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Plan and Operation of the NHANES II Mortality Study, 1992

June 1999

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Center for Health Statistics

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Preface

This first wave of the NHANES II Mortality Study was jointly funded by the National Center for Health Statistics and the Food and Drug Administration. The authors would like to acknowledge the assistance of Dorothy Blodgett, Sandy (Chia-Ying) Chien, Mary Dudley, and Shirley Gray, Division of Health Examination Statistics, in carrying out this study. Dr. Jennifer Madans, Sandra Rothwell, and Christine Cox deserve thanks for providing advice throughout the study. The contribution of Westat, Inc., the contractor who assisted with data collection, is also gratefully acknowledged.

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Abstract

Objectives

The NHANES II Mortality Study is a prospective study of adult participants examined in the second National Health and Nutrition Examination Survey (NHANES II) conducted between 1976 and 1980. It was designed to investigate the association between factors measured at baseline and mortality. The methods used in the study are described and assessed in this report.

Methods

The vital status of NHANES II participants who were 30–75 years of age at their examination was ascertained after 12–16 years. Vital status was assessed by searching the National Death Index and the Social Security Administration Death Master File for deaths occurring in the United States. Causes of death were obtained from the National Center for Health Statistics Multiple Cause of Death file or death certificates. To assess how well mortality was ascertained, the survival of the cohort after 5 and 10 years was compared to that of the U.S. population during the same period.

Results

As of December 31, 1992, 23.2 percent of the 9,250 cohort members were found to be deceased. The remaining 76.8 percent that were not found to be deceased may be assumed to be alive for analytic purposes. Cumulative survival probabilities for the cohort were generally higher than probabilities calculated from U.S. life table data. Although some differences were expected, these data suggest that after 10 years of follow-up using passive methods, mortality may have been under ascertained for the cohort. Discrepancies between the survival patterns for NHANES II cohort and U.S. vital statistics were larger for black than for white participants, indicating that ascertainment of mortality was poorer among black participants. Researchers using the NHANES II Mortality Study, 1992 data should be aware of these study limitations.

Keywords: *Epidemiologic methods • data collection • health surveys • cohort studies • longitudinal study • follow-up studies*

Plan and Operation of the NHANES II Mortality Study, 1992

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Background

The NHANES II Mortality Study is a prospective cohort study, which passively followed a subset of participants in the Second National Health and Nutrition Examination Survey (NHANES II). NHANES II, conducted between 1976–80, collected data from a national probability sample of the U.S. civilian, noninstitutionalized population 6 months–74 years of age (1). The survey included a standardized physical examination, laboratory tests, and questionnaires that covered various health-related topics. NHANES II provided a wealth of information on the prevalence of health conditions and risk factors. Nevertheless, the cross-sectional nature of the original survey limits its usefulness for studying the effects of clinical, environmental, and behavioral factors on the development of specific health conditions.

The NHANES II Mortality Study was designed to investigate the association between factors measured at baseline and overall mortality or death from specific causes. NHANES II obtained information gathered from physical examinations, laboratory tests, and interviews, whereas the NHANES II Mortality Study involved searching national data bases containing information about mortality and causes of death. Mortality data from the NHANES II Mortality Study can be linked with the earlier baseline NHANES II data to examine the relationships between various factors and specific causes of death.

Note that the design of the NHANES II Mortality Study differs substantially from that of the NHANES I Epidemiologic Followup Study (NHEFS), a longitudinal follow-up of an earlier NHANES cohort (2–5). NHEFS was an active follow-up study in which participants were recontacted and medical records and death certificates were obtained. In contrast, the NHANES II Mortality Study is entirely passive, that is, participants were not recontacted. Instead, mortality status was ascertained solely by computerized matching to national data bases and evaluation of the resulting matches. Furthermore, no recontact is planned in the future. Instead, matching to the National Death Index (NDI) and other national data bases will continue periodically. Future waves will be released for public use as they become available. One important consequence of the NHANES II Mortality Study design is that persons not found to be deceased are assumed alive for analytic purposes. As a result the potential for misclassification of vital status exists. Researchers using data from the NHANES II Mortality Study should be aware of this study limitation.

The Second National Health and Nutrition Examination Survey (1976–80)

An understanding of the NHANES II study design and procedures is needed to use the NHANES II Mortality Study, 1992 data effectively. A brief overview of the baseline study design and methods is provided as follows and reported in more detail elsewhere (1).

NHANES II was designed to collect extensive demographic, medical history, nutritional, clinical, and laboratory data on a probability sample of the civilian, noninstitutionalized population between the ages of 6 months and 74 years (1). The survey, conducted between 1976–80, had a complex sample design consisting of a multistage, stratified, probability-based cluster sample of households throughout the United States (1). The primary sampling units, which consisted of a county or group of contiguous counties, were stratified according to demographic characteristics and geographic region and grouped into 64 superstrata. One primary sampling unit was selected from each superstratum using a control selection procedure to produce a balanced sample with respect to variables such as region, State group, race-ethnicity, and poverty level (1). Within each primary sampling unit, census enumeration districts, stratified by poverty level, were selected with probability proportional to their size. Households within selected enumeration districts were clustered into segments. One segment was systematically selected within each enumeration district. Approximately one person was sampled from each household with oversampling of persons 6 months–5 years of age and 60–74 years of age.

