# NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY III

## WEIGHTING AND ESTIMATION METHODOLOGY

## EXECUTIVE SUMMARY

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## TABLE OF CONTENTS



## LIST OF TABLES

## LIST OF EXHIBITS

# EXECUTIVE SUMMARY

## 1. INTRODUCTION

### 1.1 Sample Design

The NHANES III sample represents the total civilian noninstitutionalized population, 2 months of age or older, in the 50 states of the United States. A four-stage sample design was used: (1) Primary Sampling Units (PSUs) comprising mostly single counties, (2) area segments within PSUs, (3) households within area segments, and (4) persons within households.

The PSUs in the first stage were mostly individual counties; in a few cases, adjacent counties were combined to keep PSUs above a certain minimum size. There were 81 PSUs in the sample, selected with probability proportionate to measures of size (pps) and without replacement. The measure of size reflected the desire to oversample the minority groups in NHANES III. Thirteen large counties were chosen with certainty. The 13 certainty counties were divided into 21 survey locations for logistical and operational reasons. The data collection was carried out between October 1988 and September 1994. In order to permit separate analyses for two 3-year periods (referred to as Phase 1 and Phase 2), as well as for the entire field period, the sample of PSUs was randomly allocated to the two 3-year periods. One set was allocated to the first 3-year time period during which NHANES III was conducted (Phase 1, 1988-91), and the other set to the second 3-year period (Phase 2, 1991-94). The allocation of PSUs to the two phases was made in a way that retained as much of the original stratification as possible.

For most of the sample in Phase 1, the second stage was area segments comprising city or suburban blocks, combinations of blocks, or other area segments in places where block statistics were not produced in the 1980 census. The area segments were used only for a sample of persons who lived in housing units built before 1980. For units built in 1980 and later, the second stage consisted of sets of addresses selected from building permits issued in 1980 or later (these are referred to as new construction segments). In Phase 2 of the survey, the 1990 census data were used for the selection of the second stage units, with no new construction sampling. In both phases, the area segments were stratified by percent Mexican-American prior to sample selection.

The third stage consisted of households and group quarters. All households and group quarters in the sample segments were listed, and a subsample of households and group quarters was designated for screening in order to identify potential respondents. The subsampling rates were set to produce a national, approximately equal probability sample of households in most of the U.S., with higher rates for the geographic strata with high minority concentrations.

Persons within the households or group quarters were the fourth stage of sample selection. (The persons selected for the sample are frequently referred to as SPs, Sampled Persons, throughout the report.) The screened households were grouped into a number of classes, depending on the age-sex-race/ethnicity of their members. The classes were subsampled at different rates, and, within each class, members of particular age-sex-race/ethnicity subdomains were identified as potential SPs; other members of the households were excluded from the sample. For more detail on the NHANES III sample design refer to Sample Design: Third National Health and Nutrition Examination Survey, National Center for Health Statistics, **Vital and Health Statistics** , Series 2, Number 113, September 1992.

A summary of the sample sizes for the full 6-year NHANES III sample at each stage of selection follows:

| | |
|---|---|
| Number of separate areas (PSUs) in sample | 81 |
| Number of survey locations | 89 |
| Number of segments | 2,144 |
| Number of households screened | 93,653 |
| Number of households with SPs designated for interview | 19,528 |
| Number of designated SPs | 39,695 |
| Number of interviewed SPs | 33,994 |
| Number of MEC examined SPs | 30,818 |
| Number of home examined SPs | 493 |

## 1.2 Comparisons Between NHANES I, NHANES II, Hispanic HANES, and NHANES III

It should be noted that due to differences in the sample sizes and designs for the three cycles of NHANES, estimates will differ in reliability across surveys. NHANES is one of the major programs in the series of health-related studies conducted by the National Center for Health Statistics (NCHS) over the past 30 years. This system of surveys has included NHANES I, NHANES II, Hispanic HANES (HHANES), NHANES III, and NHANES I Epidemiologic Follow-up Surveys. Although the three cycles have similar analytic objectives, there are differences in their sample designs. A comparison of the sample design parameters for the four Health and Nutrition Examination Surveys is given in Table 1.

Table 1. Selected sample design parameters for the health and nutrition examination surveys

| Parameter | NHANES I | NHANES II | Hispanic HANES | NHANES III |
|---|---|---|---|---|
| Age of civilian noninstitutionalized target population | 1-74 years | 6 months-74 years | 6 months-74 years | 2 months and over |
| Geographical areas | United States (excluding Alaska and Hawaii) | United States (including Alaska and Hawaii) | Southwest for Mexican-American persons; NY, NJ, CT for Puerto Rican persons; Dade County, FL, for Cuban persons | United States (including Alaska and Hawaii) |
| Average number of sample persons per household | 1 | 1 | 2-3 | 2-3 |
| Number of survey locations | 100 | 64 | 17 in Southwest; 9 in NY, NJ, CT; 4 in Dade County | 89 |
| Domains for oversampling | Low income: children aged 1-5 years; women aged 20-44 years; persons aged 65 years and over | Low income: children aged 6 months-5 years; persons aged 60-74 years | Dade County: 6 months-19 years and 45-74 years; Southwest and NY, NJ, and CT: persons aged 6 months-19 years and 45-74 years | 52 subdomains were predesignated consisting of age-sex groups for black, Mexican-American, and other persons. Target sample sizes were established for the subdomains. |
| Sample size | 28,043 | 27,801 | 15,931 | 39,695 |
| Examined sample size | 20,749 | 20,322 | 11,672 | 30,818 |
| Years covered | 1971-1974 | 1976-1980 | 1982-1984 | 1988-1994 |

The differences in the sample sizes and designs for the three cycles of NHANES and for HHANES should be considered when comparisons are made across various HANES surveys. For example, it should be noted that NHANES III is the only survey that includes persons 75 years or older, and that NHANES I and NHANES II did not include any oversampling of Hispanics.

## 1.3 Goals of Weighting

The purpose of weighting the sample data is to permit analysts to produce estimates of statistics that would have been obtained if the entire sampling frame had been surveyed. Sample weights can be considered as measures of the number of persons the particular sample observation represents. Weighting takes into account several features of the survey: the specific probabilities of selection for the individual domains that were oversampled, as well as nonresponse and differences between the sample and the total population. Differences between the sample and the population may arise due to sampling variability, differential undercoverage in the survey among demographic groups, and possibly other types of response errors, such as differential response rates or misclassification errors.

Sample weighting in NHANES III was used to accomplish the following objectives:

1. To compensate for differential probabilities of selection among subgroups (age-sex-race/ethnicity subdomains; persons living in different geographic strata sampled at different rates);

2. To reduce biases arising from the fact that nonrespondents may be different from those who participate;

3. To bring sample data up to the dimensions of the target population totals;

4. To compensate, to the extent possible, for inadequacies in the sampling frame (resulting from omissions of some housing units in the listing of area segments, omissions of persons with no fixed address, etc.); and

5. To reduce variances in the estimation procedure by using auxiliary information that is known with a high degree of accuracy.

The sample weighting was carried out in three stages. The first stage involved the computation of weights to compensate for unequal probabilities of selection (Objective 1

above). The second stage adjusted for nonresponse (Objective 2). The third stage used poststratification of the sample weights to Census Bureau estimates of the U.S. population to simultaneously accomplish the third, fourth, and fifth objectives.

It should be noted that due to the form of estimators typically used with data from complex samples, extreme variability in the weights may result in reduced reliability of the estimates. The NHANES III sample was designed to minimize the variability in the weights, subject to operational and analytic constraints. Additionally, measures such as weight trimming have been used to reduce the variability in the weights for NHANES III. However, the analyst should bear in mind the fact that extreme observations in conjunction with large weights may result in extremely influential observations, i.e., observations that dominate the analysis.

## 2. GENERAL OVERVIEW OF THE WEIGHTING METHODOLOGY

### 2.1 Computing Basic Weights

The first-stage (or basic) weight for each SP was calculated as the reciprocal of the SP's probability of selection, with adjustments for other variabilities in sampling rates such as changes made to the sampling rates at the time of data collection. The probability of selection of a person in NHANES III depended on three factors: (1) the person's age-sex-race/ethnicity domain; (2) the density stratum; and (3) the PSU. The following provides a brief description of each of the three components.

