered to each other, no respondent selection procedure was required. The single person or both partners were designated as the financial unit to be interviewed. If there was more than one age-eligible person and they were not married (or in an equivalent relationship), an objective procedure described by Kish (1965) was used to select a single eligible respondent to be interviewed. Regardless of circumstances, no substitutions were permitted for the designated respondent. If the selected age-eligible person had a spouse, the spouse was also designated for the HRS person interview whether or not the spouse was age eligible.

An unmarried age-eligible respondent was automatically designated the "R1" or primary household respondent. In the case of a married couple, the person who considered himself or herself more knowledgeable about the family's assets, debts, and retirement was designated the "R1" respondent and the spouse became the "R2" or secondary respondent. In a married couple household financial unit, the "R1" respondent was not necessarily age eligible.

3.E. HRS Sample Release and Survey Monitoring

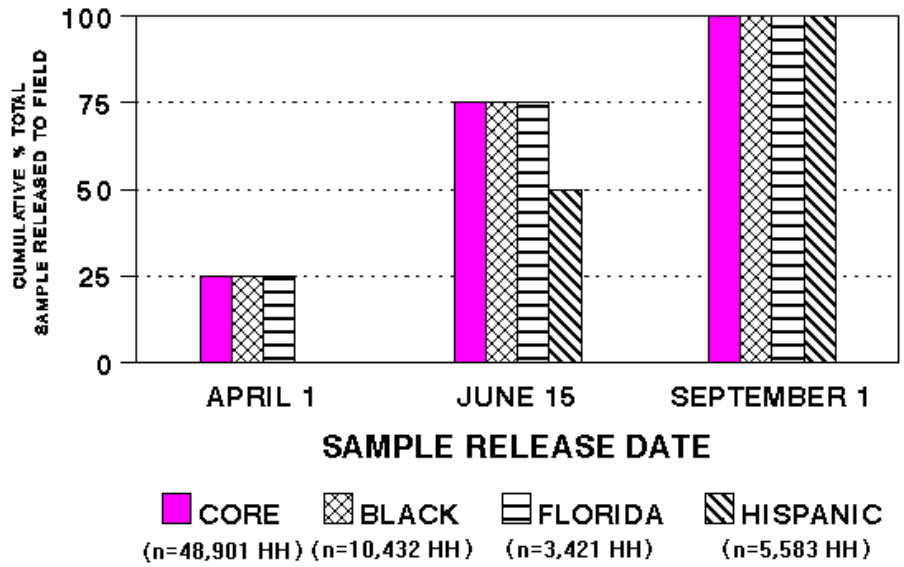
Within each PSU, the HRS SSUs were randomly divided into two rotation groups. Interviewing began in the first rotation of SSUs in April 1992 and in the second set in June 1992. This staged introduction of SSUs was designed to control sample size and cost.

In April 1992, one half of the selected housing units from the first set of SSUs or one-fourth of the total core sample was released for interviewing. In June 1992, the remaining one-half of the sample lines in the first set of SSUs and one-half of the sample lines in the second set of SSUs were introduced. At this point, three-fourths of the sample lines were in the field and one fourth of the sample was withheld. In September, the third release of sample brought the complete sample into the field. If the survey costs had been too high or the eligibility higher than expected, the size of the third release of sample could have been adjusted. This was possible because the entire sample of housing units was assigned to 24 replicates, each of which was a proper subsample of the whole. The September release could have used part or all of the available replicates.

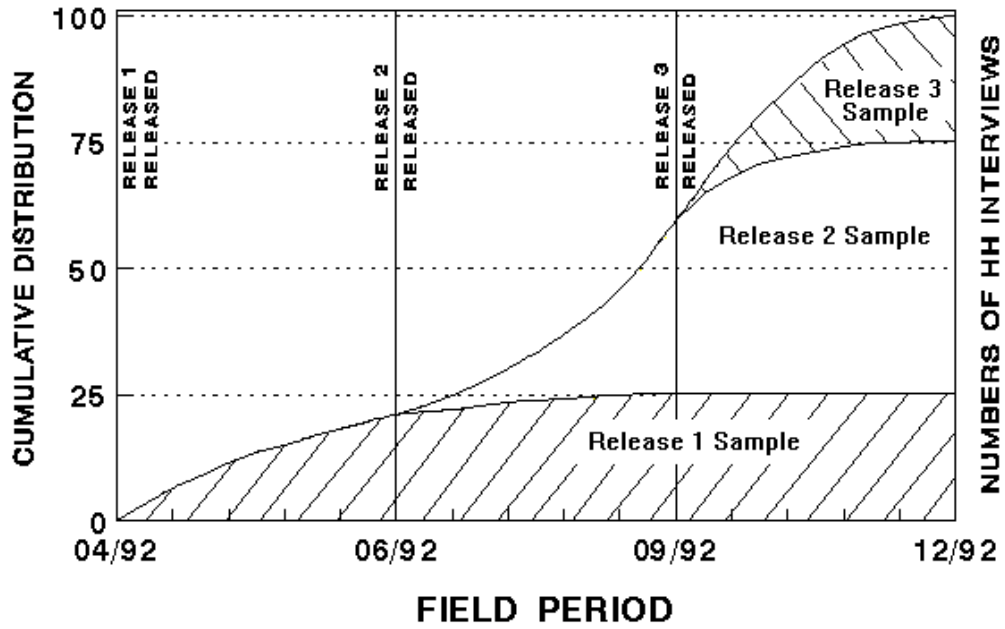
Figure 1 shows the timing of the sample release for the various components of the total sample, i.e., the core sample and the supplemental samples of Blacks and Hispanics as well as the Florida oversample. Figure 2 shows that the sample release schedule for the total sample produced an interview completion rate which facilitated monitoring of survey quality and cost factors. From April to June, interview completions accumulated at a relatively slow rate. Following the major June sample release, interview completions began to rise more sharply. Immediately prior to the September release date, about 60 percent of the expected

interviews were completed. At that point, a judgment could be made about the size of the third sample release in September. Because the eligibility rate was lower than expected, the entire third set of sample was released. The comparison of survey design parameters with survey outcomes is discussed in Section 4.

FIGURE 1
HRS SAMPLE RELEASE
FOR CONTROL OF SAMPLE SIZE AND COST



**FIGURE 2
DISTRIBUTION OF HRS INTERVIEWS
BY SAMPLE RELEASE AND FIELD PERIOD**



4. Sample Outcomes

4.A. Occupancy Rate, HU Update Rate

As part of routine survey procedure, SRC interviewers updated the housing units listings for each HRS SSU immediately prior to the start of interview data collection. Two forms of HU listing update were performed. Type I updating involved a pre-study check of the SSU listing for new or previously missed HU structures. Type II updating involved the identification of previously unidentified housing units within listed structures. In designing the sample, it was assumed that the offsetting effects of Type I and Type II updating (adding sample housing units) and the vacancy rate would result in 0.90 household contacts for every housing unit sampled. The 0.90 value is the product of a factor that reflects an expected 3% increase in sample size due to updating and an estimated occupancy rate of 87.3% (i.e., $.90 = 1.03 * .873$).

Table 5 shows the update factors and occupancy rate actually achieved for each HRS sample component. As the table indicates, the actual increase in the housing unit sample size (primary cover sheets) was lower than expected (1.3 percent instead of 3 percent increase). The occupancy rate ranged from .885 for the non-Florida core to .813 for the Florida supplement. The combined update/occupancy factor was close to the expected value for the core sample and Hispanic supplement but was lower for the Black supplement (.834) and the Florida sample (.818). The lower rate for Florida probably reflects the seasonal nature of some of the housing in that state.