A standardized set of questions and examination procedures was administered by centrally trained staff and blood was drawn for various laboratory tests (1). At the initial visit to the household, interviewers introduced the survey, administered questionnaires, and made appointments for the examination. Interviewers also obtained consent to retrieve additional information from records including those from physicians, hospitals, schools, and State registry offices (1). Interviews and examinations were conducted from Tuesdays through Saturdays in mobile examination centers (MEC's). Each MEC consisted of three trailers connected by enclosed passageways and was divided into separate rooms for examination components, including a laboratory for processing blood and other biological samples. The examination and interview lasted, on average, 2–3 hours. Quality control procedures included centralized training and periodic retraining of field staff, routine calibration of instruments, replicate measures for a subset of participants, and duplicate specimen processing for biochemical measures (1).

NHANES II Mortality Study, 1992 Study Design

The NHANES II Mortality Study cohort consists of adults who were 30–75 years of age at the time of their NHANES II examination. This cohort is a subset of the approximately 28,000 persons selected to participate in NHANES II. Some participants were interviewed but not examined and only those examined were followed for mortality status. The baseline included persons between the ages of 6 months and 74 years but only adults were included in the follow-up cohort. Age at examination was used to identify participants 30 years of age and over for selection into the NHANES II Mortality Study, 1992 cohort. Because several weeks could have elapsed between the interview and examination, some participants who were 74 years of age during their interview turned 75 years of age between their interview and examination. Therefore, the upper age limit for the NHANES II Mortality Study, 1992 cohort is 75 years. At baseline, 12,102 adults 30–74 years of age agreed to be interviewed and 9,252 (76 percent) completed a physical examination.

During this first wave of the study, mortality status was ascertained for the years 1976–92. Two participants were unable to be followed because of incomplete personal identifying data and are considered lost to follow-up. The remaining 9,250 cohort members were traced in the NHANES II Mortality Study, 1992 by searching national data bases containing mortality and cause of death information. Length of follow-up ranges from 12 through 16 years. Approximately 23 percent (n = 2,145) of the NHANES II Mortality Study, 1992 cohort were found to be deceased as of December 31, 1992 (figure 1).

Mortality Ascertainment

Mortality status was ascertained by searching two computerized data bases containing information on deaths occurring in the United States. The NDI, compiled by the National Center for Health Statistics (NCHS), contains a standard set of identifying data for each decedent provided by State vital statistics offices (6,7). Beginning with deaths occurring in 1979, the NDI contains deaths for all 50 States, the District of Columbia, Puerto Rico, and the Virgin Islands (6). The Social Security Administration's (SSA) Death Master File (DMF) contains information on all U.S. decedents whose beneficiaries received death benefits from the SSA (8). The DMF pools data from a variety of SSA files, including the SSA Master Beneficiary Record that contains a record for each person entitled to receive retirement or survivor's benefits and disability insurance.

The results of each search were evaluated separately and later combined using the following process (also, outlined in figure 2) to create the NHANES II Mortality Study, 1992 public-release file.

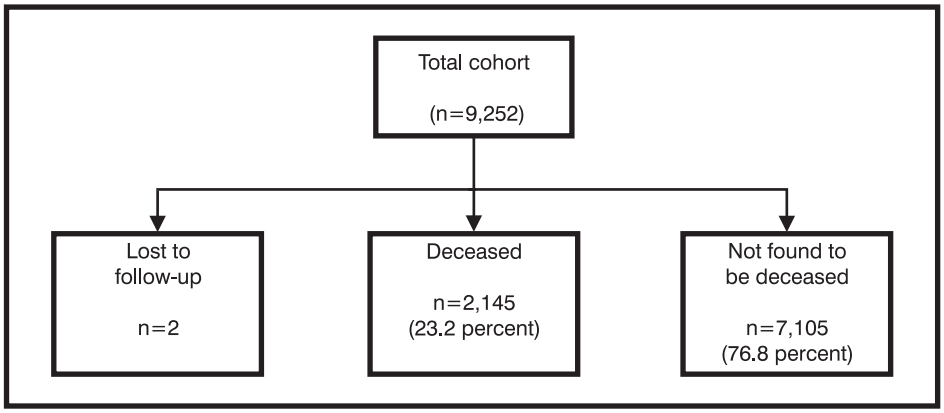

Figure 1. Tracing status of participants in the NHANES II Mortality Study, 1992 cohort

National Death Index Search

The NDI was searched for deaths occurring between 1979–92. At the time the NHANES II Mortality Study, 1992 data were collected, 1992 was the latest year for which cause of death data were available. Social Security numbers were not collected during NHANES II; therefore, potential matches with the NDI were initially identified using name, date of birth, and sex, according to the standard NDI matching process (6). These NDI matching criteria are liberal enough to ensure that true matches will not be missed, but also they generally yield many false matches, especially for participants with common names.

In an attempt to eliminate false positive matches, all matches returned by the NDI were manually reviewed using the previously mentioned information and, additionally, observed race, State of birth, State of residence, and marital status. Each potential NDI match was tentatively classified by NHANES II Mortality Study, 1992 staff as ''true,'' ''possible,'' or ''false.'' The only exceptions to this manual review process were those matches that matched all fields exactly (i.e., name, date of birth, sex, observed race, State of birth, State of residence, and marital status); these matches were classified as true without further review (54 percent of 1,973 true matches). For all other NDI matches, a ''true'' classification was assigned if enough evidence existed to assume that the death pertained to the NHANES II participant. A ''possible'' was assigned if NHANES II Mortality Study, 1992 staff were uncertain whether the death pertained to the NHANES II participant based on the available evidence from the NDI. This code was used to identify cases for whom the death certificate identified by the potential match should be ordered to allow for further evaluation. A ''false'' was assigned if the available evidence from the NDI suggested that the death did not pertain to the NHANES II participant. Overall, NHANES II Mortality Study, 1992 staff erred on the side of being conservative and assigned a possible if they were uncertain in either direction.