Older persons, children, Mexican-Americans, and black persons were oversampled to insure a prespecified minimum sample size for each analytic domain so that estimates of the health and nutrition status of persons in each domain could be made with acceptable precision. The oversampling in NHANES III was part of a pattern established in the sample design. The population was decomposed into 52 subdomains: 7 age groups by sex for black and Mexican-American persons and 12 age groups by sex for white persons and other racial groups combined. After defining age-sex-race/ethnicity subdomains, variable sampling rates were derived to ensure the achievement of sample sizes sufficient to permit analyses of the data for each subdomain.

The density strata were established by dividing the census blocks (or enumeration districts) in each sampled PSU into six classes with each class having a different level of concentration of Mexican-American persons. Blocks with high concentrations of Mexican-American persons were oversampled to increase the sample yield for this group.

The third component, the PSU factor, was introduced to adjust the basic weights to reflect the effect of the relatively fixed sample size within each PSU in NHANES III on the sample weights. The reason for the relatively fixed sample size by PSU was to have a manageable and efficient field procedure. However, the use of nearly a fixed number of examinations per PSU implied that NHANES III would not consist of exact self-weighting samples.

## 2.2 Adjusting for Nonresponse and Poststratification

If every selected household had agreed to complete the screener and every selected person had agreed to complete the interview and the medical examination, weighted estimates based on the data would be close to unbiased estimates of statistics for the total U.S. population. However, nonresponse occurs in any survey operation, and thus, nonresponse bias may result. The best approach to minimizing nonresponse bias is to plan and implement field procedures that maintain high cooperation rates. For NHANES III, the payment of cash incentives and repeated callbacks for refusal conversion were very effective in reducing nonresponse, and thus, nonresponse bias. Because some nonresponse occurs even with the best strategies, adjustments are always necessary to minimize potential nonresponse bias.

All persons selected in the sample were asked to participate in a personal interview at their home, where medical history and socio-demographic information were collected. After the initial interview, all interviewed persons were invited to the MEC for physical examination. Persons who were unable to come to the MEC were offered an abbreviated physical examination at their home.

Therefore, nonresponse in NHANES III occurred at several stages of the data collection process. Some of the sample persons who were screened (100% of the selected sample was screened, including about 6.7 percent for which neighbors provided the information) refused to be interviewed (interview nonresponse). Some of the interviewed SPs refused the medical examination (exam nonresponse). The overall interview and exam

nonresponse rates were 14 percent and 9 percent, respectively. The adjustment procedures used for unit nonresponse were slightly different from those Ezzati, et. al. (1991, 1992) used for creating preliminary weights for Phase 1 of the survey. A two-stage procedure for nonresponse adjustment and poststratification to known population totals was carried out to adjust for unit nonresponse in NHANES III. Exploratory research and analysis were carried out to identify variables to be used for nonresponse adjustment. A clustering methodology was used to identify potential variables and their subclasses for use in nonresponse adjustment. The SI-CHAID (Statistical Innovation's Chi-Square Automatic Interaction Detection) software was used to examine the relationship between response and various independent predictor variables (see Kass 1980, Lee 1989). SI-CHAID forms adjustment classes that maximize the variation in response rates. The outcome has a tree-shaped structure that identifies, based on chi-square values, the predictor variables that are highly related to the dependent variable (response status). Separate weighting class nonresponse adjustments were carried out for groups of sample individuals, defined by the following set of characteristics for the interviewed sample: (1) race/ethnicity, (2) age, and (3) household size, For the examined sample, the nonresponse classes were defined by: (1) race/ethnicity, (2) age, (3) household size, and (4) self-reported health status.

Extreme weights may occasionally result when units are sampled to yield fixed sample sizes within a PSU, as was the case with NHANES III. Additionally, the procedures used to make nonresponse and poststratification weighting adjustments can contribute to extreme weights. A few unexpectedly large sampling weights can seriously inflate the variance of the survey estimates. Thus, for a very small number of records, weight trimming procedures were used to reduce the impact of such large weights on the estimates produced from the sample.

Poststratification of sample weights to independent population estimates is used for several purposes. In most household surveys, certain demographic groups in the U.S. population (for example, young black males) experience fairly high rates of undercoverage in survey efforts. Poststratification to Census estimates partially compensates for such undercoverage and for any differential nonresponse, and can help to reduce the resulting bias in the survey estimates. Poststratification can also help to reduce the variability of sample estimates as well as achieve consistency with accepted U.S. figures for various subpopulations.

For both Phase 1 and Phase 2, a two-stage poststratification procedure was used. The first-stage adjustment was poststratified to Census region/MSA status totals, while the second-stage adjustment used age-sex-race/ethnicity domain totals. The Current Population Survey (CPS) was used for both stages of the poststratification for the control totals. The estimates used as control totals for poststratification corresponded to the midpoint of each time period for Phase 1 and Phase 2. For Phase 1, the control totals used were derived from the March 1990 CPS; for Phase 2, the totals were from the March 1993 CPS. For both Phase 1 and Phase 2, all control totals were obtained using undercount adjusted CPS weights. These CPS weights have themselves undergone poststratification to the Census Bureau's best estimates of the total civilian noninstitutionalized population of the United States, including homeless and others not counted in surveys or in the most recent decennial census. The NHANES III poststratification therefore brings the weighted totals up to the level of the presumed total civilian noninstitutionalized population in the United States. Furthermore, the detailed cells used in poststratification correct for distortions in the age-sex-race/ethnicity composition of the sample arising from undercoverage, as well as distortions in geography, etc. Tables 2 and 3 provide the 1990 and 1993 undercount adjusted CPS population totals used in poststratification for Phase 1 and Phase 2 of the survey.

The final weight for each sample person is the product of the basic weight and the nonresponse adjustment, trimming, and poststratification adjustment factors. Some SPs were considered ineligible for the exam or for certain components of the exam due to nonresponse at the interview stage, or due to the fact that they were not selected into the subsample under consideration. For nonrespondents, the final weight is zero, while for ineligibles, the final weight is missing. Three full-sample weights are provided for each phase: Interview, Mobile Examination Center (MEC) exam, and MEC+Home exam weights. For Phase 1 and Phase 2, each of these weights was computed using the procedures described above. In addition to the full-sample weights, weights were computed for four subsamples of the NHANES III sample: Persons examined at the MEC, or MEC+Home, with morning (Standard) blood draws; persons examined at the MEC, or MEC+Home, with afternoon/evening (Modified) blood draws; persons administered allergy tests at the MEC; and persons administered neurobehavioral tests or Central Nervous System (CNS) tests. Persons in the Standard sample were instructed to fast overnight for 12 hours, while persons in the Modified sample were instructed to fast for 6 hours. (The actual fasting hours, however, could be different from the instructions given to the respondents.) For more detail on the fasting instructions, refer to the Plan and Operation of the Third National Health and Nutrition Examination Survey, Vital and Health Statistics (1992). The Allergy subsample

consists of all sampled persons aged 6 to 19, and a half-sample of persons aged 20 to 59. The CNS subsample consists of the other half-sample of persons aged 20 to 59. Sampling weights were also created for the combined Phase 1 and Phase 2 samples by multiplying the weights for each phase by a factor of one-half and then combining the two phase samples. The following sections provide brief descriptions of the various sampling weights computed for NHANES III.