**Table 5A: HRS Update and Occupancy Rates
Update Rate by Sample Component**

Sample Component	Total Sample Lines	Original Sample Lines	Growth By Update
Complete Sample	69,337	68,442	1.013
Core (not Florida)	48,901	48,331	1.012
Black Supplement	10,432	10,226	1.020
Hispanic Supplement	6,583	6,484	1.015
Florida Sample	3,421	3,401	1.006

Table 5B: HRS Occupancy Rate by Sample Component

Sample Component	Total Sample	Total Non-Sample Lines	Total HHs	Sub-sampled	Occupancy Rate
Complete Sample	69,337	9,419	59,918	460	0.871
Core (not Florida)	48,901	5,894	43,007	272	0.885
Black Supplement	10,432	1,970	8,462	75	0.818
Hispanic Supplement	6,583	892	5,691	87	0.878
Florida Sample	3,421	663	2,758	26	0.813

Table 5C: HRS Household Contact Rate by Sample Component

Sample Component	Update rate * Occupancy Rate = Household Contact Rate
Complete Sample	1.013 * 0.871 = 0.882
Core (not Florida)	1.012 * 0.885 = 0.896
Black Supplement	1.020 * 0.818 = 0.834
Hispanic Supplement	1.015 * 0.813 = 0.891
Florida Sample	1.006 * 0.813 = 0.818

4.B. Household Eligibility and Subsampling Respondents Within Households

Because the HRS was designed to study households with at least one member aged 51-61 (born from 1931 - 1941), a large share of the sampled housing units were screened out due to not having an eligible household financial unit. In designing the sample, it was necessary to estimate several factors: (1) the proportion of households which had at least one age-eligible person, (2) the proportion of age-eligible persons who were married, (3) the proportion of married couples in which both were age-eligible, (4) the proportion of households in which there were more than one unmarried age-eligible person. These parameters had to be estimated for the core sample as well as the supplemental samples.

The estimate from the 1989 Current Population Survey March Supplement was that 19.3 percent of households would have at least one age-eligible person and that there would be 1.62 persons eligible for interview per age-eligible household. Table 6 shows the eligibility rates for each of the components of the HRS Wave 1 sample. Table 7 shows the number of designated person respondents per eligible household, and Table 8 the number of interviewed persons per interviewed household.

²The number of non-sample lines includes the lines which were subsampled because of dangerous areas, locked buildings, or gated subdivisions. However, the subsampled lines are treated as occupied housing units in calculating the occupancy rate.

Comparing the CPS estimates for the nationally representative core sample to the HRS sample outcomes, several important differences can be noted. Whereas the CPS household eligibility estimate was 19.3%, the HRS core sample "household eligibility rate" was only 16.6%. Where CPS estimated 1.64 eligible persons per household, the HRS survey experience yielded 1.70. Throughout the HRS Wave 1 field period, the discrepancy between the CPS-estimated household eligibility rate and the HRS sample eligibility rate was a source of concern. If the difference was real, it pointed to potential household undercoverage bias in the HRS sample design. Careful checks of screening questions and verification of screening outcomes provided no evidence of a bias in the screening process. Analysis of single year of age distributions identified no serious perturbations such as underrepresentation at the boundaries of the eligible age range. Ultimately, the discrepancy was explained by a simple difference in the way the Bureau of Census (CPS) and SRC define households in housing units occupied by multiple financial units. SRC considers all persons residing in a housing unit to constitute a household unit. The Bureau of Census counts unmarried, not partnered persons living in a housing unit as separate households. While the difference in definition does not affect the quality of the sampling processes, it does complicate the comparison of rates in which the household unit is involved -- i.e., household eligibility rates, eligible persons per household.

The definitional difference fully accounts for the observed discrepancy between the CPS-estimated and HRS-observed household eligibility rates. When the HRS household eligibility is recomputed under the CPS definition, the revised HRS household eligibility rate is 19.1%. Accordingly, the revised value for eligible persons per household also corresponds very closely to the CPS-based estimate.

Table 6: HRS Household Eligibility Rate

Sample Component	Total HHs	DK Elig.	NER	HHs Excl. DK Elig.	Elig. HHs	Elig. Rate
Complete Sample	59,918	214	50,437	50,437	9,267	0.155
Core (not Florida)	43,007	141	35,771	42,866	7,095	0.166
Black Supplement	8,462	36	6,982	8,426	1,444	0.171
Hispanic Supplement	5,691	27	5,360	5,664	304	0.054
Florida Sample	2,758	10	2,324	2,748	424	0.154

³This overall eligibility rate includes the Hispanic eligibility factor used in the Hispanic Supplement. Therefore, it is lower than the eligibility rate based solely on the household having an age-eligible respondent.

Table 7: HRS Eligible Persons per Eligible Household

Sample Component	Designated Person Respondents	Eligible HHs	HRS Persons/HH	Design Persons/HH
Complete Sample	15,497	9,267	1.67	1.62
Core (not Florida)	12,052	7,095	1.70	1.64
Black Supplement	2,211	1,444	1.53	1.43
Hispanic Supplement	509	304	1.67	1.66
Florida Sample	725	424	1.71	1.63

Table 8: HRS Interviewed Persons per Interviewed Household

Sample Component	Interviewed Persons	Interviewed HHs	HRS Interview Persons/HH	Design Interviewed Persons/HH
Complete Sample	12,654	7,608	1.66	1.62
Core (not Florida)	9,872	5,828	1.69	1.64
Black Supplement	1,794	1,193	1.50	1.43
Hispanic Supplement	392	236	1.66	1.66
Florida Sample	596	351	1.70	1.63

⁴The number of designated person respondents includes household respondents (R1s) and both age-eligible and age-ineligible spouses.

⁵The number of interviewed persons includes household respondents (R1s) and both age-eligible and age-ineligible spouses.

4.C. Household-level and Person-level Response Rates

Table 9 summarizes the household-level response rate experience of the overall HRS survey and its sample components. Table 10 shows the corresponding person-level response rates. The sample design specifications called for an 80 percent response rate. The tables below show that this rate was met or exceeded by all sample components except the Hispanic supplement which has a household response rate of 78 percent and a person-level response rate of 77 percent.

Table 9: HRS Wave 1 Household-level Response Rates

Sample Component	Elig. + DK Elig. HHs	Known Elig. HHs	Interviews	Response Rate	
				Low	High
Complete Sample	9,481	9,267	7,608	0.802	0.821
Core (not Florida)	7,236	7,095	5,828	0.805	0.821
Black Supplement	1,480	1,444	1,193	0.806	0.826
Hispanic Supplement	331	304	236	0.713	0.776
Florida Sample	434	424	351	0.809	0.828

Table 10: HRS Wave 1 Person-level Response Rates

Sample Component	Eligible	Interviewed	Response Rate
Complete Sample	15,497	12,654	0.816
Core (not Florida)	12,052	9,872	0.819
Black Supplement	2,211	1,794	0.811
Hispanic Supplement	509	392	0.770
Florida Sample	725	596	0.822

Of the 12,654 HRS Wave 1 interviews, 609 interviews (351 R1s and 258 R2s) were obtained in response to special incentives as part of the HRS Nonresponse Study. These 609 interviews were from a sample of 2,602 HRS selected respondents (1617 sample households) who initially refused to participate. Of the 1,617 household refusals in the Nonresponse Study, 67 were found to have no eligible respondents.

⁶Two response rates are shown. The low response rate includes the DK eligible households in the denominator. The high response rate includes only known eligible households in the denominator.

5. Wave 1 Health and Retirement Study Weights for Data Analysis

The complex sample design of the Health and Retirement Study, which includes oversamples of Hispanics, Blacks, and households in the state of Florida requires compensatory weighting in descriptive analyses of the survey data. Beyond simple compensation for unequal selection probabilities, weighting factors are also used to adjust for geographic and race group differences in response rates and for the subsampling of households in a small number of locked buildings or dangerous areas. Poststratification adjustments are made at both the household and person level in order to control sample demographic distributions to known 1990 Census totals. This section describes the weight variables which have been developed for the HRS Wave 1 data.

The household analysis weight is a composite weight which has been formed from the product of five component factors: (1) the housing unit selection weight, (2) an adjustment factor for non-listed segments, (3) an adjustment factor for subsampled areas, (4) a household nonresponse adjustment factor, and (5) a household post-stratification factor. The person level analysis weight incorporates two additional factors, the respondent selection weight and a person level post-stratification factor. The following sections describe the purpose, construction, and use of each of these component weights.

5.A. Household Selection Weight

To compute the sample selection weight for HRS households, the HRS sample is divided into four sample domains: 1) General (not in oversample areas); 2) Black Oversample (Census Tract is \geq 10% Black); 3) Hispanic Oversample (Census Tract is \geq 10% Hispanic and the stratum was eligible for Hispanic oversample selections); and 4) state of Florida.