Social Security Administration Death Master File Search

Because the NDI does not include deaths occurring before 1979, the SSA DMF was searched for deaths occurring in 1976–78. Additionally, the DMF was also searched from 1979 through March 31, 1988, to confirm the NDI match results for this period. Data extracted from the DMF after March 1988 were not available at the time this study was conducted.

As with the NDI, the initial criteria to identify potential matches to the DMF were based on name and date of birth and were liberal enough to ensure that ''true'' matches would not be missed. The quality of potential matches was further evaluated using a numerical scoring algorithm based on first and last name, date of birth, and State of residence. Matches with scores high enough to indicate at least partial matching on name and date of birth were then manually examined in an attempt to eliminate ''false'' matches. Besides name and date of birth, these evaluations used the last known State of residence compared with the Zip code where the lump sum payment was sent.

Each DMF match was tentatively classified by NHANES II Mortality Study, 1992 staff as true, possible, or false. A ''true'' classification was assigned if enough evidence existed to assume that the death pertained to the NHANES II participant. A ''possible'' was assigned if NHANES II Mortality Study, 1992 staff were uncertain whether the death pertained to the NHANES II participant based on the available evidence from DMF. The ''possible'' code was used to identify cases for whom the death certificate identified by the potential match should be ordered to allow for further evaluation. A ''false'' was assigned if the available evidence from DMF suggested that the death did not pertain to the NHANES II participant. Overall, NHANES II Mortality Study, 1992 staff erred on the side of being conservative and assigned a ''possible'' if they were uncertain in either direction.

Combination of the National Death Index and Death Master File Searches for 1979–88

When the NDI and DMF results were combined, differing outcomes existed for some NHANES II participants. For example, NCHS staff may have assigned a ''true'' match based on NDI and a ''possible'' match based on DMF for the same participant. In some cases, NDI and DMF could have been referring to the same death certificate, but NHANES II Mortality Study, 1992 staff could not be certain because DMF did not provide the death certificate number. The dates of death were used to identify cases where NDI and DMF were most likely referring to the same death certificate.

Because very few cases existed where the NDI and DMF dates of death differed, NHANES II Mortality Study, 1992 staff were able to order the death certificates for both matches from State vital statistics offices. If the certificates were received, they were evaluated to resolve the discrepancy. Data on the

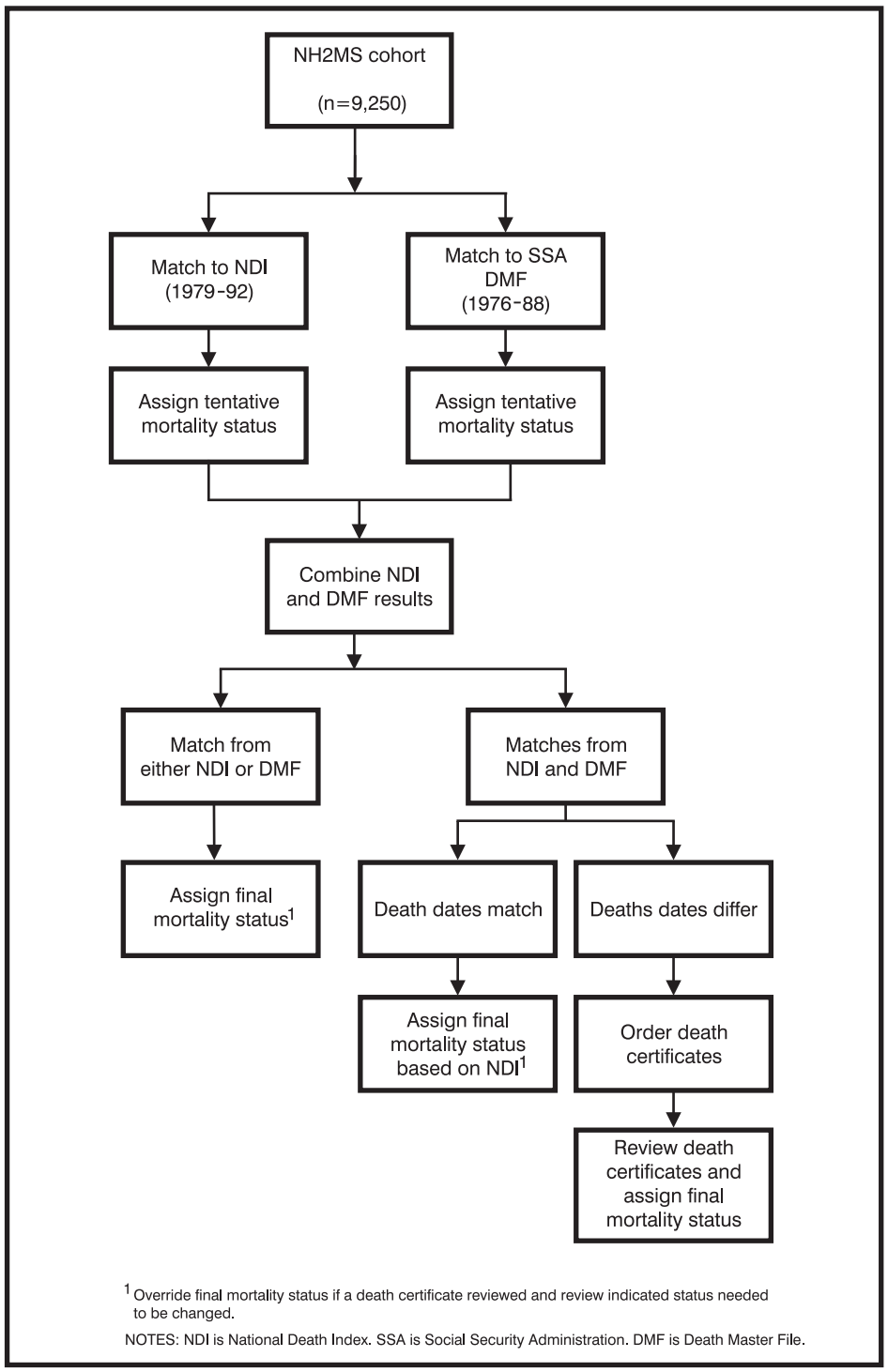

Figure 2. An overview of the process used to assign mortality status to the NHANES II Mortality Study, 1992 participants