Table 2. March 1990 undercount adjusted CPS totals*

| | White/Other | | Black, Non-Hispanics | | Mexican-Americans | |
|---|---|---|---|---|---|---|
| Age | Male | Female | Male | Female | Male | Female |
| 2-11 months** | 1,287,784 | 1,220,410 | 892,888 | 866,286 | 530,908 | 489,043 |
| 1 to 2 years | 2,980,860 | 2,822,836 | | | | |
| 3 to 5 years | 4,374,435 | 4,140,866 | 911,942 | 907,764 | 524,592 | 533,892 |
| 6 to 11 years | 8,629,062 | 8,152,429 | 1,737,184 | 1,706,130 | 962,604 | 948,191 |
| 12 to 19 years | 11,042,440 | 10,581,409 | 2,170,730 | 2,206,642 | 1,194,780 | 1,122,249 |
| 20 to 29 years | 15,688,213 | 16,154,034 | 4,548,182 | 5,611,803 | 3,010,919 | 2,499,606 |
| 30 to 39 years | 16,935,511 | 17,257,300 | | | | |
| 40 to 49 years | 13,113,718 | 13,505,554 | 2,439,958 | 2,995,107 | 1,055,783 | 1,061,955 |
| 50 to 59 years | 9,011,922 | 9,529,197 | | | | |
| 60 to 69 years | 8,299,588 | 9,707,882 | 1,325,033 | 1,956,130 | 387,851 | 462,704 |
| 70 to 79 years | 5,051,094 | 7,115,632 | | | | |
| 80+ years | 1,803,494 | 3,422,850 | | | | |
| Total | 98,218,122 | 103,610,396 | 14,025,917 | 16,249,863 | 7,667,437 | 7,117,640 |

Overall total 246,889,375

*These totals were used as population controls for poststratification to the 52 age-sex-race/ethnicity domains for Phase 1

**The population totals for 2-11 month old white/other babies were estimated by taking 5/6 of the total CPS estimate for less than 1 year old white/others. The population totals for 2-35 month old black and Mexican-American babies were estimated by taking 17/18 of the CPS estimate for less than 3 year old black or Mexican-American babies.

SOURCE: Current Population Survey

Table 3. March 1993 undercount adjusted CPS totals*

| | White/Other | | Black, Non-Hispanics | | Mexican-Americans | |
|---|---|---|---|---|---|---|
| Age | Male | Female | Male | Female | Male | Female |
| 2-11 months** | 1,220,009 | 1,195,902 | 987,819 | 923,857 | 665,129 | 597,756 |
| 1 to 2 years | 3,084,848 | 2,938,969 | | | | |
| 3 to 5 years | 4,524,065 | 4,268,933 | 959,781 | 969,256 | 601,980 | 592,474 |
| 6 to 11 years | 8,932,943 | 8,338,142 | 1,803,866 | 1,759,779 | 1,033,780 | 1,050,243 |
| 12 to 19 years | 11,048,058 | 10,564,791 | 2,211,922 | 2,230,171 | 1,165,540 | 1,224,296 |
| 20 to 29 years | 14,928,357 | 15,138,441 | 4,708,931 | 5,745,358 | 3,198,334 | 2,766,656 |
| 30 to 39 years | 17,657,521 | 17,937,053 | | | | |
| 40 to 49 years | 14,498,177 | 14,877,962 | 2,717,786 | 3,329,443 | 1,296,774 | 1,274,973 |
| 50 to 59 years | 9,605,640 | 10,058,779 | | | | |
| 60 to 69 years | 8,107,318 | 9,350,120 | 1,368,276 | 2,038,108 | 439,283 | 539,568 |
| 70 to 79 years | 5,474,728 | 7,453,251 | | | | |
| 80+ years | 2,054,518 | 3,844,970 | | | | |
| Total | 101,136,181 | 105,967,312 | 14,758,383 | 16,995,971 | 8,400,820 | 8,045,966 |
| Overall total | 255,304,631 | | | | | |

* These totals were used as population controls for poststratification of the 52 age-sex-race/ethnicity domains for Phase 2

**The population totals for 2-11 month old white/other babies were estimated by taking 5/6 of the total CPS estimate for less than 1 year old white/others. The population totals for 2-35 month old black and Mexican-American babies were estimated by taking 17/18 of the CPS estimate for less than 3 year old black or Mexican-American babies.

SOURCE: Current Population Survey

# 3. WEIGHTING FOR FUL L SAMPLE AND SUBSAMPLES FOR PHASE 1 AND PHASE 2

## 3.1 Weighting for Full Sample

### Interview Weights

All sampled persons were contacted for an interview at home. Those who did not participate in the interview were considered nonrespondents in the calculation of interview weights; all who did respond to the interview were assigned interview weights. There was a total of 17,464 interview respondents out of the eligible 20,277 SPs for Phase 1, and 16,530 interview respondents out of the eligible 19,418 SPs for Phase 2. Interview weights were computed by applying interview nonresponse adjustment to the basic poststratified weights. Weight trimming was used on a small number of cases (less than 1 percent of interviewed cases) with extreme weights. Poststratification was then applied to the nonresponse adjusted trimmed weights.

### MEC Examination Weights

All interviewed persons were invited to the MEC for physical examinations. Those who reported to the MEC were considered as respondents in calculating the MEC exam weight. All home examinees and interviewed persons who were not examined were treated as nonrespondents. All SPs who were not interviewed were regarded as ineligibles for the purpose of computing MEC exam weights. Out of the 20,277 interviewed cases in Phase 1, there were 15,630 respondents to the MEC exam, 1,834 nonrespondents, and 2,813 ineligible (interview nonrespondents). For Phase 2, the 19,418 SPs comprise 15,188 MEC respondents, 1,342 nonrespondents, and 2,888 ineligibles (interview nonrespondents). The final interview weight was adjusted for examination nonresponse. Again, the weights for a small number of cases (less than 1 percent of MEC examined cases) were trimmed to reduce their effect on the variance estimates. Poststratification was then carried out on the nonresponse adjusted trimmed exam weights to arrive at the final MEC examination weights.

### MEC+Home Examination Weights

An additional 493 persons who were unable to come to the MEC were examined at their home. For the calculation of the MEC+Home exam weight, sampled persons examined either at the MEC or at their home were considered respondents. All interviewed persons who were not examined were considered nonrespondents. Of the 20,277 sampled persons in Phase 1, there were 15,884 respondents to the MEC or home examination. Out of 19,418 sampled persons in Phase 2, there were 15,427 respondents to the MEC or home examination. The final MEC+Home exam weights were calculated by adjusting the final interview weights for exam (MEC+Home) nonresponse, trimming the MEC+Home exam nonresponse adjusted weights (less than 1 percent of MEC+Home examined cases had their weights trimmed), and applying the two-stage poststratification procedure.

## 3.2 Weighting for Subsamples

### Standard and Modified Weights

Person 12 years or older in a random half of the households selected in the sample were instructed to fast overnight (12 hours) and report to the morning examination session. The sample is referred to as the "Standard" subsample. The other half of the sample (persons 12 years or older) were instructed to fast for 6 hours and then report to either the afternoon or evening examination session. This sample is referred to as the "Modified" subsample. Two Standard half-sample weights were computed for each phase: MEC exam and MEC+Home exam for persons who were examined at the MEC, and persons who were examined either at the MEC or at home. Similarly, both MEC exam and MEC+Home exam weights were calculated for the Modified half-sample. Since each of these subsamples is approximately a half-sample of the age-eligible sample, the basic MEC exam and the basic MEC+Home exam weights were computed by doubling the final full-sample MEC exam weight and the final full-sample MEC+Home weight, respectively, for each person in the given (i.e., Standard or Modified) half-sample.

A ratio adjustment for "nonresponse" due to reporting to the "wrong" session was applied, and then the two-stage poststratification was carried out to obtain the final MEC exam and MEC+Home weights for the given half-sample.

The Standard half-sample for Phase 1 consisted of 4,913 SPs aged 12 years and older, of which 4,785 SPs were examined at the MEC, and 128 SPs were examined at home. For Phase 2, there was a total of 5,134 SPs, with 5,016 SPs examined at the MEC, and 118 SPs examined at home.

The Modified half-sample for Phase 1 consisted of 5,048 SPs, of age 12 years and older of which 4,947 SPs were examined at the MEC, and 101 SPs were examined at home. For Phase 2, there was a total of 5,146 SPs, with 5,036 SPs examined at the MEC, and 110 SPs examined at home.

### Allergy and CNS Weights

All person aged 6-19 years and a random half of adults aged 20-50 years, were eligible for the allergy test. The other random half of persons aged 20-50 were assigned to the CNS component. The Allergy and CNS components of the exam were assigned only to those persons in the Allergy and CNS subsamples, respectively, who reported to the MEC for their exam. Thus, all interviewed persons who were not examined at the MEC were considered nonrespondents. This means that the nonresponse adjustment for the Allergy and CNS subsamples was completed during the examination nonresponse adjustment. However, the weights for the Allergy and CNS subsamples for ages 20 to 59 did go through, another round of an adjustment to reflect the random assignment to either CNS or allergy, trimming, and poststratification.