All HRS respondents in the general domain receive a relative household selection weight of 1.0. Respondents in the Black oversample domain and Florida received a double chance of selection relative to respondents in the general domain. Therefore their relative household selection weight is 0.5. Only Hispanics (all Hispanics, not only Mexican-Americans) were eligible to be selected from the Hispanic oversample domain. Therefore, in the Hispanic oversample domain, Hispanic households have a household selection weight of 0.5 while non-Hispanic households have a household selection weight of 1.0. A household was classified as Hispanic if at least one eligible person in the household was Hispanic. In 29 cases, the R1 was non-Hispanic and the R2 was Hispanic. There was no race screening in the Black supplement. All households in Census tracts with at least ten percent Black population were eligible for the Black supplement and have a household selection weight of 0.5. All Florida households also have a

⁷A subsampling procedure was used in two types of areas: (1) dangerous areas which were determined to be too risky for normal interviewing procedures, and (2) locked buildings or gated residential areas in which the interviewers were unable to gain access. Instead of excluding the entire affected area, one-third of the sample lines in these segments were subsampled and special efforts and resources were concentrated on the smaller set of cases in order to have at least some representation from the area.

⁸Listing of area segments in Los Angeles coincided with the riots associated with the Rodney King verdict. Interviewers were not able to list two Black supplement segments and four Hispanic supplement segments. Sample lines in similar segments received weights to compensate for the non-listed segments.

⁹The 150 Hispanic supplement PSUs were allocated to Hispanic supplement strata in proportion to Mexican-American population. Strata with significant Mexican-American population were included in the sampling frame. These were mainly in the West and Southwest, although the Chicago PSU in the Midwest region was eligible and received 7 of the 150 Hispanic segments.

selection weight of 0.5.

It is possible for HRS sampled households to be part of more than one oversample domain and therefore have four times the base chance of selection. Sampled housing units in these overlapping domains have a household selection weight of 0.25. There are areas which are in Census tracts in which both the Black and Hispanic population proportion is at least ten percent. Hispanic households in this type of area receive a household selection weight of 0.25 while other households receive a selection weight of 0.5. Some of the Florida SSUs are in Census tracts which are at least ten percent Black. Sampled households in the Black/Florida overlap have a household selection weight of 0.25. It is not possible to have a Hispanic/Florida overlap domain because the Florida strata do not have significant Mexican-American population and were not eligible for the Hispanic supplement sample.

5.B. Adjustment Factor for Non-Listed SSUs

There were six SSUs in Los Angeles which could not be listed because of the danger from the April 1992 riots which followed the Rodney King verdict. In addition, one SSU in New Haven, CT, was not listed because it was in a very dangerous area and one SSU in Anaheim, CA, was not listed because it was a locked and gated area.

The strategy used to compensate for SSUs which were selected from the PSU but were not listed was to create a weight factor which was the ratio of the number of SSUs in a domain in a PSU which should have been listed to the number which actually were listed and to apply the weight to all sample lines in the listed SSUs. For example, in Los Angeles, seven Black supplement SSUs were selected but only five were listed. Therefore, an adjustment weight of 7/5 or 1.40 was applied to sample lines in the five listed SSUs.

The SSU location was also taken into account in constructing this weight factor. In New Haven, the weight factor was applied only to the SSUs in the central city which were similar to the dangerous SSU which was not listed. In this case a weight factor of 8/7 or 1.14 was applied to the seven listed SSUs in the central city.

5.C. Adjustment Factor for Subsampled SSUs

There were 39 SSUs in which a subsampling procedure was used -- either for all or part of the sample housing units in the SSUs. Twenty-four of these were subsampled because of access problems such as locked buildings or gated subdivisions. Fifteen of the SSUs were subsampled because they were dangerous areas. Interviewers could request the subsampling of an SSU when normal procedures for interviewing in the SSU failed. These requests were reviewed by their supervisor and if approved were sent to the Sampling Section for subselection. The Sampling Section then selected a systematic sample of one-third of the sample lines for attempted interviews. The goal of the subselection process was to obtain at least some interviews from the difficult SSUs. Special efforts and resources were expended on the one-third of the sample lines retained, and the remaining two-thirds received a special non-sample result code (75).

The weighting to compensate for subsampled lines was spread across all sample lines in groups of similar SSUs in the same PSU. For example, there were two SSUs in Manhattan (New York City) which were subselected because of access problems. In order to create the weight factor to compensate for this subsampling, a list of all Manhattan SSUs was compiled together with a count of the original number of selected housing units in each SSU. The number of sample lines which were "subselected out" was also determined. The weight factor which was applied to each sample line in the Manhattan SSUs was the total number of original sample lines divided by the total number of sample lines after subselection. In this case, eleven lines were removed from two SSUs by subselection and the total number of original sample lines in

the fourteen Manhattan SSUs was 388. Therefore the weight factor was $388/377 = 1.029$.

This procedure of forming groups of similar SSUs within a PSU and calculating weight factors equal to the total original lines selected divided by the total lines after subselection was done for each of the thirty-nine SSUs. In some cases, such as the Manhattan SSUs, more than one subselected SSU was in the same weighting group.

5.D. Household Nonresponse Adjustment Factor

Nonresponse is a potential source of nonsampling error in the HRS survey data. In an effort to counteract potential biases that may result from differential response across sample subclasses and domains, a nonresponse adjustment weight factor is incorporated as one of the multiplicative factors in the final HRS household and person analysis weights. PSUs and the sample domain of the SSU are used to define the "cells" for the nonresponse adjustment weight factor.

The major source of nonresponse was household nonresponse rather than nonresponse by one member of a couple in a cooperating household. In the 5,200 interviewed married-couple households, both husband and wife cooperated over 95 percent of the time. Therefore the nonresponse adjustment was made at the household rather than at the person level. Households were assigned to nonresponse adjustment cells based on PSU and racial composition of the neighborhood. Post-stratification adjustments are included in both the household and person-level analysis weights (see 5.E and 5.F).

Three race/ethnicity groups were defined for computing household nonresponse adjustments: (1) non-Black/non-Hispanic; (2) Black; and (3) Hispanic. The first group consists of households in Census tracts which were less than ten percent Black (the Black oversample domain) and less than ten percent Hispanic. Households in the second or third group were in tracts which were at least ten percent Black or Hispanic respectively. If a household was in a tract which qualified for both the second and third group it was assigned to the group which had the highest proportion of population in the tract. The race of the respondent was not considered in the assignment of a household to race/ethnicity group; only the proportion Black or Hispanic in the Census tract in which the SSU was located was considered.

The weighted response rate for each PSU by Race/Ethnicity cell was determined by dividing the weighted total households interviewed (R1s) by the weighted total known eligible households. The weight used in the household response rate calculation was the adjusted relative selection weight described in Section 5.4. Households with unknown eligibility were excluded from the denominator of this calculation. The overall HRS weighted household response rate was 83.6 percent. The household nonresponse adjustment weight for each respondent household is the reciprocal of the weighted response rate for households in its nonresponse adjustment cell. Table 11 shows the weighted response rate and household nonresponse adjustment factor for each PSU by Race/Ethnicity cell.

¹⁰Only SSUs in PSUs which were eligible for the Hispanic oversample (those with significant Mexican-American population) were classified as Hispanic in forming the nonresponse adjustment cells.

Table 11: Computations of Household Nonresponse Adjustment Weights

PSU	Race/Ethnicity	Weighted Response Rate	Nonresponse Adjustment Weight
1	Non-Black, non-Hispanic	64.9	1.541
1	Black	72.2	1.385
2	Non-Black, non-Hispanic	69.5	1.439
2	Black	90.6	1.104
2	Hispanic	68.3	1.464
3	Non-Black, non-Hispanic	80.2	1.247
3	Black	81.1	1.233
3	Hispanic	70.8	1.412
4	Non-Black, non-Hispanic	85.5	1.170
4	Black	82.1	1.218
5	Non-Black, non-Hispanic	86.5	1.156
5	Black	80.6	1.241
6	Non-Black, non-Hispanic	84.5	1.183
6	Black	75.6	1.323
6	Hispanic	89.8	1.114
7	Non-Black, non-Hispanic	82.5	1.212
7	Black	75.4	1.326
8	Non-Black, non-Hispanic	82.4	1.214
8	Black	83.8	1.193
8	Hispanic	76.6	1.305
9	Non-Black, non-Hispanic	65.4	1.529
9	Black	88.4	1.131
9	Hispanic	72.3	1.383
10	Non-Black, non-Hispanic	69.5	1.439
10	Black	77.8	1.285
11	Non-Black, non-Hispanic	87.2	1.147
11	Black	87.9	1.138
12	Non-Black, non-Hispanic	79.2	1.263
12	Black	56.5	1.770
13	Non-Black, non-Hispanic	77.0	1.299
13	Black	72.3	1.383
14	Non-Black, non-Hispanic	77.4	1.292
14	Black	82.7	1.209