death certificate, including address, spouse, State of birth, next of kin, race, marital status, and usual occupation, were checked against these data collected during NHANES II. Based on this review, NHANES II Mortality Study, 1992 staff decided which of the two matches, if any, pertained to the NHANES II participant.

More cases existed where the death dates from NDI and DMF matched exactly or were fairly close (e.g., the year was the same but the month differed, and it looked like a transposition error). In such cases, it was assumed that NDI and DMF were referring to the same death certificate. Before ordering death certificates, NHANES II Mortality Study, 1992 staff assigned an outcome that gave more weight to the NDI results because more information was used in the matching process for NDI (i.e., name, gender, date of birth, race, State of birth, State of residence, and marital status) as compared with DMF (i.e., name, gender, date of birth, and State of residence). However, the NDI-based outcome may have been changed in these discrepant cases if the DMF-identified death certificate was reviewed and it was determined that the DMF match pertained to the NHANES II participant.

Death Certificate Ordering and Review

Because of limited resources for this study, NHANES II Mortality Study, 1992 staff were unable to order death certificates from States and evaluate all of the true and possible matches identified from the NDI and DMF. The matches were ranked and as many of the death certificates as resources allowed were ordered. Priority was given to the following:

- Matches for which NHANES II Mortality Study, 1992 staff could not obtain the cause of death from internal NCHS files.
- Cases with discrepant matches from NDI and DMF in which the dates of death differed.
- ‘‘True’’ and ‘‘possible’’ matches identified solely through DMF (because NCHS had received so little information from DMF to determine whether the match pertained to the NHANES II participant). NHANES II Mortality Study, 1992 staff ordered as many NDI ‘‘true’’ and ‘‘possible’’ matches as resources permitted, mainly from States that NCHS was already requesting death certificates identified by DMF, because this was the most cost-effective approach. As a result, death certificates were ordered for relatively few NDI ‘‘true’’ and ‘‘possible’’ matches, because NHANES II Mortality Study, 1992 staff felt more

confident given that the NDI matches used more information in the matching process.

Death certificates were ordered and received for approximately 27 percent of the 2,145 decedents. A small percentage of the death certificates ordered were not received for one of the following reasons:

- DMF did not provide the State of death and death certificate number, and the State vital statistics office could not find the death certificate based on name, gender, date of death, and date of birth.
- NDI provided the State of death and death certificate number; but in a small number of cases, the death certificate received did not appear to be the death certificate referenced on the NDI, possibly because of typographic errors in the death certificate number.

NCHS was unable to evaluate all of the death certificates received because of staffing limitations. For deaths occurring during the period covered by DMF only (1976–78), death certificates were evaluated for a sample of the DMF ''true'' matches to ensure that criteria for classifying DMF ''true'' matches were sensitive. For the same period, all death certificates were evaluated for DMF ''possible'' matches because of the uncertainty about these matches that were based on so little information. Certificates for deaths occurring between 1979–88 for all ''true'' and ''possible'' matches identified solely through DMF were evaluated in case the death on the NDI was missed. A sample of death certificates for all NDI ''true'' and ''possible'' matches were evaluated to ensure that criteria for classifying them were sensitive. In all evaluations data on the death certificate were checked against these data collected during NHANES II, including address, spouse, State of birth, next of kin, race, marital status, and usual occupation. About one-third of the 712 death certificates ordered and received were reviewed by NHANES II Mortality Study, 1992 staff.

Final Mortality Status on the Public-Release File

Decedents on the public-release file consist only of participants with a final ''true'' match after combining the results of the NDI and DMF evaluations and reviewing selected death certificates. For participants with a final ''possible'' match, NHANES II Mortality Study, 1992 staff concluded that the available evidence was not convincing enough to determine that the match pertained to the NHANES II participant. Thus, NHANES II Mortality Study, 1992 staff assumed that the participants were still alive. Matches with a ''possible'' code will be stored on internal NCHS files for later investigation if the participant does not match to a national data base after a reasonable amount of time. Participants with a final ''false'' match were also assumed alive.

In all, 2,145 deaths were identified using the process described earlier. The numbers of deaths by year of follow-up and sources of mortality data are presented in table 1. Between 1976 and 1978, 84 deaths were identified through DMF, the only source of mortality information available for this period. Between 1979 and 1988, 863 deaths were identified through NDI and DMF, 363 deaths by NDI alone, and 88 deaths by DMF alone. During the final period 1989–92, 747 deaths were identified through the NDI, the only source available. A small percentage of the deaths that occurred between 1979–88 were identified through DMF (4.1 percent) and were not found through NDI. In these cases, NHANES II Mortality Study, 1992 staff reviewed the death certificates and confirmed the deaths.