For Phase 1, the Allergy sample consisted of 7,616 SPs, of which 6,097 were respondents. For Phase 2, the 7,483 SPs in the Allergy sample comprised 6,009 respondents. The CNS sample for Phases 1 and 2 contains 3,645 and 3,811 SPs, respectively. For Phase 1, there were 2,751 respondents, while for Phase 2 the number of respondents was 2,911.

## 4. WEIGHTING FOR PHASES 1 AND 2 COMBINED

The full sample and subsample weights for Phases 1 and 2 combined were computed by taking one-half the weights for the phase to which the sampled person was assigned. The decision to forego any further poststratification of these weights was based on the duration of the survey. Because Phase 1 collection spanned the years 1988 to 1991, and Phase 2 collection occurred from 1991 to 1994, any control totals used to poststratify the

combined Phases 1 and 2 samples would not appropriately reflect the population over each of the reference periods. However, because weights for each phase were poststratified separately, they do reflect the population for their respective reference periods. In addition, estimates obtained for the full NHANES III sample will be consistent with estimates obtained separately for either Phase 1 or Phase 2. Tables 4 and 5 provide the number of respondents, by sampling domain, for each of the samples for which weights were computed. For the interviewed and MEC samples, Table 6 shows the 5th and 95th percentiles, and the mean of the distribution of the weights. The distribution of the weights for the MEC+Home sample is similar to that of the MEC sample, since home examined cases constitute a very small portion of the examinations conducted for elderly persons and babies. Similarly, the distributions of weights for the subsamples closely resemble those of the full-sample, since the subsamples are random subsets of the full-sample. For example, if the subsample includes a random one-half of the SPs in a given sampling domain, the subsample MEC weights for a domain would be about twice as large as the full-sample MEC weights.

Flow charts of the methodology used to weight the samples for Phase 1 and for Phase 2, are given in Exhibit 1. Table 7 summarizes the appropriate uses of the weights.

Table 4. Number of respondents by age-sex-race/ethnicity subdomain for Phases 1 and 2 combined

| Age-Sex-Race/Ethnicity subdomain | Number of respondents | | | |
|---|---|---|---|---|
| | Screened | Interviewed | MEC examined | MEC+Home examined |
| Total | 39,695 | 33,994 | 30,818 | 31,311 |
| White/Other | | | | |
| Male | | | | |
| 2-11 months | 748 | 704 | 639 | 659 |
| 1-2 years | 560 | 525 | 490 | 490 |
| 3-5 year | 582 | 539 | 503 | 503 |
| 6-11 years | 632 | 565 | 518 | 518 |
| 12-19 years | 536 | 471 | 433 | 433 |
| 20-29 years | 674 | 535 | 472 | 472 |
| 30-39 years | 740 | 564 | 506 | 506 |
| 40-49 years | 669 | 521 | 475 | 476 |
| 50-59 years | 694 | 519 | 456 | 461 |
| 60-69 years | 795 | 609 | 539 | 549 |
| 70-79 years | 796 | 613 | 503 | 535 |
| 80+ years | 843 | 688 | 486 | 576 |
| Female | | | | |
| 2-11 months | 731 | 707 | 658 | 668 |
| 1-2 years | 552 | 524 | 475 | 475 |
| 3-5 year | 632 | 578 | 519 | 519 |
| 6-11 years | 591 | 527 | 489 | 489 |
| 12-19 years | 706 | 615 | 552 | 552 |
| 20-29 years | 743 | 631 | 579 | 582 |
| 30-39 years | 892 | 731 | 678 | 681 |
| 40-49 years | 717 | 598 | 539 | 542 |
| 50-59 years | 763 | 604 | 536 | 541 |
| 60-69 years | 818 | 619 | 529 | 548 |
| 70-79 years | 1,061 | 806 | 634 | 685 |
| 80+ years | 1,049 | 823 | 511 | 639 |

Table 4. Number of respondents by age-sex-race/ethnicity subdomain for Phases 1 and 2 combined (continued)

| Age-Sex-Race/Ethnicity subdomain | Number of respondents | | | |
|---|---|---|---|---|
| | Screened | Interviewed | MEC examined | MEC+Home examined |
| Black, non-Hispanic | | | | |
| Male | | | | |
| 2-35 months | 585 | 555 | 532 | 535 |
| 3-5 years | 575 | 535 | 512 | 512 |
| 6-11 years | 655 | 605 | 577 | 577 |
| 12-19 years | 656 | 579 | 542 | 542 |
| 20-39 years | 1,287 | 1,057 | 986 | 987 |
| 40-59 years | 814 | 645 | 585 | 588 |
| 60+ years | 730 | 598 | 527 | 544 |
| Female | | | | |
| 2-35 months | 552 | 532 | 515 | 515 |
| 3-5 years | 600 | 565 | 542 | 542 |
| 6-11 years | 606 | 556 | 541 | 541 |
| 12-19 years | 692 | 629 | 601 | 601 |
| 20-39 years | 1,538 | 1,333 | 1,280 | 1,281 |
| 40-59 years | 940 | 776 | 723 | 728 |
| 60+ years | 831 | 662 | 546 | 581 |
| Mexican-American | | | | |
| Male | | | | |
| 2-35 months | 667 | 630 | 594 | 595 |
| 3-5 years | 642 | 601 | 564 | 564 |
| 6-11 years | 644 | 598 | 570 | 570 |
| 12-19 years | 655 | 572 | 535 | 535 |
| 20-39 years | 1,488 | 1,265 | 1,147 | 1,149 |
| 40-59 years | 756 | 593 | 558 | 558 |
| 60+ years | 743 | 609 | 532 | 552 |
| Female | | | | |
| 2-35 months | 650 | 619 | 585 | 587 |
| 3-5 years | 689 | 647 | 620 | 620 |
| 6-11 years | 657 | 616 | 591 | 591 |
| 12-19 years | 642 | 575 | 548 | 548 |
| 20-39 years | 1,432 | 1,261 | 1,188 | 1,191 |
| 40-59 years | 736 | 596 | 563 | 563 |
| 60+ years | 709 | 569 | 495 | 515 |

Table 5. Number of respondents by age-sex-race/ethnicity subdomain for Phases 1 and 2

| Age-Sex-Race/Ethnicity subdomain | Number of respondents | | | | | |
|---|---|---|---|---|---|---|
| | Allergy component | CNS component | Standard MEC examined | Standard MEC+Home examined | Modified MEC examined | Modified MEC+Home examined |
| Total | 12,106 | 5,662 | 9,127 | 9,254 | 9,497 | 9,630 |
| White/Other | | | | | | |
| Male | | | | | | |
| 6-11 years | 518 | | | | | |
| 12-19 years | 433 | | 169 | 169 | 212 | 212 |
| 20-29 years | 224 | 248 | 214 | 214 | 239 | 239 |
| 30-39 years | 249 | 257 | 233 | 233 | 250 | 250 |
| 40-49 years | 232 | 243 | 218 | 218 | 226 | 226 |
| 50-59 years | 230 | 226 | 219 | 219 | 216 | 218 |
| 60-69 years | | | 266 | 270 | 250 | 255 |
| 70-79 years | | | 254 | 263 | 235 | 245 |
| 80+ years | | | 218 | 247 | 240 | 267 |
| Female | | | | | | |
| 6-11 years | 489 | | | | | |
| 12-19 years | 552 | | 216 | 216 | 240 | 240 |
| 20-29 years | 261 | 318 | 283 | 283 | 280 | 281 |
| 30-39 years | 350 | 328 | 315 | 315 | 343 | 343 |
| 40-49 years | 274 | 265 | 245 | 246 | 269 | 271 |
| 50-59 years | 258 | 278 | 269 | 270 | 248 | 250 |
| 60-69 years | | | 265 | 267 | 238 | 245 |
| 70-79 years | | | 286 | 299 | 317 | 335 |
| 80+ years | | | 234 | 270 | 238 | 272 |
| Black, non-Hispanic | | | | | | |
| Male | | | | | | |
| 6-11 years | 577 | | | | | |
| 12-19 years | 542 | | 213 | 213 | 263 | 263 |
| 20-39 years | 496 | 490 | 474 | 474 | 478 | 479 |
| 40-59 years | 303 | 282 | 288 | 289 | 272 | 273 |
| 60+ years | | | 251 | 255 | 250 | 254 |
| Female | | | | | | |
| 6-11 years | 541 | | | | | |
| 12-19 years | 601 | | 240 | 240 | 276 | 276 |
| 20-39 years | 639 | 641 | 602 | 603 | 631 | 631 |
| 40-59 years | 345 | 378 | 334 | 335 | 359 | 361 |
| 60+ years | | | 258 | 267 | 258 | 266 |
| Mexican-American | | | | | | |
| Male | | | | | | |
| 6-11 years | 570 | | | | | |
| 12-19 years | 535 | | 206 | 206 | 266 | 266 |
| 20-39 years | 596 | 551 | 531 | 532 | 559 | 559 |
| 40-59 years | 261 | 297 | 262 | 262 | 276 | 276 |
| 60+ years | | | 257 | 263 | 255 | 260 |
| Female | | | | | | |
| 6-11 years | 591 | | | | | |
| 12-19 years | 548 | | 251 | 251 | 225 | 225 |
| 20-39 years | 621 | 567 | 573 | 574 | 562 | 563 |
| 40-59 years | 270 | 293 | 263 | 263 | 274 | 274 |
| 60+ years | | | 220 | 228 | 252 | 255 |