Table 11, continued

PSU	Race/Ethnicity	Weighted Response Rate	Nonresponse Adjustment Weight
15	Non-Black, non-Hispanic	89.5	1.117
15	Black	100.0	1.000
16	Non-Black, non-Hispanic	83.0	1.205
16	Black	90.8	1.101
17	Non-Black, non-Hispanic	92.8	1.078
17	Black	90.0	1.111
18	Non-Black, non-Hispanic	77.0	1.299
18	Black	81.4	1.228
21	Non-Black, non-Hispanic	76.5	1.307
21	Black	75.1	1.332
23	Non-Black, non-Hispanic	83.9	1.192
23	Black	81.5	1.227
24	Non-Black, non-Hispanic	78.6	1.272
26	Non-Black, non-Hispanic	89.0	1.124
26	Black	95.1	1.052
27	Non-Black, non-Hispanic	82.2	1.217
27	Black	69.4	1.441
28	Non-Black, non-Hispanic	82.6	1.211
28	Black	90.1	1.110
29	Non-Black, non-Hispanic	89.2	1.121
29	Black	88.9	1.125
31	Non-Black, non-Hispanic	83.5	1.198
31	Black	88.2	1.134
32	Non-Black, non-Hispanic	86.8	1.152
32	Black	88.5	1.130
33	Non-Black, non-Hispanic	87.5	1.143
33	Black	77.8	1.285
34	Non-Black, non-Hispanic	83.6	1.196
34	Black	89.2	1.121
36	Non-Black, non-Hispanic	86.7	1.153
36	Black	76.9	1.300

Table 11, continued

PSU	Race/Ethnicity	Weighted Response Rate	Nonresponse Adjustment Weight
37	Non-Black, non-Hispanic	90.9	1.100
37	Black	75.7	1.321
38	Non-Black, non-Hispanic	85.7	1.167
38	Black	88.4	1.131
39	Non-Black, non-Hispanic	95.0	1.053
39	Black	94.7	1.056
40	Non-Black, non-Hispanic	85.8	1.166
40	Black	74.7	1.339
41	Non-Black, non-Hispanic	77.9	1.284
41	Black	86.3	1.159
42	Non-Black, non-Hispanic	95.7	1.045
42	Black	76.7	1.304
43	Non-Black, non-Hispanic	82.8	1.208
43	Black	85.0	1.176
44	Hispanic	82.5	1.212
45	Non-Black, non-Hispanic	82.9	1.206
45	Black	94.1	1.063
45	Hispanic	75.0	1.333
46	Non-Black, non-Hispanic	79.4	1.259
46	Black	100.0	1.000
47	Non-Black, non-Hispanic	90.9	1.100
48	Non-Black, non-Hispanic	82.6	1.211
48	Black	95.2	1.050
49	Non-Black, non-Hispanic	92.0	1.087
49	Black	100.0	1.000
50	Non-Black, non-Hispanic	87.0	1.149
50	Black	90.3	1.107
51	Non-Black, non-Hispanic	89.8	1.114
51	Black	94.4	1.059
52	Hispanic	78.3	1.277

Table 11, continued

PSU	Race/Ethnicity	Weighted Response Rate	Nonresponse Adjustment Weight
53	Non-Black, non-Hispanic	80.0	1.250
53	Black	88.9	1.125
55	Non-Black, non-Hispanic	81.0	1.235
55	Black	77.8	1.285
55	Hispanic	76.1	1.314
56	Non-Black, non-Hispanic	93.8	1.066
56	Black	88.0	1.136
57	Non-Black, non-Hispanic	86.7	1.153
57	Hispanic	76.8	1.302
58	Non-Black, non-Hispanic	90.9	1.100
58	Hispanic	88.3	1.133
59	Non-Black, non-Hispanic	89.5	1.117
60	Non-Black, non-Hispanic	85.3	1.172
60	Hispanic	91.9	1.088
62	Non-Black, non-Hispanic	74.4	1.344
63	Non-Black, non-Hispanic	96.5	1.036
64	Non-Black, non-Hispanic	72.3	1.383
65	Non-Black, non-Hispanic	93.1	1.074
66	Non-Black, non-Hispanic	85.5	1.170
67	Non-Black, non-Hispanic	80.7	1.239
68	Non-Black, non-Hispanic	92.4	1.082
69	Non-Black, non-Hispanic	89.5	1.117
70	Non-Black, non-Hispanic	90.9	1.100
71	Non-Black, non-Hispanic	91.3	1.095
71	Black	75.0	1.333
72	Non-Black, non-Hispanic	85.7	1.167
72	Black	81.7	1.224
73	Black	93.7	1.067
74	Non-Black, non-Hispanic	100.0	1.000
74	Black	94.1	1.063

Table 11, continued

PSU	Race/Ethnicity	Weighted Response Rate	Nonresponse Adjustment Weight
75	Non-Black, non-Hispanic	88.5	1.130
75	Black	100.0	1.000
76	Hispanic	94.5	1.058
77	Non-Black, non-Hispanic	77.8	1.285
77	Black	78.8	1.269
78	Non-Black, non-Hispanic	88.9	1.125
78	Black	90.2	1.109
79	Non-Black, non-Hispanic	85.4	1.171
80	Non-Black, non-Hispanic	94.5	1.058
81	Non-Black, non-Hispanic	80.0	1.250
81	Black	88.3	1.133
82	Non-Black, non-Hispanic	88.5	1.130
82	Black	88.9	1.125
83	Hispanic	91.9	1.088
84	Non-Black, non-Hispanic	91.7	1.091
84	Hispanic	87.3	1.145
85	Non-Black, non-Hispanic	81.0	1.235
85	Black	84.6	1.182
86	Non-Black, non-Hispanic	89.3	1.120
86	Black	75.0	1.333
87	Non-Black, non-Hispanic	84.6	1.182
87	Black	85.7	1.167
88	Non-Black, non-Hispanic	81.7	1.224
88		86.3	1.159
89	Non-Black, non-Hispanic	86.5	1.156
89	Black	50.0	2.000
90	Non-Black, non-Hispanic	100.0	1.000
90		82.1	1.218
91	Non-Black, non-Hispanic	84.2	1.188
91	Black	86.7	1.153

Table 11, continued

PSU	Race/Ethnicity	Weighted Response Rate	Nonresponse Adjustment Weight
92	Hispanic	88.9	1.125
93	Hispanic	70.0	1.429
94	Hispanic	84.6	1.182
95	Hispanic	40.0	2.500
96	Hispanic	62.5	1.600
97	Hispanic	93.3	1.072
98	Hispanic	85.7	1.167
99	Hispanic	77.4	1.292
100	Hispanic	71.4	1.401
101	Hispanic	100.0	1.000

5.E. Household Post-Stratification Factor

In spite of weighting corrections that reflect sample household selection probabilities and nonresponse adjustments, weighted sample distributions of major demographic and geographic characteristics may not correspond exactly to those for the known household population. The departures of sample distributions from the underlying population are in part due to the variation that is inherent in the sampling process itself. Sample undercoverage, originating in the sampling frame or in the field sampling and updating procedures, also can cause sample distributions to deviate from known Census proportions. "Coverage" and estimation errors can also be introduced via the multiple weighting adjustments that are applied to the survey interview data. (Weights designed to attenuate one source of survey error may accentuate others.)

Post-stratification factors are small adjustments to analysis weights that are designed to bring weighted sample frequencies for important demographic and geographic subgroups in line with corresponding population totals that are available from a source that is external to the survey data collection process. Beyond the simple appeal of the population controls, the post-stratification procedure is expected to reduce the mean square error of sample estimates. The geographic and demographic variables and categories chosen for the household level post-stratification of the HRS data set are: Census Region (Northeast, Midwest, South, West), Race (Black/non-Black) and Marital Status (Married/Not Married). The control values for the 16 household level post-strata (4 x 2 x 2) defined in Table 12 are from the U.S. Bureau of the Census 1990 Public Use Microdata Sample (PUMS). The 1990 Census PUMS data set used was the 5 percent sample from the 1990 Census.