Causes of Death

For most deaths identified through the NDI, causes of death were obtained from the NCHS Multiple Cause of Death (MCD) file (9,10) by matching on the death certificate number. These deaths were coded by nosologists in the individual State vital statistics offices or at NCHS according to the *International Classification of Diseases, Ninth Revision* (ICD–9). Death certificates were ordered for all deaths identified only through the DMF. The causes of death for these participants were coded by nosologists at NCHS using the same criteria as those used for the MCD file. Additionally, death certificates were ordered and causes of death coded for a small percentage of NDI-identified deaths from States that did not have 100 percent coverage on the MCD file.

Multiple causes of death are available for 98 percent (n = 2,104) of decedents, and, thus, are missing for 41 decedents. Causes of death were missing if the death certificate could not be found in State vital statistics offices. Additionally, causes of death were not obtained for a few deaths that were later determined to be missing from the MCD file.

The date of death was abstracted from either the file returned by NDI or the death certificate.

Assessment of the NHANES II Mortality Study, 1992

The main advantage of using passive follow-up methods is the low cost of tracing large, dispersed cohorts. Nevertheless, reliance solely on these methods to ascertain mortality introduces some uncertainty and potential biases (11). Previous studies have estimated the sensitivity of matching to the NDI at 87 to 97 percent. As in the NHANES II Mortality Study, 1992, these studies used name and date of birth as initial matching criteria with additional information, such as gender, race, and marital status, to eliminate false matches (12–15). Estimates of the sensitivity of searching the SSA DMF are unavailable from previous studies when the Social Security number is not used in the matching process. In this study the sensitivity of matching to DMF with the NHANES II Mortality Study, 1992 study protocol was 70 percent, using overlapping data for the period 1979–88 from the DMF and NDI and using NDI as the ''gold standard.''

Given the limitations of passive methods, the survival of the NHANES II Mortality Study, 1992 cohort was compared to that of the U.S. population during the same period to assess how well mortality was ascertained in the NHANES II Mortality Study, 1992. The overall performance of the combined results from the NDI and DMF searches were evaluated by examining cumulative survival rates after 5 and 10 years. Additionally, the number of expected deaths were compared with observed deaths for the period covered solely by DMF because matching to DMF appeared to be less sensitive than matching to NDI.

Methods Used

To assess how well mortality was ascertained in the NHANES II Mortality Study, 1992, the survival of the cohort was compared to that of the U.S. population during the same period. Cumulative survival probabilities after 5 and 10 years were calculated for 24 race-sex-age groups in the NHANES II Mortality Study, 1992 cohort using the Kaplan-Meier product limit method (16). Sample weights were used to calculate estimates for the cohort but the complex sample design of NHANES II was not taken into account. Cumulative survival probabilities ($_nP_0$) for the U.S. population after 5 and 10 years were calculated using mortality rates extracted from U.S. life tables according to formula (1):

$$ {}_nP_0 = \prod_{i=0}^{n-1} [1 - {}_1q_{a+i,\,1978+i}] \qquad (1) $$

where

n = number of years of follow-up

$_1q_{x,y}$ = probability that persons in a given race-sex group alive at age x will die within 1 year according to the U.S. life table for year y

a = midpoint of the age interval at baseline (1978)

The year 1978 was used as the beginning of follow-up because it was the approximate midpoint of NHANES II. Mortality rates for successive years from life tables were used to account for the decrease in U.S. death rates that occurred over the follow-up period. Participants of race groups other than white and black were omitted from this analysis because of their small numbers in the NHANES II Mortality Study, 1992 cohort.

To evaluate mortality ascertainment for the years covered solely by the DMF, the number of deaths expected to occur between 1976 and 1978 were estimated and compared with the observed number of deaths for this period. Mortality rates for each race, sex, and age group from U.S. life tables were used to calculate the expected number of survivors at the beginning of 1979 (n_{1979}) as:

$$ \begin{aligned} n_{1979} = {} & [O_{1976}\,(1 - q_{a,\,1976}{}^{1/2}) \\ & (1 - q_{a+1,\,1977})\,(1 - q_{a+2,\,1978})] \\ & + [O_{1977}\,(1 - q_{a,\,1977}{}^{1/2}) \\ & (1 - q_{a+1,\,1978})] \\ & + [O_{1978}\,(1 - q_{a,\,1978}{}^{1/2})] \end{aligned} \qquad (2) $$

where

O_y = number examined during year y

$_1q_{x,y}$ = probability that persons in a given race-sex group alive at age x will die within 1 year according to the U.S. life table for year y

a = midpoint of the age interval at baseline

The expected number of deaths in each race-age-sex group was then calculated as the difference between the total number examined from 1976–79 ($N_{1976–78}$) and the expected number of survivors during this period (n_{1979}).

Results

The cumulative survival probabilities for the U.S. population and the NHANES II Mortality Study, 1992 cohort are presented in table 2 by race, sex, and age group. The survival probabilities for the cohort were larger than for the U.S. population in each of the four race-sex groups. Differences between probabilities for the cohort and the U.S. population were most similar among white males and females. In both groups the largest differences after five years were observed in the oldest age group but after 10 years, groups with the largest differences expanded to include 65–69-year-olds and 60–64-year-old females. The largest discrepancies between the cohort and U.S. survival patterns were found among black men and women. Compared with white men and women, differences between survival probabilities after 5 years of follow-up were consistently larger in all age groups and much larger among black males 70–75 years of age. Differences between survival probabilities by race were generally larger after 10 years compared to 5 years of follow-up.

The expected and observed number of deaths during 1976–78 are presented in table 3 by sex and age group for all race groups combined and in table 4 for 24 selected race-sex-age groups. Overall, 84 deaths were observed, just over one-half of the expected deaths during this period. Ratios of observed to expected deaths were lowest among participants 50–59 and 70–75 years of age and highest among those 60–64 and 65–69 years of age. Observed to expected ratios were approximately the same for males and females, although some variation existed by age group between the sexes, primarily in the younger age groups. Ratios were approximately the same for white males and white females but lower for black participants. While the observed to expected ratio for all age groups combined was lowest among black females, there were more age groups among black males in which none of the expected deaths were found during the first 3 years of follow-up.