Table 6. Fifth and 95th percentiles, and the mean values of the weights by sampling domain

| Age-sex-race/ethnicity domain* | Interview weights | | | MEC exam weights | | |
|---|---|---|---|---|---|---|
| | 5% | Mean | 95% | 5% | Mean | 95% |
| White | | | | | | |
| Male | | | | | | |
| 2-11 months | 1,028 | 1,775 | 3,187 | 1,104 | 1,951 | 3,603 |
| 1 to 2 years | 3,435 | 5,835 | 10,318 | 3,647 | 6,231 | 11,049 |
| 3 to 5 years | 3,481 | 8,452 | 19,259 | 3,632 | 9,083 | 21,783 |
| 6 to 11 years | 6,850 | 16,081 | 36,139 | 7,438 | 17,477 | 40,788 |
| 12 to 19 years | 12,809 | 24,582 | 44,631 | 14,055 | 26,657 | 48,042 |
| 20 to 29 years | 16,417 | 29,532 | 48,769 | 18,886 | 33,480 | 56,947 |
| 30 to 39 years | 14,042 | 30,923 | 66,802 | 14,937 | 34,522 | 76,759 |
| 40 to 49 years | 14,372 | 27,347 | 56,634 | 15,194 | 30,043 | 56,124 |
| 50 to 59 years | 7,638 | 17,722 | 41,610 | 8,469 | 20,183 | 47,973 |
| 60 to 69 years | 5,622 | 13,419 | 23,994 | 6,170 | 15,155 | 30,140 |
| 70 to 79 years | 4,441 | 8,496 | 18,677 | 5,599 | 10,348 | 22,565 |
| 80+ years | 1,486 | 2,776 | 5,200 | 2,214 | 3,922 | 6,965 |
| Female | | | | | | |
| 2-11 months | 983 | 1,678 | 3,082 | 1,013 | 1,798 | 3,273 |
| 1 to 2 years | 2,894 | 5,417 | 10,492 | 3,175 | 5,981 | 11,636 |
| 3 to 5 years | 2,819 | 7,212 | 16,339 | 2,942 | 7,994 | 19,256 |
| 6 to 11 years | 7,014 | 15,838 | 35,150 | 7,288 | 17,057 | 37,685 |
| 12 to 19 years | 7,141 | 17,569 | 35,424 | 8,745 | 19,567 | 41,651 |
| 20 to 29 years | 7,700 | 25,491 | 50,726 | 8,429 | 27,848 | 52,573 |
| 30 to 39 years | 7,484 | 24,258 | 47,953 | 8,251 | 26,128 | 55,136 |
| 40 to 49 years | 9,583 | 24,082 | 50,456 | 10,666 | 26,923 | 56,937 |
| 50 to 59 years | 8,287 | 16,573 | 26,700 | 8,860 | 18,712 | 32,029 |
| 60 to 69 years | 9,021 | 15,593 | 25,388 | 10,635 | 18,254 | 30,467 |
| 70 to 79 years | 3,283 | 9,132 | 20,604 | 3,974 | 11,611 | 26,557 |
| 80+ years | 2,429 | 4,413 | 7,545 | 3,728 | 7,087 | 13,336 |
| Black, non-Hispanic | | | | | | |
| Male | | | | | | |
| 2-35 months | 962 | 1,694 | 2,797 | 956 | 1,768 | 3,095 |
| 3 to 5 years | 1,016 | 1,749 | 2,999 | 1,055 | 1,828 | 2,890 |
| 6 to 11 years | 1,622 | 2,926 | 4,913 | 1,602 | 3,069 | 5,540 |
| 12 to 19 years | 1,487 | 3,785 | 7,122 | 1,547 | 4,043 | 7,705 |
| 20 to 39 years | 2,507 | 4,379 | 7,472 | 2,569 | 4,694 | 8,320 |
| 40 to 59 years | 2,016 | 3,998 | 6,308 | 2,108 | 4,408 | 7,142 |
| 60+ years | 1,424 | 2,252 | 3,596 | 1,511 | 2,555 | 4,001 |
| Female | | | | | | |
| 2-35 months | 903 | 1,682 | 2,919 | 915 | 1,738 | 3,013 |
| 3 to 5 years | 982 | 1,661 | 3,023 | 962 | 1,732 | 3,012 |
| 6 to 11 years | 1,763 | 3,117 | 5,059 | 1,825 | 3,203 | 5,322 |
| 12 to 19 years | 1,069 | 3,527 | 7,046 | 1,086 | 3,691 | 7,577 |
| 20 to 39 years | 1,951 | 4,260 | 8,490 | 1,740 | 4,436 | 9,398 |
| 40 to 59 years | 1,782 | 4,075 | 8,273 | 1,899 | 4,374 | 8,857 |
| 60+ years | 1,622 | 3,017 | 5,737 | 1,928 | 3,658 | 7,440 |

Table 6. Fifth and 95th percentiles, and the mean values of the weights by sampling domain (continued)