Table 12: Computations of Household Post-Stratification Weights

Census Region	Race	Marital Status	1990 Census PUMS Estimate	1992 HRS Estimate	HH Poststratification Factor PUMS/HRS
Northeast	Non-Black	Not Married	1,036,384	843,907	1.228
Northeast	Non-Black	Married	2,361,714	2,289,389	1.032
Northeast	Black	Not Married	236,297	292,757	0.807
Northeast	Black	Married	174,170	253,801	0.686
Midwest	Non-Black	Not Married	1,029,695	1,027,224	1.002
Midwest	Non-Black	Married	2,797,328	3,283,215	0.852
Midwest	Black	Not Married	212,715	222,701	0.955
Midwest	Black	Married	165,920	233,075	0.712
South	Non-Black	Not Married	1,438,124	1,193,378	1.205
South	Non-Black	Married	3,743,765	3,663,416	1.022
South	Black	Not Married	500,944	578,321	0.866
South	Black	Married	447,549	542,545	0.825
West	Non-Black	Not Married	1,056,187	884,505	1.194
West	Non-Black	Married	2,274,809	2,164,814	1.05
West	Black	Not Married	93,311	93,258	1.001
West	Black	Married	80,367	83,942	0.957

In order to be eligible for the Health and Retirement Study, a household had to include at least one person born during the years 1931 - 1941 (age 51 - 61). The PUMS file did not have a year of birth variable; therefore the persons' ages were used directly. An age-eligible household was one in which at least one person was between the ages of 51 and 61. If any age-eligible household member was Black, the household was classified as Black. If any age-eligible household member was married, the household was classified as married. The PUMS data was weighted by the PUMS household weight, yielding a weighted total of age-eligible households equal to 17,649,279. In order to compare the weighted population totals by post-stratification cell for HRS data to the PUMS cell totals, the HRS household weights were multiplied by a factor of 17,649,279/6910 to inflate the HRS household weight to the PUMS total. Table 12 shows the weighted totals for the 16 household post-stratification cells for the 1990 PUMS and the household post-stratification factor which is the 1990 PUMS estimate of total households divided by the HRS weighted estimate of total households.

The final household analysis weight is the product of all of the factors described above -- the relative household selection weight, the adjustments for non-listed segments, the adjustment for subsampled, locked, or dangerous segments, the household nonresponse adjustment, and the household post-stratification factor. This household weight should be used for descriptive analysis of household-level data from the 7,608 Health and Retirement Study households interviewed in Wave 1.

The HRS household selection weight is a relative weight value designed to be used with contemporary software systems that support weighted estimation and data analysis. HRS data analysts may opt to scale this relative weight. Some analysts may prefer the sum of weights to equal the nominal sample size ($n = 7608$). Others may prefer a scaled version of the weight that sums over cases to the eligible household total ($N = 17,649,279$ for 1990 U.S. households). With the exception of estimates of household population totals, weighted estimation and analysis of HRS household data should be invariant to linear scaling of the relative household weight value. Nevertheless, HRS data analysts are advised to investigate how their chosen analysis program treats weights in estimation and inference. Also, see Section 6 for a discussion of the effect of weights on estimates of variances for survey statistics.

5.F. Person Level Weight - Respondent Selection Factor

The Health and Retirement Study is a sample of households with at least one person born during the period 1931 - 1941. Although non-age eligible persons were interviewed for HRS if they were a spouse or partner of an age-eligible respondent, the HRS is not a probability sample of persons born before 1931 or after 1941. These age-ineligible persons have a person level analysis weight of zero. Their data is useful in constructing household level estimates or models, but they should not be part of a person-level analysis.

Two factors determine the value of the respondent selection weight: (1) the marital status of the respondent, and (2) the number of age-eligible persons in the household. The respondent selection weight is the inverse of the probability of selection of the age-eligible respondent from the total number of age-eligible household members. A few examples will illustrate the calculation of this weight factor :

1. Single Respondent (age-eligible).

The probability of selection is 1.0 and the respondent selection weight is also 1.0.

2. Two Single Respondents (both age-eligible).

One of the two single age-eligible household members is chosen at random. Therefore the probability of selection is 1/2 and the respondent selection weight is 2.0.

3. Married Couple - (both age-eligible; no other age-eligible persons in household).

The probability of selection of each partner is 1.0 and each has a respondent selection weight of 1.0.

4. Married Couple - (one age-eligible, one age-ineligible; no other age-eligible persons in household).

The probability of selection of the age-eligible person is 1.0 and the respondent selection weight is 1.0. The conditional selection probability of the age-ineligible partner is also 1.0 but because HRS is not a proper sample of age-ineligible persons, the respondent selection weight field is assigned a value of zero.

5. Married Couple and Single Person - (all age-eligible).

The probability of selection of each person is initially 1/3. But if either married partner is selected, the other partner is automatically selected. Therefore, if the married couple is selected, each partner has a respondent selection weight of 1.5. If the single person was selected the respondent selection weight is 3.0.

Table 13 shows the assignment of the respondent selection weight for each marital status by number of eligible persons combination.

**Table 13: Probability of Selection and Respondent Selection Weight
by Marital Status and Number of Age-eligible Persons**

Marital Status	Number of Age-Eligible Persons	Probability of Selection within Household	Respondent Selection Weight
Not Married	1	1.0	1.0
Not Married	2	1/2	2.0
Not Married	3	1/3	3.0
Not Married	4	1/4	4.0
Married	1	1.0	1.0
Married	2	1.0	1.0
Married	3	2/3	1.5
Married	4	1/2	2.0

5.G. Person Level Post-Stratification Weight

In addition to the post-stratification to known 1990 Census household totals for Census Region by Race by Marital Status, the HRS survey data is post-stratified at the person level to 1990 PUMS totals for Census Region (4) by Race/Ethnicity (3) by Sex (2) by Age Group (3). In all, 72 post-stratification cells were formed ($4 \times 3 \times 2 \times 3 = 72$). Age-eligible respondents were weighted by the product of the Household Analysis Weight and the Respondent Selection Weight and weighted totals were obtained for each of the 72 post-stratification cells. The person-level post-stratification factor was then formed by dividing the 1990 PUMS estimate of total population for each cell by the weighted HRS estimate of the population total. Table 14 shows the definition for each cell, the PUMS and HRS estimates, and the person-level post-stratification factor.

Table 14: Computation of Person-Level Post-Stratification Weights

Census Region	Race	Sex	Age Group	1990 Census PUMS Estimate	1992 HRS Estimate	Person-level Poststratification Factor
Northeast	Non-Black, Non-Hispanic	Male	51-53	580,374	549,615	1.056
			54-57	738,544	688,230	1.073
			58-61	778,031	736,179	1.057
		Female	51-53	615,280	678,561	0.907
			54-57	796,601	817,113	0.975
			58-61	851,093	839,160	1.014
	Black	Male	51-53	63,082	67,133	0.940
			54-57	73,987	63,079	1.173
			58-61	64,779	53,287	1.216
		Female	51-53	83,040	89,347	0.929
			54-57	99,412	94,190	1.055
			58-61	86,692	85,653	1.012
	Hispanic	Male	51-53	40,113	37,004	1.084
			54-57	46,991	18,341	2.562
			58-61	39,769	23,535	1.690
		Female	51-53	46,933	53,466	0.878
			54-57	55,296	63,543	0.870
			58-61	46,444	41,230	1.126

Table 14, continued

Census Region	Race	Sex	Age Group	1990 Census PUMS Estimate	1992 HRS Estimate	Person-level Poststratification Factor	
North Central	Non-Black, Non-Hispanic	Male	51-53	718,745	680,010	1.057	
			54-57	886,433	887,052	0.999	
			58-61	887,026	795,985	1.114	
		Female	51-53	749,841	730,831	1.026	
			54-57	946,648	934,445	1.013	
			58-61	977,674	980,999	0.997	
		Black	Male	51-53	59,286	49,505	1.198
				54-57	74,421	68,163	1.092
				58-61	69,162	62,700	1.103
	Female		51-53	74,397	68,978	1.079	
			54-57	94,813	96,441	0.983	
			58-61	88,839	91,467	0.971	
	Hispanic	Male	51-53	14,910	19,447	0.767	
			54-57	17,075	11,594	1.470	
			58-61	16,406	10,730	1.529	
		Female	51-53	14,139	8,445	1.674	
			54-57	16,744	11,648	1.438	
			58-61	15,801	18,551	0.852	

Table 14, continued

Census Region	Race	Sex	Age Group	1990 Census PUMS Estimate	1992 HRS Estimate	Person-level Poststratification Factor
South	Non-Black, Non-Hispanic	Male	51-53	905,125	931,280	0.972
			54-57	1,122,296	1,073,942	1.045
			58-61	1,094,992	1,019,889	1.074
		Female	51-53	935,998	896,688	1.044
			54-57	1,201,718	1,171,241	1.026
			58-61	1,225,327	1,061,194	1.155
	Black	Male	51-53	153,763	125,607	1.224
			54-57	189,566	174,390	1.087
			58-61	166,385	168,073	0.990
		Female	51-53	190,270	178,403	1.067
			54-57	240,152	241,150	0.996
			58-61	220,082	238,332	0.932
	Hispanic	Male	51-53	69,983	115,394	0.606
			54-57	81,491	95,247	0.856
			58-61	74,436	90,484	0.823
		Female	51-53	74,679	120,504	0.620
			54-57	92,725	131,257	0.706
			58-61	89,048	120,687	0.738