Discussion

Cumulative survival probabilities for the NHANES II Mortality Study, 1992 cohort were generally higher than expected probabilities calculated from U.S. life table data. Based on the magnitude of differences between them, mortality ascertainment was better for the white participants and worse for the black participants. Ascertainment after 5 years was poorer among the white

participants 70–75 years of age compared with other age groups, although it did not change substantially after 10 years for the oldest age group. On the other hand, ascertainment among white females 60 years of age and over was poorer after 10 years compared with 5 years. Among black participants poor ascertainment was not limited to specific age groups. Although differences between 5- and 10-year survival varied by age group among the black participants, the differences suggest that ascertainment was generally poorer after 10 years.

Some differences in mortality ascertainment were expected given the NHANES II sample design. NHANES II was a sample of noninstitutionalized persons, whereas expected probabilities were based on data for the entire U.S. population that included institutionalized persons with lower survival rates. Given this design the largest differences were expected among the oldest age group and should have decreased over time. This expectation was consistent with the results. Mortality ascertainment was poorest among participants in the oldest age group during the first 3 years of follow-up. Larger discrepancies in 5-year survival existed in this age group, and such differences did not increase over time except among black females. However, it is unlikely that the sample design could explain all of the differences found between the cohort and U.S. survival patterns, even among white men and women.

Incomplete national mortality data for the first 3 years of follow-up could have contributed to under ascertainment of mortality in the NHANES II Mortality Study, 1992. Because the first wave of the study included years not covered by NDI, NHANES II Mortality Study, 1992 staff relied on the DMF for finding deaths occurring for 1976–79. In another study comparing the total number of deaths on the DMF to U.S. vital statistics data, the DMF contained 89 percent of all deaths occurring in the United States between 1975–84 (8). Thus, at best, only 89 percent of deaths could be detected in the NHANES II Mortality Study during the first 3 years of follow-up. The percent of deaths actually detected during the first 3 years of the study was much less than this, especially among black participants 70–75 years of age at baseline.

Limitations in personal identifying data for NHANES II participants probably also contributed to under ascertainment. NHANES II was not designed as a longitudinal study, and because of this, important personal identifiers, such as Social Security number and father's surname, were not collected. Furthermore, personal identifiers were not recorded with as much care as they would have been if NHANES II staff had known that identifiers would be used to link to national mortality data bases. For example, some participants only gave their first and middle initials instead of complete names and this was accepted without further probing. Thus, the quality of personal identifiers was not as high as it could have been if a longitudinal component had been included in the NHANES II design. Problems with personal identifiers in the NHANES II Mortality Study would have affected passive follow-up throughout the entire follow-up period, and possibly contributed to larger differences in survival probabilities between 5 and 10 years among the black participants and older women.

Under ascertainment of deaths during the years covered solely by the DMF was greater among the black than among the white participants. Poorer mortality ascertainment among the black participants was consistent with larger discrepancies in 5-year survival for this group and with previous studies (17,18) using the DMF. Furthermore, discrepancies in 10-year survival were larger among black than white participants, suggesting that ascertainment was problematic for the former group throughout the entire follow-up period. Previous studies evaluating the effectiveness of NDI have suggested that ascertainment may not be as good for black decedents as it is for white decedents (12,19,20). In a study of the survival of the NHEFS cohort, differences between observed and expected survival after 5 and 8 years of follow-up were larger for black than for white participants (21). Because mortality was ascertained through active tracing methods in NHEFS (22), some of the differential ascertainment by race in the NHANES II Mortality Study, 1992 may have been independent of the passive methods used. Other factors besides under ascertainment may have contributed to the larger differences in survival among black participants. In the NHANES II Mortality Study, 1992, survival estimates for black participants may have been less stable than for white participants, given the smaller number of black participants compared with white participants in the NHANES II sample. Differences by race in the quality of denominator data used to calculate the U.S. estimates may also have affected the comparisons.

In conclusion, the analysis presented here suggests that after 10 years of follow-up using passive methods, mortality may have been under ascertained for the NHANES II Mortality Study, 1992 cohort. Because this analysis used expected data based on the U.S. population, it probably overestimated the degree of under ascertainment, but it is unclear by how much. Nonetheless, the analysis shows that compared with white participants, ascertainment of mortality was poorer among black participants.

NHANES II Mortality Study, 1992 Analytic Cohort

Approximately 23 percent (n = 2,145) of the NHANES II Mortality Study, 1992 cohort (n = 9,250) was found to be deceased (table 5). The percentage of male decedents (28.9 percent) was higher than the percentage of female decedents (18.1 percent) among all races combined, a trend that was also observed within each age group (table 5). This same pattern, higher percentages of male decedents compared with female decedents, was also observed among the white and black participants (table 6).

The remaining 77 percent (n = 7,105) that were not found to be deceased as of December 31, 1992, (table 5) may be assumed to be alive for analytic purposes. This assumption may potentially result in the misclassification of vital status for some cohort members because of the passive methods used in this study. That is, some true matches may have been inadvertently eliminated and some false matches retained. It is more likely that true matches were eliminated rather than false matches retained because NHANES II Mortality Study, 1992 staff erred on the side of being conservative in determining matches. True matches that were eliminated would continue to accumulate person-years of follow-up. If the rate of eliminating true matches is unrelated to the exposure of interest, eliminating true matches should not attenuate risk ratios but may reduce the statistical power of studies using the NHANES II Mortality Study, 1992 data (11). More important, caution should be exercised when using the NHANES II Mortality Study, 1992 data to make comparisons based on race because of the apparent differential ascertainment of mortality by race. Researchers using the NHANES II Mortality Study, 1992 data should be aware of these study limitations and consider them when drawing conclusions based on these data.