| Age-sex-race/ethnicity domain* | Interview weights | | | MEC exam weights | | |
|---|---|---|---|---|---|---|
| | 5% | Mean | 95% | 5% | Mean | 95% |
| Mexican-American | | | | | | |
| Male | | | | | | |
| 2-35 months | 345 | 949 | 2,188 | 360 | 1,007 | 2,304 |
| 3 to 5 years | 363 | 937 | 2,228 | 384 | 999 | 2,290 |
| 6 to 11 years | 269 | 1,669 | 3,676 | 280 | 1,751 | 3,944 |
| 12 to 19 years | 1,023 | 2,063 | 4,075 | 1,053 | 2,206 | 4,334 |
| 20 to 39 years | 1,287 | 2,454 | 4,850 | 1,404 | 2,707 | 5,269 |
| 40 to 59 years | 810 | 1,984 | 3,909 | 820 | 2,108 | 4,170 |
| 60+ years | 230 | 679 | 1,882 | 242 | 777 | 2,106 |
| Female | | | | | | |
| 2-35 months | 314 | 878 | 2,192 | 343 | 929 | 2,276 |
| 3 to 5 years | 285 | 870 | 2,204 | 300 | 908 | 2,308 |
| 6 to 11 years | 243 | 1,622 | 4,994 | 248 | 1,691 | 5,245 |
| 12 to 19 years | 921 | 2,040 | 4,168 | 959 | 2,141 | 4,267 |
| 20 to 39 years | 1,065 | 2,088 | 4,049 | 1,103 | 2,216 | 4,384 |
| 40 to 59 years | 891 | 1,961 | 4,080 | 955 | 2,075 | 4,292 |
| 60+ years | 403 | 881 | 1,972 | 442 | 1,012 | 2,373 |
| Other | | | | | | |
| Male | | | | | | |
| 2-11 months | 1,099 | 1,822 | 3,072 | 1,181 | 2,042 | 3,439 |
| 1 to 2 years | 1,979 | 5,467 | 8,953 | 1,953 | 5,971 | 9,712 |
| 3 to 5 years | 1,700 | 7,199 | 15,901 | 1,795 | 7,643 | 16,229 |
| 6 to 11 years | 2,446 | 12,407 | 36,139 | 2,781 | 14,034 | 42,915 |
| 12 to 19 years | 2,655 | 17,478 | 46,071 | 2,983 | 19,555 | 51,296 |
| 20 to 29 years | 3,834 | 23,611 | 43,848 | 4,065 | 26,888 | 50,046 |
| 30 to 39 years | 5,163 | 28,633 | 66,840 | 5,313 | 31,513 | 73,023 |
| 40 to 49 years | 4,168 | 17,949 | 40,236 | 4,339 | 20,156 | 45,842 |
| 50 to 59 years | 4,363 | 20,085 | 49,443 | 5,143 | 22,693 | 58,288 |
| 60 to 69 years | 6,114 | 14,266 | 33,623 | 6,510 | 16,183 | 34,555 |
| 70 to 79 years | 2,138 | 11,736 | 26,172 | 2,883 | 14,469 | 32,791 |
| 80+ years | 1,453 | 3,699 | 7,940 | 2,227 | 5,353 | 15,722 |
| Female | | | | | | |
| 2-11 months | 1,116 | 1,885 | 3,548 | 1,184 | 2,047 | 3,811 |
| 1 to 2 years | 2,023 | 6,218 | 16,005 | 2,369 | 6,777 | 17,031 |
| 3 to 5 years | 1,596 | 7,649 | 15,877 | 1,766 | 8,696 | 19,547 |
| 6 to 11 years | 2,775 | 14,255 | 43,375 | 2,773 | 15,516 | 47,138 |
| 12 to 19 years | 1,585 | 15,154 | 44,062 | 1,859 | 17,064 | 52,279 |
| 20 to 29 years | 2,575 | 20,334 | 47,400 | 2,729 | 21,798 | 52,190 |
| 30 to 39 years | 2,674 | 22,604 | 53,511 | 2,644 | 24,656 | 57,541 |
| 40 to 49 years | 2,955 | 21,138 | 50,456 | 3,321 | 22,153 | 56,159 |
| 50 to 59 years | 3,043 | 12,712 | 26,197 | 3,162 | 14,505 | 30,559 |
| 60 to 69 years | 3,791 | 13,087 | 26,673 | 4,625 | 15,650 | 29,733 |
| 70 to 79 years | 3,423 | 7,083 | 13,143 | 3,919 | 9,210 | 17,896 |
| 80+ years | 2,627 | 4,509 | 8,114 | 4,498 | 7,961 | 14,136 |

*The race/ethnicity domain, white/other, is divided into white and other (the remainder of white/other) groups in this table to show the distribution of the weights separately for each group.

Exhibit 1. NHANES III Weighting Flow Chart
Phase 1, Phase 2 (separately)

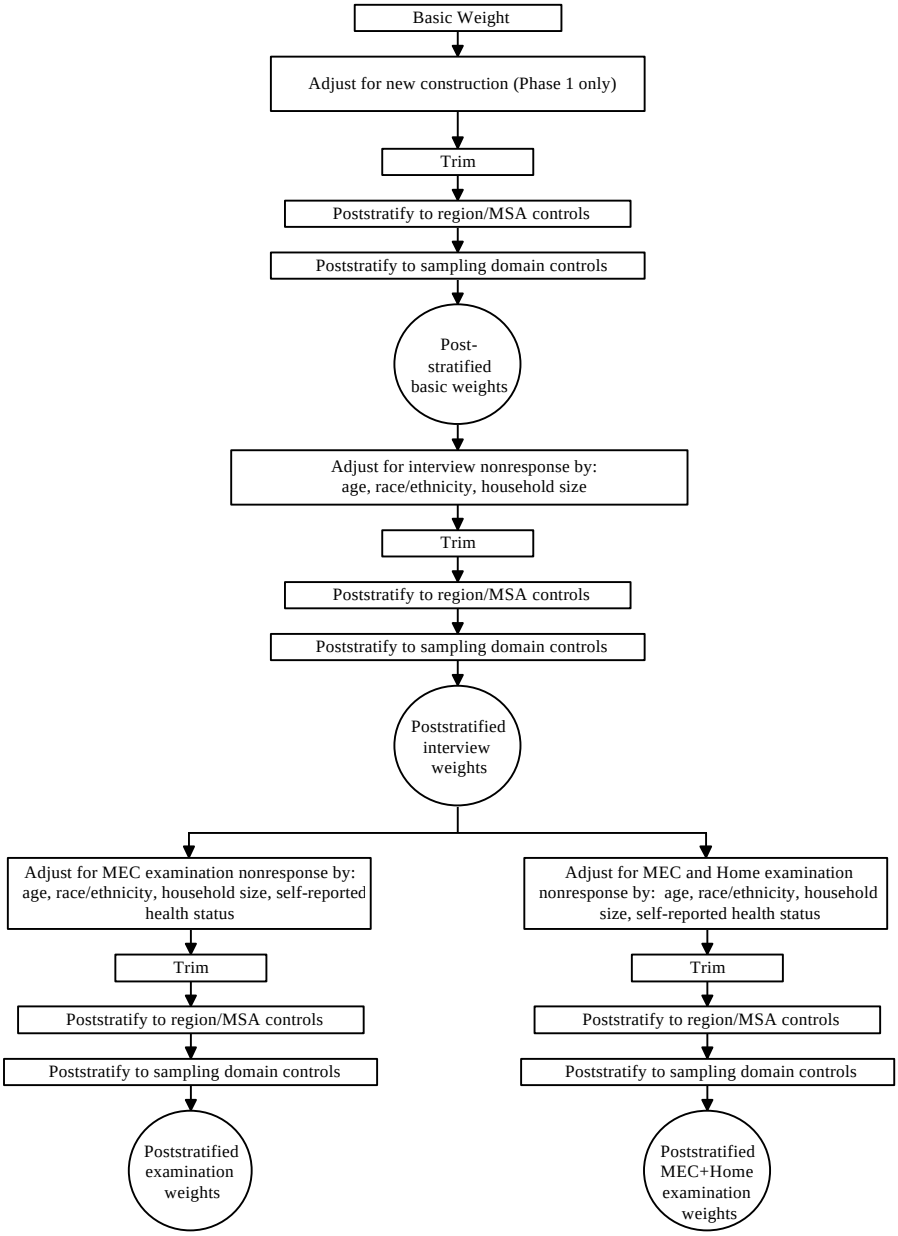


Exhibit 1. NHANES III Weighting Flow Chart (continued)
Phase 1, Phase 2 (separately)