Table 14, continued

Census Region	Race	Sex	Age Group	1990 Census PUMS Estimate	1992 HRS Estimate	Person-level Poststratification Factor
West	Non-Black, Non-Hispanic	Male	51-53	560,382	501,974	1.116
			54-57	670,141	629,922	1.064
			58-61	653,039	606,596	1.077
		Female	51-53	570,495	588,793	0.969
			54-57	698,989	704,455	0.922
			58-61	697,014	590,658	1.180
	Black	Male	51-53	34,009	20,651	1.647
			54-57	38,726	46,243	0.837
			58-61	29,307	21,835	1.342
		Female	51-53	33,564	42,557	0.789
			54-57	41,459	43,353	0.956
			58-61	34,695	38,258	0.907
	Hispanic	Male	51-53	86,735	88,363	0.982
			54-57	98,317	120,848	0.814
			58-61	89,019	91,426	0.974
		Female	51-53	88,565	110,847	0.799
			54-57	106,999	145,545	0.735
			58-61	99,450	108,822	0.914

5.H. Summary of Household and Person-level Analysis Weights

The Person-level Analysis Weight is the product of the Household Analysis Weight, the Respondent Selection Weight and the Person-level Poststratification Weight. Only age-eligible respondents have valid person-level weights. Age-ineligible respondents have a value of zero for the person weight. Household-level data appears only on the primary respondent (R1) record. Therefore only R1s have valid household analysis weights. Secondary respondents (R2s) have a household weight of zero. Age-eligible R2 cases incorporate the household weight as one of the multiplicative factors of the final person-level analysis weight. Table 15 shows the relationship of respondent type, age-eligibility and weights.

Table 15: Use of Household and Person Weights

Respondent Type	Age-Eligibility (Year of Birth: 1931-1941)	Type of Analysis Variable	Use Household Weight	Use Person Weight
Primary (R1)	Yes	Household	Yes	No
Primary (R1)	Yes	Person	No	Yes
Primary (R1)	No	Household	Yes	No
Primary (R1)	No	Person	No	No
Secondary (R2)	Yes	Household	No	No
Secondary (R2)	Yes	Person	No	Yes
Secondary (R2)	No	Household	No	No
Secondary (R2)	No	Person	No	No

6. Health and Retirement Survey: Procedures for Sampling Error Estimation

This section focuses on sampling error estimation and construction of confidence intervals for survey estimates of descriptive statistics such as means, proportions, ratios, and coefficients for linear and logistic linear regression models.

6.A Overview of Sampling Error Analysis of HRS Sample Data

The HRS is based on a stratified multi-stage area probability sample of United States households. The HRS sample design is very similar in its basic structure to the multi-stage designs used for major federal survey programs such as the Health Interview Survey (HIS) or the Current Population Survey (CPS). The survey literature refers to the HRS, HIS and CPS samples as complex designs, a loosely-used term meant to denote the fact that the sample incorporates special design features such as stratification, clustering and differential selection probabilities (i.e., weighting) that analysts must consider in computing sampling errors for sample estimates of descriptive statistics and model parameters.

Standard analysis software systems such SAS, SPSS, OSIRIS assume simple random sampling (SRS) or equivalently independence of observations in computing standard errors for sample estimates. In general, the SRS assumption results in underestimation of variances of survey estimates of descriptive statistics and model parameters. Confidence intervals based on computed variances that assume independence of observations will be biased (generally too narrow) and design-based inferences will be affected accordingly.

6.B Sampling Error Computation Methods and Programs

6.B.1 Linearization approach

If data are collected using a complex sample design with unequal size clusters, most statistics of interest will not be simple linear functions of the observed data. The objective of the linearization approach is to apply Taylor's method to derive an approximate form of the estimator that is linear in statistics for which variances and covariances can be directly estimated (Kish 1965; Woodruff, 1971).

Most univariate, descriptive analysis of survey data including the estimation of means and

$$\hat{r} = \sum_{i=1}^n w_i y_i / \sum_{i=1}^n w_i x_i = y / x$$

proportions involves the use of the combined ratio estimator:
where:

- † = the sample estimate of the ratio of population totals $R = Y/X$;
- y_i, x_i = variables for observation i ($x_i = 1$ for mean);
- w_i = weight for observation i ;
- y, x = weighted sample totals for the variables y, x .

The linearized approximation to the variance of the combined ratio estimator is (see Kish and

$$\text{var}(\hat{r}) \approx \frac{1}{x^2} \left[\text{var}(y) + r^2 \text{var}(x) - 2r \cdot \text{cov}(y, x) \right]$$

Hess, 1959)

Similarly, linearized variance approximations are derived for estimators of finite population regression coefficients and correlation coefficients (Kish and Frankel, 1974). Software packages such as SUDAAN and PC CARP (see below) use the Taylor Series linearization method to estimate standard errors for the coefficients of logistic regression models. In these programs, an iteratively reweighted least squares algorithm is used to compute maximum likelihood estimates of model parameters. At each step of the model fitting algorithm, a Taylor Series linearization approach is used to compute the variance/covariance matrix for the current iteration's parameter estimates (Binder, 1983).

Available sampling error computation software that utilizes the Taylor Series linearization method includes: SUDAAN and PC SUDAAN, SUPERCARP and PC CARP, CLUSTERS, OSIRIS PSALMS, OSIRIS PSRATIO, and OSIRIS PSTABLES. PC SUDAAN and PC CARP include procedures for estimation of sampling error both for descriptive statistics (means, proportions, totals) and for parameters of commonly used multivariate models (least squares regression, logistic regression).

6.B.2 Resampling Approaches

In the mid-1940s, P.C. Mahalanobis (1946) outlined a simple replicated procedure for selecting probability samples that permits simple, unbiased estimation of variances. The practical difficulty with the simple replicated approach to design and variance estimation is that many replicates are needed to achieve stability of the variance estimator. Unfortunately, a design with many independent replicates must utilize a coarser stratification than alternative designs -- to achieve stable variance estimates, sample precision must be sacrificed. Balanced Repeated Replication (BRR), Jackknife Repeated Replication (JRR) and the Bootstrap are alternative replication techniques that may be used for estimating sampling errors for statistics based on complex sample data.

The BRR method is applicable to stratified designs in which two half-sample units (i.e., PSUs) are selected from each design stratum. The conventional "two PSU-per-stratum" design in the best theoretical example of such a design although in practice, collapsing of strata (Kalton, 1977) and random combination of units within strata are employed to restructure a sample design for BRR variance estimation. The half-sample codes prepared for the HRS Wave 1 data set require the collapsing of nonself-representing strata and the randomized combination of selection units within self-representing (SR) strata. When full balancing of the half-sample assignments is employed (Wolter, 1985), BRR is the most computationally efficient of the replicated variance estimation techniques. The number of general purpose BRR sampling error estimation programs in the public domain is limited. The OSIRIS REPERR program includes the option for BRR estimation of sampling errors for least squares regression coefficients and correlation statistics. Research organizations such as Westat, Inc. (WESTVAR), and the National Center for Health

Statistics have developed general purpose programs for BRR estimation of standard errors. Another option is to use SAS or SPSS Macro facilities to implement the relatively simple BRR algorithm. The necessary computation formulas and Hadamard matrices to define the half-sample replicates are available in Wolter (1985).

With improvements in computational flexibility and speed, jackknife (JRR) and bootstrap methods for sampling error estimation and inference have become more common (J.N.K. Rao & Wu, 1988). Few general purpose programs for jackknife estimation of variances are available to analysts. OSIRIS REPERR has a JRR module for estimation of standard errors for regression and correlation statistics. Other stand-alone programs may also be available in the general survey research community. Like BRR, the algorithm for JRR is relatively easy to program using SAS, SPSS or S-Plus macro facilities.