Finally, subjects 60–74 years of age were oversampled in NHANES II and, thus, are overrepresented in the NHANES II Mortality Study, 1992 cohort. Therefore, NCHS recommends that analysts use the baseline sample weights and sample design variables to account for the complex sample design in analyses of the NHANES II Mortality Study, 1992 data.

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Table 1. Number of deaths according to years of follow-up and sources of mortality status information in the the NHANES II Mortality Study, 1992

Year	Source of morality status							
	DMF[1]		NDI[2] and DMF		NDI		Total	
	Number of deaths	Percent	Number of deaths	Percent	Number of deaths	Percent	Number of deaths	Percent
1976–78	84	3.9	. . .		. . .	. . .	84	3.9
1979–88[3]	88	4.1	863	40.2	363	16.9	1,314	61.3
1989–92	. . .	. . .	. . .		747	34.8	747	34.8
Total	172	8.0	863	40.2	1,110	51.7	2,145	100.0

. . . Category not applicable.

[1]DMF is the Social Security Administration's Death Master File.

[2]NDI is National Death Index.

[3]DMF was available through March 31, 1988. The remainder of 1988 was covered solely by the NDI.

NOTE: NHANES II is the Second National Health and Nutrition Examination Survey.

Table 2. Comparison of cumulative survival probabilities after 5 and 10 years for the U.S. population compared with those for the NHANES II Mortality Study cohort according to race, sex, and age group

Race, sex, and age group	5 years		10 years	
	United States	NHANES II Mortality Study cohort[1]	United States	NHANES II Mortality Study cohort[1]
White male				
30–39 years	0.990	0.996	0.977	0.980
40–49 years	0.977	0.987	0.944	0.954
50–59 years	0.940	0.957	0.858	0.891
60–64 years	0.874	0.880	0.735	0.763
65–69 years	0.824	0.835	0.624	0.669
70–75 years	0.744	0.811	0.485	0.550
White female				
30–39 years	0.995	0.994	0.988	0.989
40–49 years	0.987	0.981	0.968	0.968
50–59 years	0.969	0.989	0.923	0.937
60–64 years	0.938	0.952	0.852	0.902
65–69 years	0.908	0.935	0.780	0.847
70–75 years	0.857	0.904	0.668	0.720
Black male				
30–39 years	0.974	0.995	0.940	0.977
40–49 years	0.948	1.000	0.883	0.980
50–59 years	0.892	0.943	0.770	0.836
60–64 years	0.827	0.887	0.654	0.834
65–69 years	0.782	0.846	0.556	0.711
70–75 years	0.715	0.872	0.451	0.595
Black female				
30–39 years	0.989	1.000	0.973	0.989
40–49 years	0.973	0.952	0.938	0.924
50–59 years	0.942	1.000	0.865	0.964
60–64 years	0.901	0.929	0.784	0.866
65–69 years	0.869	0.942	0.706	0.859
70–75 years	0.812	0.892	0.600	0.723

[1]Sample weights from the Second National Health and Nutrition Examination Survey were used.

NOTE: NHANES II is the Second National Health and Nutrition Examination Survey.

Table 3. Expected number of survivors and decedents based on U.S. vital statistics data compared with observed number of decedents from 1976–78 in the NHANES II Mortality Study according to sex and age for all races combined

Sex and age group	Number examined	Expected number of survivors	Expected number of decedents	Observed number of decedents	Ratio of observed to expected
Male[1]					
30–39 years	629	626	3	–	–
40–49 years	497	493	4	3	0.75
50–59 years	511	501	10	2	0.20
60–64 years	631	607	24	18	0.75
65–69 years	495	468	27	19	0.70
70–75 years	373	345	28	12	0.43
Total	3,136	3,040	96	54	0.56
Female[1]					
30–39 years	697	696	1	2	2.00
40–49 years	541	538	3	1	0.33
50–59 years	591	585	6	3	0.50
60–64 years	660	648	12	6	0.50
65–69 years	585	570	15	11	0.73
70–75 years	452	433	19	7	0.37
Total	3,526	3,470	56	30	0.54
Total[1]					
30–39 years	1,326	1,322	4	2	0.50
40–49 years	1,038	1,031	7	4	0.57
50–59 years	1,102	1,086	16	5	0.31
60–64 years	1,291	1,255	36	24	0.67
65–69 years	1,080	1,038	42	30	0.71
70–75 years	825	778	47	19	0.40
Total	6,662	6,510	152	84	0.55

– Quantity zero.

[1]Includes races other than white and black.

NOTE: NHANES II is the Second National Health and Nutrition Examination Survey.