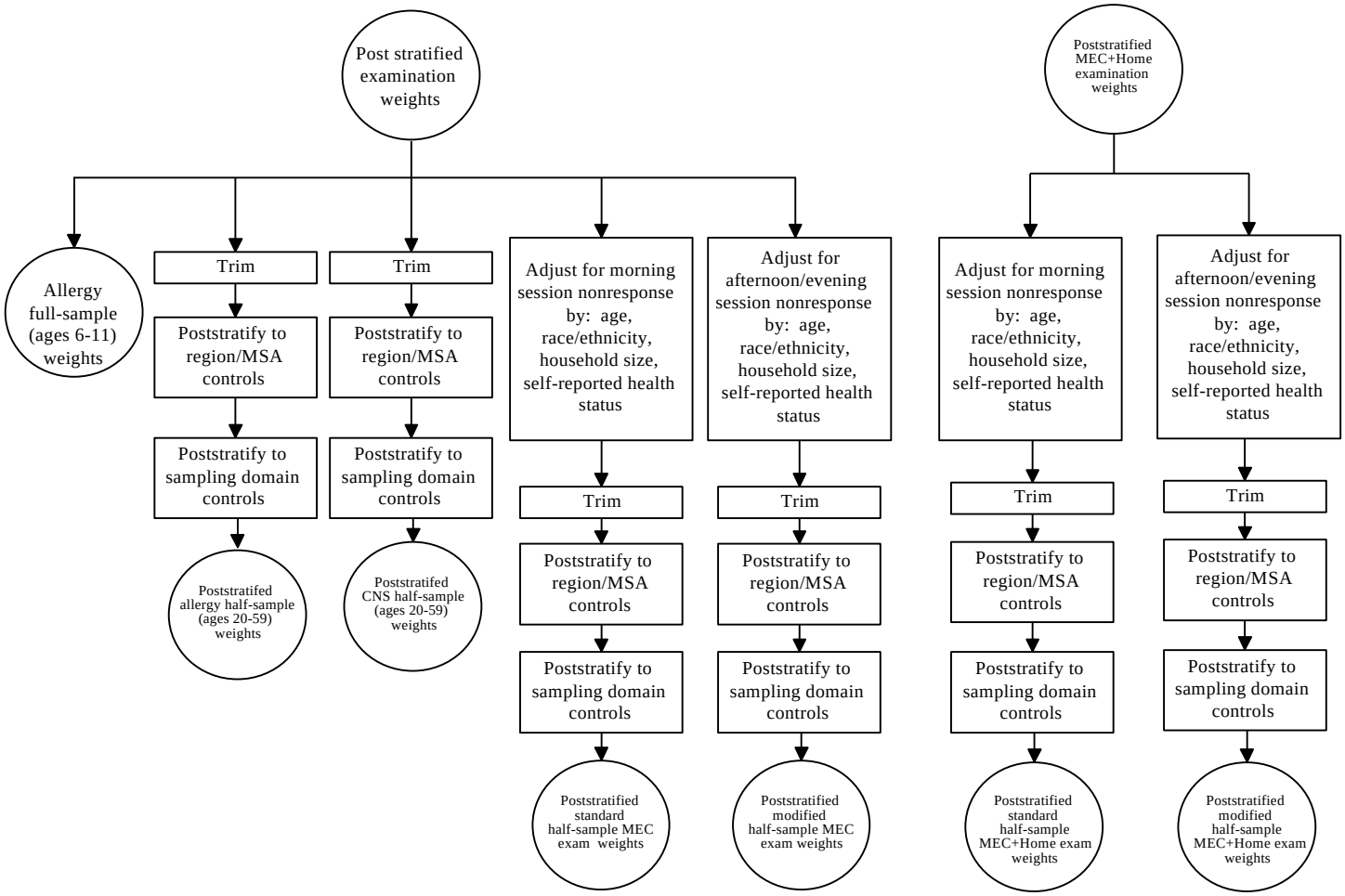


Table 7. Appropriate uses of the weights

| Weight | Application |
|---|---|
| Final interview weight | Use only in conjunction with the sample interviewed at home, and only with items collected during the household interview. |
| Final exam (MEC only) weight | Use only in conjunction with the MEC examined sample, and only with interview and examination items collected at the MEC. |
| Final MEC+Home exam weight | Use only in conjunction with the MEC+Home examined sample, and only with items collected at both the MEC and home. |
| Final Allergy weight | Use only in conjunction with the Allergy subsample, and only with items collected as part of the allergy component of the exam. |
| Final CNS weight | Use only in conjunction with the CNS subsample, and only with items collected as part of the CNS component of the exam. |
| Final Standard exam (MEC only) weight | Use only in conjunction with the MEC examined persons assigned to the Standard subsample, and only with items collected at the MEC exam. These weights should be used to analyze tests such as the Oral Glucose Tolerance Tests (OGTT), where overnight fasting is preferred. |
| Final Modified exam (MEC only) weight | Use only in conjunction with the MEC examined persons assigned to the Modified subsample, and only with items collected at the MEC exam. |
| Final Standard MEC+Home exam weight | Use only in conjunction with the MEC and home examined persons assigned to the Standard subsample, and only with items collected during the MEC and home examinations. |
| Final Modified MEC+Home exam weight | Use only in conjunction with the MEC and home examined persons assigned to the Modified subsample, and only with items collected during the MEC and home examinations. |

## 5. VARIANCE ESTIMATION

When data are collected as part of a complex sample survey, care is needed to produce approximately unbiased and design-consistent estimates of variance analytically. In a complex sample survey setting, variance estimates computed using standard statistical software packages that assume simple random sampling are biased. Two common approaches are available for estimation of variances for complex survey data: linearization and replication.

For the linearization approach, nonlinear estimates are approximated by linear ones for the purpose of variance estimation. The linear approximation is derived by taking the first order Taylor series approximation for the estimator. Standard variance estimation methods for linear statistics are then used to estimate the variance of the linearized estimator.

For a two-PSUs-per-stratum sample design such as NHANES III, with some simplifying assumptions including with replacement sampling at the first stage (See Wolter, 1985), the linearization variance estimate is obtained by summing the squared differences between the linearized estimates for the two PSUs in each stratum. That is,

$$v(z) = \sum_{h=1}^{H} (z_{h1} - z_{h2})^2,$$

where $z_{h1}$ and $z_{h2}$ are the linearized estimates for PSU 1 and PSU 2, respectively, of stratum $h$.

Replication methods provide a general means for estimating variances for the types of complex sample designs and weighting procedures usually encountered in practice. The basic idea behind the replication approach is to select subsamples repeatedly from the whole sample, to calculate the statistic of interest for each of these subsamples, and then to use the variability among these subsamples or replicate statistics to estimate the variance of the full-sample statistics. See Wolter (1985) for further descriptions of both the replication and linearization approaches.

One of the main advantages of the replication approach is its ease of use at the analysis stage. The same estimation procedure is used for the total sample and for each replicate. The variance estimates are then readily computed by a simple procedure.

Furthermore, the same procedure is applicable to most statistics desired such as means, percentages, ratios, correlations, etc. (Efron, 1982). These estimates can also be calculated for analytic groups or subpopulations. Another important advantage of the replication approach is that it provides a simple way to account for adjustments that are made in weighting, such as adjustments for nonresponse and poststratification. By separately computing the weighting adjustments for each replicate, it is possible to reflect the effects of poststratification and nonresponse adjustment in the estimates of variance.

There are different ways of creating replicates from the full sample. Jackknife and balanced repeated replication (BRR) methods are two common procedures for the derivation of replicates. The jackknife procedure retains most of the sample in each replicate, whereas the BRR approach retains about one-half of the sample in each replicate. The choice of a replication method for NHANES III depended on the objectives of the survey. In NHANES, special attention is given to (1) estimates of health characteristics for subdomains of the population, and (2) estimates of quartiles for various statistics. For small subdomain estimation, the jackknife procedure is more stable since every replicate includes most of the entire sample, and the chance of having replicates with no observation for the characteristic of interest is small. However, the BRR method has proven to be more reliable for the estimation of quartiles. Kovar, Rao, and Wu (1988) found in an empirical study that the jackknife replication method performed poorly for estimating the variance estimates of population quartiles, but BRR seemed to work relatively well for these quartiles. Rao, Wu, and Yue (1992) report on both jackknife and BRR procedures for estimating the median for cluster samples.

For the combined Phases 1 and 2 sample, replicate weights were calculated using Fay's Method, a variant of the balanced repeated replication (BRR) method. For more details on Fay's Method, refer to Judkins (1990). BRR is generally used with stratified multistage sample designs when two PSUs per stratum have been selected. For standard BRR, each replicate half-sample estimate is formed by selecting one of the two PSUs from each stratum and then using only the selected PSUs to estimate the parameter of interest. The weights for the units selected are multiplied by a factor of two to form the replicate weights.

Fay's Method produces replicate weights by multiplying the full-sample weights by factors of $K$ and $2\text{-}K$ ($0 < K < 1$). For creating replicate weights for NHANES III, $K$=0.3 was used. In studies where quartile estimates and small domain estimates are both of interest, Fay's Method has sometimes been used as a compromise between the jackknife and standard

BRR. Judkins (1990) demonstrates that for estimation of quartiles and other statistics, Fay's Method with $K$=0.3 does well in terms of both bias and stability.

The full-sample estimate, $\hat{q}$ , is calculated using the full-sample weights. The replicate weights are then used to calculate replicate estimates, $\hat{q}_{(j)}$, using the same methodology as was used to calculate the full-sample estimate. The variance estimator, v($\hat{q}$ ), then takes the form

$$v(\hat{q}) = \frac{1}{G(1-K)^2} \sum_{j=1}^{G} (\hat{q}_{(j)} - \hat{q})^2$$

where $G$ is the total number of replicates formed. The degrees of freedom associated with this variance estimator is approximately $L$, the number of PSUs minus the number of strata.