BRR and JRR are variance estimation techniques, each designed to minimize the number of "resamplings" needed to compute the variance estimate. In theory, the bootstrap is not simply a tool for variance estimation but an approach to actual inference for statistics. In practice, the bootstrap is implemented by resampling (with replacement) from the observed sample units. To ensure that the full complexity of the design is reflected, the selection of each bootstrap sample reflects the full complexity of the stratification, clustering and weighting that is present in the original sample design. A large number of bootstrap samples are selected and the statistic of interest is computed for each. The empirical distribution of the estimate that results from the large set of bootstrap samples can then be used to obtain a variance estimate and a support interval for inference about the population statistic of interest.

In most practical survey analysis problems, the JRR and Bootstrap methods should yield similar results. Most survey analysts should choose JRR due to its computational efficiency. HRS data analysts interested in the bootstrap technique are referred to LePage and Billard (1992) for additional reading and a bibliography for the general literature on this topic.

One aspect of BRR, JRR and bootstrap variance estimation that is often pushed aside in practice is the treatment of analysis weights. In theory, when a resampling occurs (i.e., a BRR half sample is formed), the analysis weights should be recomputed based only on the selection probabilities, nonresponse characteristics and post-stratification outcomes for the units included in the resample. This is the correct way of performing resampling variance estimation; however, in practice acceptable estimates can be obtained through use of the weights as they are provided on the public use data set.

6.C Sampling Error Computation Models

Regardless of whether linearization or a resampling approach is used, estimation of variances for complex sample survey estimates requires the specification of a *sampling error computation model*. HRS data analysts who are interested in performing sampling error computations should be aware that the estimation programs identified in the preceding section assume a specific sampling error computation model and will require special sampling error codes. Individual records in the analysis data set must be assigned sampling error codes which identify to the programs the complex structure of the sample (stratification, clustering) and are compatible with the computation algorithms of the various programs. To facilitate the computation of sampling error for statistics based on HRS data, design-specific sampling error codes will be routinely

included in all public-use versions of the data set. Although minor recoding may be required to conform to the input requirements of the individual programs, the sampling error codes that are provided should enable analysts to conduct either Taylor Series or Replicated estimation of sampling errors for survey statistics.

Table 16 defines the sampling error coding system for HRS sample cases. Two sampling error code variables are defined for each case based on the sample design PSU and SSU in which the sample household is located.

SESTRAT - The sampling error stratum code is the variable which defines the sampling error computation strata for all sampling error analysis of the HRS data. With the exception of the New York, Los Angeles and Chicago MSAs, each self-representing (SR) design stratum is represented by one sampling error computation stratum. Due to their population size, two sampling error computation strata are defined for each of the three largest MSAs. Pairs of similar nonself-representing (NSR) primary stage design strata are "collapsed" (Kalton, 1977) to create NSR sampling error computation strata.

Controlled selection and a "one-per-stratum" design allocation are used to select the primary stage of the HRS national sample. The purpose in using Controlled Selection and the "one-per-stratum" sample allocation is to reduce the between-PSU component of sampling variation relative to a "two-per-stratum" primary stage design. Despite the expected improvement in sample precision, a drawback of the "one-per-stratum" design is that two or more sample selection strata must be collapsed or combined to form a sampling error computation stratum. Variances are then estimated under the assumption that a multiple PSU per stratum design was actually used for primary stage selection. The expected consequence of collapsing design strata into sampling error computation strata is the overestimation of the true sampling error; that is, the sampling error computation model defined by the codes contained in Table 20 will yield estimates of sampling errors which in expectation will be slightly greater than the true sampling error of the statistic of interest.

HALFSAM - Stratum-specific half sample code for analysis of sampling error using the BRR method or approximate "two-per-stratum" Taylor Series method (Kish and Hess, 1959). Within the self-representing sampling error strata, the half sample units are created by dividing sample cases into random halves, HALFSAM=1 and HALFSAM=2. The assignment of cases to half-samples is designed to preserve the stratification and second stage clustering properties of the sample within an SR stratum. Sample cases are assigned to half samples based on the SSU in which they were selected. For this assignment, sample cases were placed in original stratification order (SSU number order) and beginning with a random start entire SSU clusters were systematically assigned to either HALFSAM=1 or HALFSAM=2.

In the general case of nonself-representing (NSR) strata, the half sample units are defined according to the PSU to which the respondent was assigned at sample selection. That is, the half samples for each NSR sampling error computation stratum bear a one-to-one correspondence to the sample design NSR PSUs.

The particular sample coding provided on the HRS public use data set is consistent with the "ultimate cluster" approach to complex sample variance estimation (Kish, 1965; Kalton, 1977).

Individual stratum, PSU and SSU code variables may be needed by HRS analysts interested in components of variance analysis or estimation of hierarchical models in which PSU-level and neighborhood-level effects are explicitly estimated.

Table 16: Sampling Error Codes for HRS Wave 1 (Self-Representing PSUs)

Sampling Error Codes		Sample Design
SESTRAT SE Stratum	HALFSAM Half-Sample Code	Number of SSUs
1	1	15
	2	16
2	1	16
	2	16
3	1	16
	2	15
4	1	16
	2	16
5	1	13
	2	14
6	1	14
	2	13
7	1	17
	2	17
8	1	17
	2	16
9	1	12
	2	12
10	1	13
	2	12
11	1	11
	2	11
12	1	15
	2	15

Table 16, Sampling Error Codes for HRS Wave 1, cont.

Sampling Error Codes		
SESTRAT SE Stratum	HALFSAM Half-Sample Code	Number of SSUs
13	1	9
	2	9
14	1	7
	2	8
15	1	8
	2	8
16	1	8
	2	8
17	1	10
	2	9
18	1	8
	2	8
19	1	9
	2	9
20	1	13
	2	12
21	1	12
	2	11
22	1	8
	2	9
23	1	6
	2	5
24	1	6
	2	6
25	1	8
	2	7

Table 16, Sampling Error Codes for HRS Wave 1, cont.

Sampling Error Codes		Sample Design	
SESTRAT SE Stratum	HALFSAM Half-Sample Code	National Sample Stratum	Number of SSUs
26	1	52	2
	2	52	2

NonselF-Representing PSUs

27	1	17	27
	2	18	26
28	1	21	24
	2	23	26
29	1	24	19
	2	34	28
30	1	26	26
	2	27	25
31	1	28	26
	2	29	21
32	1	31	22
	2	32	25
33	1	33	23
	2	47	16
34	1	36	21
	2	38	15
35	1	37	17
	2	39	21
36	1	44	19
	2	45	18
37	1	87	12
	2	89	12

Table 16, Sampling Error Codes for HRS Wave 1, cont.

Sampling Error Codes		Sample Design	
SESTRAT SE Stratum	HALFSAM Half-Sample Code	National Sample Stratum	Number of SSUs
38	1	43	23
	2	90	10
39	1	46	12
	2	49	19
40	1	50	22
	2	51	16
41	1	48	12
	2	55	24
42	1	53	22
	2	59	22
43	1	56	23
	2	57	27
44	1	58	27
	2	60	26
45	1	63	12
	2	64	11
46	1	65	11
	2	66	12
47	1	67	6
	2	68	12
48	1	69	6
	2	70	12
49	1	62	6
	2	71	6
50	1	72	10
	2	73	15

Table 16, Sampling Error Codes for HRS Wave 1, cont.

Sampling Error Codes		Sample Design	
SESTRAT SE Stratum	HALFSAM Half-Sample Code	National Sample Stratum	Number of SSUs
51	1	74	15
	2	77	18
52	1	75	12
	2	91	12
53	1	78	12
	2	81	16
54	1	79	6
	2	80	11
55	1	76	12
	2	83	8
56	1	82	12
	2	84	11
57	1	92	5
	2	93	5
58	1	94	6
	2	99	6
59	1	95	1
	2	97	4
60	1	96	3
	2	98	5
61	1	100	3
	2	101	2
TOTAL (SR and NSR)			Total: 1629 HALFSAM 1: 803 HALFSAM 2: 826

Appendix: Glossary

Area Segment - Here synonymous with SSU. A geographic area, in most cases defined by discernible physical boundaries such as streets, roads, railroad tracks, streams, corporate limits, etc, within which a listing of housing units is made. In the more urban areas, cities, towns or villages, area segments are usually a census block or a group of blocks. The census blocks are numbered uniquely within tracts or block numbering areas and are associated with available Census data. In the more rural parts of primary sampling units the segments sometimes consist of a part or parts of a census block. A minimum measure of size in terms of households is specified for the area segments.

Area Segment Block Map - A printed map showing the area of the selected segment. Since an area segment is a census block or group of blocks, the boundaries are identified along with known interior divisions such as roads, railroad tracks, rivers, and streams. The block maps are provided to field personnel during data collection (or national study interviewing operations). These maps serve as "pictorial" records of segments throughout their active lives, as well as guides for ascertaining proper geographic locations.

Census Divisions - Nine geographic subdivisions of contiguous states within each of the four Census Regions of the United States. The exception to contiguous states is Alaska and Hawaii in the Pacific Division of the West Region.

<u>Region</u>	<u>Division</u>
North East	New England Middle Atlantic
Midwest	East North Central West North Central
South	South Atlantic East South Central West South Central
West	Mountain Pacific

Census Maps - Smaller scale maps which show the location of the defined area segment census blocks within a larger geographic area..

Census Minor Civil Division/Census County Division (MCD/CCD) - Part of the hierarchical census organization within counties for tabulation and reporting statistics. The MCDs/CCDs are townships or places (incorporated or census-designated places) within townships. Some cities or villages are independent of townships and are MCDs or CCDs exclusive of surrounding townships, precincts, districts, wards, Indian reservations and so on. State law in 28 states provided for the MCDs as primary divisions of counties. Twenty-one states have CCDs as primary county divisions. These

areas have been defined by the Census Bureau in cooperation with state and county officials.

Census Region - The grouping of the 50 states into four main geographic divisions: Northeast, Midwest, South and West (see "Census Division" entry).

Census Tract - A census statistical area with boundaries established cooperatively by the Census Bureau and a local census statistical area committee. Tracts are small, relatively permanent areas into which metropolitan statistical areas (MSAs) and certain other areas are divided for the purpose of providing statistics for small areas. The tracts are designed to be homogeneous with respect to population characteristics, economic status and living conditions. Generally the population size per tract is 2,500 to 8,000 residents. The tract boundaries are relatively permanent from one decennial census to another so that statistical comparisons can be made.

Certainty Selection - At whatever stage of sampling the sampling unit has a selection probability of 1.0.

Consolidated Metropolitan Statistical Area (CMSA) - A term used by the Census Bureau to describe a large concentration of metropolitan population composed of two or more contiguous Primary Metropolitan Statistical Areas (PMSAs) which together meet certain criteria of population size, urban character, social and economic integration, and/or contiguity of urbanized areas.

FIPS Codes - Geographic codes (standard codes used by all Federal agencies), published by the U.S. Bureau of Standards, Department of Commerce. FIPS stands for "Federal Information Processing Standards." Included are codes for states and outlying areas; counties and county equivalents; Metropolitan Statistical Areas; congressional districts; named, populated places and related entities.

Household - A household includes all persons who occupy a housing unit. In documentation, the term is used interchangeably with *occupied housing unit*.

Housing Unit - A house, an apartment, a group of rooms, or a single room occupied as a separate living quarters or, if vacant, intended for occupancy as separate living quarters. Separate living quarters are defined as:

1. Occupants live and eat separately from any other persons in the building; AND
2. The quarters have direct access from the outside of the building or through a common hall.

Measure of Size (MOS) - For the 1990 National Sample, the number of occupied housing units was used as the measure of size for the primary and subsequent stages of sampling up to the final stage.

Metropolitan Statistical Area (MSA) - An area with a large population nucleus and nearby communities which have a high degree of economic and social integration with that nucleus. Each MSA consists of one or more entire counties (or county equivalents) that meet specified standards pertaining to population, commuting ties and metropolitan character. (New England MSAs are defined by towns and cities rather than counties.) All MSAs are designated by the U.S. Office of Management and Budget. Specifically the MSAs meet one or both of these criteria: 1) include a city with a population of 50,000 within defined limits; 2) include a Census Bureau-defined urbanized

area (which must have a population of at least 100,000 -- or in New England, 75,000). MSAs which are components of a Consolidated Metropolitan Statistical Area are designated by the U.S. Office of Management and Budget as Primary Metropolitan Statistical Areas (PMSAs).

Multistage Area Probability Design - The design used in selecting the SRC National Samples. Using hierarchical steps, geographically defined sampling units of decreasing size were selected with probability proportionate to each of their total occupied housing unit counts (at each stage of selection).

National Sample Universe - The National Sample universe includes all U.S. households in the 48 coterminous states, the District of Columbia, Alaska and Hawaii. This universe includes civilian households on military reservations within the United States.

Noncertainty Selection - A selection from an explicitly defined group of sample units that represents itself and all other members of its group. Such a primary sampling unit selection for the National Sample is from a stratum of at least one other primary sampling unit, and is selected with a probability of less than 1.0. (See Nonself-representing Primary Sampling Units.)

Nonself-representing Primary Sampling Units - Those primary sampling units (PSUs) in the National Sample selected from strata containing more than one other area to represent themselves and the other members (PSUs) of their respective strata.

Primary Sampling Units (PSUs) - Areas (of the SRC National Sample) which are MSAs, single non-MSA counties or groups of non-MSA counties. The term *Primary Sampling Unit* is used to refer to different physical locations which enter the sample either with certainty or by sampling, at the primary stage of selection.

PPS Selection - Selection of some sampling unit with "probability proportionate to size" (PPS). As an example, the noncertainty selection of a PSU from a nonself-representing stratum is accomplished using probabilities proportionate to PSU size (in total occupied housing units as measured by the Census).

Sample Frame - A specified and defined group of elements from which to sample at various stages. The SRC National Sample uses a multistage design so that in the hierarchical selection process each stage of selection used a separate frame. The initial or first-stage frame is the whole of which each succeeding stage is a subpart.

Sampling Stage

First stage

Second/Third stages

Final stage

Possible
post-final stage

Frame Description

Census data files and maps which define the distribution of occupied HUs at the MSA and county level

Census data files and maps which define the distribution of occupied HUs at the census tract and block level

List of housing units for each selected area segment (SSU)

List of eligible members within each sample household

Second-Stage Selection Unit (SSU) - Census blocks in both the MSA and non-MSA PSUs are the second-stage sampling units. See "Area Segment."

Self-Representing Primary Areas - The largest Metropolitan Statistical Areas, each being the single member of its respective stratum, thus selected with certainty and representing only itself.

Stratification - The division of a population of sampling units into distinct subpopulations at various stages of sampling. For the 1980 National Sample the initial stratification (outside of the 16 largest self-representing primary areas) divided counties within Regions into 68 strata. Each stratum's member counties are as homogeneous as possible among certain criteria.

Urbanized Area - Census term defining a population concentration of at least 50,000 inhabitants, generally consisting of a central city and the surrounding, closely settled, contiguous area (suburbs). The criteria include: 1) a population density of at least 1,000 persons per square mile; 2) can also include less densely settled areas such as industrial parks or railroad yards within the densely settled parts. The urbanized area (UA) is typically included within an MSA -- sometimes more than one UA is located within an MSA.

References

- Binder, D.A. (1983). "On the variances of asymptotically normal estimators from complex surveys," *International Statistical Review*, Vol. 51, pp. 279-292.
- Heeringa, S., Connor, J., Darrah, D. (1986). *1980 SRC National Sample. Design and Development*. Ann Arbor: Institute for Social Research.
- Kalton, G. (1977). "Practical methods for estimating survey sampling errors," *Bulletin of the International Statistical Institute*, Vol 47, 3, pp. 495-514.
- Kish, L. (1965). *Survey Sampling*. John Wiley & Sons, Inc., New York.
- Kish, L., & Frankel, M. R. (1974). "Inference from complex samples," *Journal of the Royal Statistical Society, B*, Vol. 36, pp. 1-37.
- Kish, L., & Hess, I. (1959). "On variances of ratios and their differences in multi-stage samples," *Journal of the American Statistical Association*, 54, pp. 416-46.
- Kish, L., & Scott, A. (1971). "Retaining units after changing strata and probabilities." *Journal of the American Statistical Association*, Vol. 667, Number 335, Applications Section.
- LePage, R., & Billard, L. (1992). *Exploring the Limits of Bootstrap*. John Wiley & Sons, Inc., New York.
- Mahalanobis, P.C. (1946). "Recent experiments in statistical sampling at the Indian Statistical Institute," *Journal of the Royal Statistical Society*, Vol 109, pp. 325-378.
- Rao, J.N.K., & Wu, C.F.J. (1988). "Resampling inference with complex sample data," *Journal of the American Statistical Association*, 83, pp. 231-239.
- Wolter, K.M. (1985). *Introduction to Variance Estimation*. New York: Springer-Verlag.
- Woodruff, R.S. (1971). "A simple method for approximating the variance of a complicated estimate," *Journal of the American Statistical Association*, Vol. 66, pp. 411-414.