The total number of replicate samples that can be formed is $2^L$. However, it is not necessary to form all replicates. All of the information available in the $2^L$ replicates can be captured using $G$ orthogonal or "balanced" replications. The Plackett-Burman algorithm, described in McCarthy (1966), is used to create the orthogonal Hadamard matrix. The minimum number of replicates needed to have the full information, $G$, is the smallest integer divisible by 4 which is greater than or equal to $L$. For NHANES III, $L$=49, so $G$=52 replicates were used.

Replicate weights are provided for both the interviewed and MEC examined samples for Phases 1 and 2 combined. Exhibit 2 contains a flow chart of the methodology used to create the replicate weights. The PC software, WesVarPC, can be used to analyze NHANES III data using the replicate weights. WesVarPC may be accessed via the Internet at Westat's home page (URL: www.westat.com). Any other replication software (such as V-PLX developed by Bob Fay) that accounts for Fay's Method in the computation of variances can also be used.

Replicate weights were not created for the MEC+Home examined sample or for the subsamples. WesVarPC may be used to create simple replicate weights for these samples. Unlike the interview and MEC replicate weights that are provided, replicate weights created using WesVarPC will not reflect all the stages of adjustment that were applied to the weights. However, WesVarPC does have the capacity to reflect the final stage of poststratification; to obtain the poststrata totals that should be input, for each age-sex-race/ethnicity domain,

average the Phase 1 poststrata totals given in Table 2 with the Phase 2 poststrata totals given in Table 3. For specific instructions on using WesVarPC to create replicate weights, refer to ***A User's Guide to WesVarPC***. This manual may be obtained via the Internet at Westat's home page (URL: www.westat.com).

In addition to the replicate weights, pseudo-stratum and pseudo-PSU identifiers along with probabilities are provided, and may be used to calculate variance estimates using standard linearization software such as SUDAAN (developed by Research Triangle Institute), PC-CARP (developed by the Iowa State University), or OSIRIS (developed by the University of Michigan).

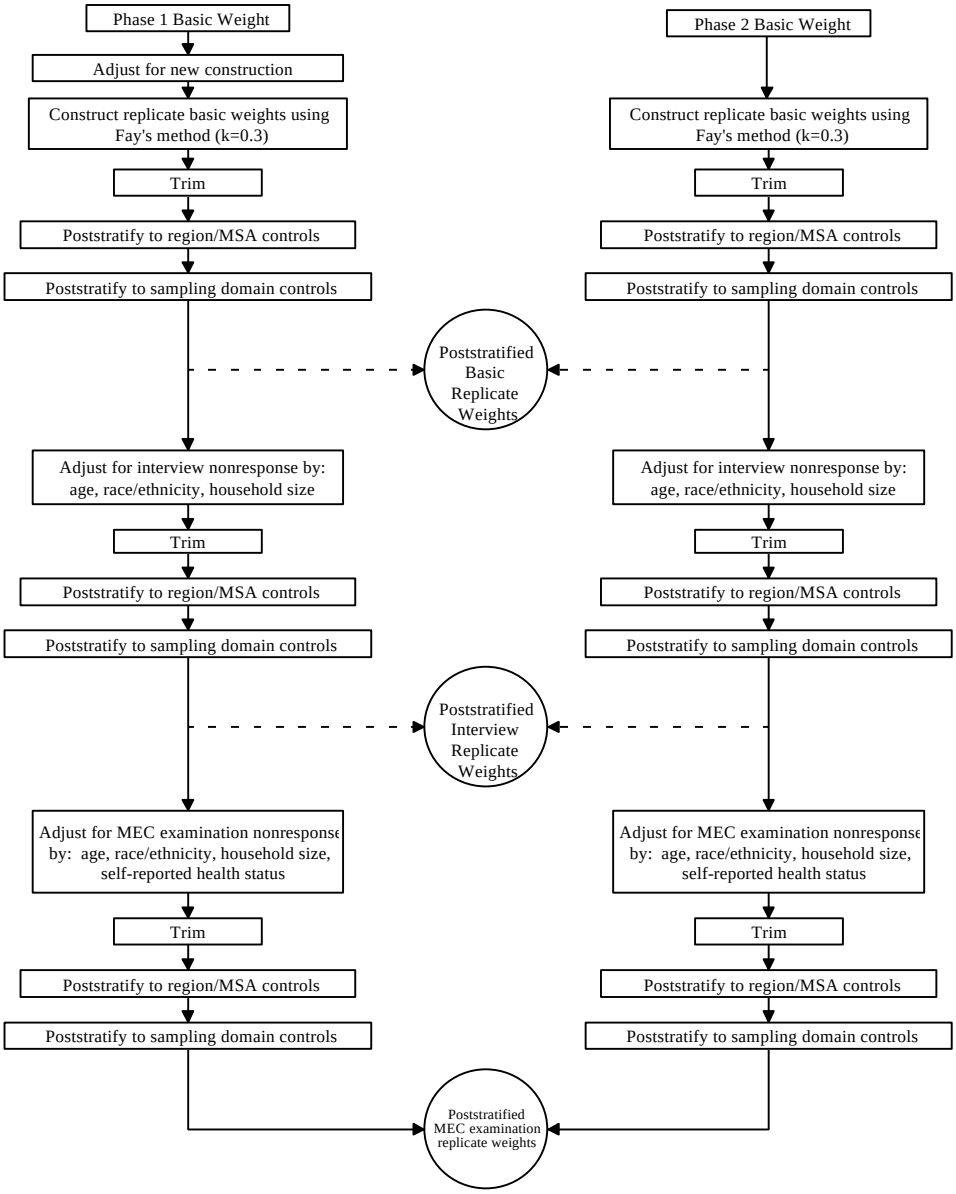
Occasionally, analysts may wish to compute estimates based on only Phase 1 or only Phase 2 data. This could occur if certain data items were collected in one phase of the survey, but not collected in the other phase. In addition, analysts may wish to compare an estimate based only on Phase 1 data with the corresponding estimate based on only Phase 2 data. These applications create special problems for variance estimation.

NHANES III was designed with 2 PSUs selected per stratum. Each of the two selected PSUs in a stratum was randomly assigned to either Phase 1 or Phase 2 of the data collection. Thus, each phase has only one PSU per stratum in the sample. In order to compute variance estimates for only one phase, strata must be collapsed, or paired, so that an implied two-PSUs-per-stratum design exists in each phase. Because this is not how the sample was actually designed, an additional between-PSU component of variation is artificially introduced, and variance estimates based on the collapsed strata are slight over-estimates of the "true" sampling variances. Furthermore, the degrees of freedom for estimating the variances in only one phase is reduced by one-half. This make the variance estimates less stable; that is, the variance of the variance estimates is increased.

If data are available from all 6 years of data collection, but separate phase estimates are desired, it is advisable to calculate the variance (or relative variance) estimates based on the true survey design and the 6 years of data as discussed above. The variance (or rel-variance) for an estimate based on one phase of data is then taken to be twice the variance (or rel-variance) of the 6-year estimate. For example, if $X_t$ is an estimate based on the 6 years of data, with variance estimate $V_t$, and if $X_1$ is the corresponding estimate based on only Phase 1 data, then the variance of $X_1$ is $2*V_t$.

If data are available in only one phase of the survey, then a paired (collapsed) strata estimate of variance must be used. This will provide a slight over-estimate of the sampling variance. For the NHANES III survey, paired strata for both Phase 1 and Phase 2 are available. The SUDAAN software can use the pairings directly to produce linearized variance estimates. WesVarPC can be used to create simple replicate weights based on the paired strata, to produce BRR variance estimates. Again, no matter what procedure is used for individual phase variance estimates, there will be problems related to the stability of the variance estimates. It is suggested that some generalized variance function technique, such as relative variance curves or average design effect models, be employed to smooth the unstable variance estimates.

Exhibit 2. NHANES III Weighting Flow Chart
Phase 1+2 Replicate Weights



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