Table 4. Expected number of survivors and decedents based on U.S. vital statistics data compared with observed number of decedents from 1976–78 in the NHANES II Mortality Study according to race, sex, and age for selected race groups

Race, sex, and age group	Number examined	Expected number of survivors	Expected number of decedents	Observed number of decedents	Ratio of observed to expected
White male					
30–39 years	549	547	2	–	–
40–49 years	442	439	3	3	1.00
50–59 years	455	447	8	2	0.25
60–64 years	572	551	21	14	0.67
65–69 years	428	406	22	15	0.68
70–75 years	329	305	24	12	0.50
Total	2,775	2,695	80	46	0.58
White female					
30–39 years	602	601	1	2	2.00
40–49 years	457	455	2	–	–
50–59 years	503	499	4	3	0.75
60–64 years	588	578	10	5	0.50
65–69 years	517	504	13	10	0.77
70–75 years	410	394	16	6	0.38
Total	3,077	3,031	46	26	0.57
Black male					
30–39 years	62	61	1	–	–
40–49 years	39	38	1	–	–
50–59 years	47	45	2	–	–
60–64 years	52	49	3	4	1.33
65–69 years	48	44	4	3	0.75
70–75 years	37	33	4	–	–
Total	285	270	15	7	0.47
Black female					
30–39 years	82	82	–	–	. . .
40–49 years	72	71	1	1	1.00
50–59 years	74	72	2	–	–
60–64 years	60	58	2	1	0.50
65–69 years	55	53	2	1	0.50
70–75 years	38	35	3	1	0.33
Total	381	371	10	4	0.40

– Quantity zero.

. . . Category not applicable.

NOTE: NHANES II is the Second National Health and Nutrition Examination Survey.

Table 5. Number of participants in the NHANES II Mortality Study by mortality status at end of follow-up in 1992 according to sex and age at baseline for all races combined

Sex and age group	Total	Status at follow-up			
		Assumed alive[1]		Decedents	
		Number	Percent	Number	Percent
Male[2]					
30–39	871	832	95.5	39	4.5
40–49	691	629	91.0	62	9.0
50–59	700	565	80.7	135	19.3
60–64	877	548	62.5	329	37.5
65–69	697	339	48.6	358	51.4
70–75	513	178	34.7	335	65.3
Total	4,349	3,091	71.1	1,258	28.9
Female[2]					
30–39	988	968	98.0	20	2.0
40–49	766	719	93.9	47	6.1
50–59	795	701	88.2	94	11.8
60–64	926	727	78.5	199	21.5
65–69	799	565	70.7	234	29.3
70–75	627	334	53.3	293	46.7
Total	4,901	4,014	81.9	887	18.1
Total[2]					
30–39	1,859	1,800	96.8	59	3.2
40–49	1,457	1,348	92.5	109	7.5
50–59	1,495	1,266	84.7	229	15.3
60–64	1,803	1,275	70.7	528	29.3
65–69	1,496	904	60.4	592	39.6
70–75	1,140	512	44.9	628	55.1
Total	9,250	7,105	76.8	2,145	23.2

[1]Not found to be deceased, therefore, assumed alive.

[2]Includes races other than white and black.

NOTE: NHANES II is the Second National Health and Nutrition Examination Survey.

Table 6. Number of participants in the NHANES II Mortality Study by mortality status at end of follow-up in 1992 according to race, sex, and age at baseline for selected race groups

Race, sex, and age group	Total	Status at follow-up			
		Assumed alive[1]		Decedents	
		Number	Percent	Number	Percent
White male					
30–39	750	719	95.9	31	4.1
40–49	610	560	91.8	50	8.2
50–59	611	500	81.8	111	18.2
60–64	791	490	62.0	301	38.0
65–69	605	285	47.1	320	52.9
70–75	448	152	33.9	296	66.1
Total	3,815	2,706	70.9	1,109	29.1
White female					
30–39	860	843	98.0	17	2.0
40–49	654	618	94.5	36	5.5
50–59	677	595	87.9	82	12.1
60–64	828	653	78.9	175	21.1
65–69	696	491	70.6	205	29.4
70–75	559	296	53.0	263	47.0
Total	4,274	3,496	81.8	778	18.2
Black male					
30–39	98	91	92.9	7	7.1
40–49	63	52	82.5	11	17.5
50–59	79	56	70.9	23	29.1
60–64	78	52	66.7	26	33.3
65–69	73	41	56.2	32	43.8
70–75	58	23	39.7	35	60.3
Total	449	315	70.2	134	29.8
Black female					
30–39	111	108	97.3	3	2.7
40–49	98	88	89.8	10	10.2
50–59	103	92	89.3	11	10.7
60–64	85	66	77.6	19	22.4
65–69	88	61	69.3	27	30.7
70–75	64	36	56.2	28	43.8
Total	549	451	82.1	98	17.8

[1]Not found to be deceased, therefore, assumed alive.

NOTE: NHANES II is the Second National Health and Nutrition Examination Survey.

Appendix I

NHANES II baseline examination components for participants 30–75 years of age (1976–80)

Examination components	Test group	
	Bile acids	Glucose tolerance
Urine	X	X
Body measurements	X	X
Physician examination	X	X
Venipuncture	X	X
Dietary interview	X	X
Allergy test	X	X
Electrocardiogram	X	X
Chest and neck x rays	X	X
Back x ray		
30–75 years for men	X	X
50–75 years for women	X	X
Glucose tolerance test		X
Bile acids test: 35–75 years only	X	

NOTE: NHANES II is the Second National Health and Nutrition Examination Survey.

Appendix II

NHANES II baseline blood and urine assessments by specimen types for participants 30–75 years of age (1976–80)

	Test group	
	Bile acids[1]	Glucose tolerance
Whole blood		
Lead: Odd-numbered examinees	X	X
Carboxyhemoglobin: Even-numbered examinees	X	X
Protoporphyrin	X	X
Red blood cell folate[2]	X	X
Serum		
Ferritin[2]	X	X
Bile acids: 35–75 years only	X	
Cholesterol	X	X
Triglyceride		X
High density lipoprotein		X
Pesticides: All examinees	X	
Creatinine	X	X
Syphilis	X	X
Iron	X	X
Total iron binding capacity	X	X
Folate[2]	X	X
Vitamin B12[2]	X	X
Copper	X	X
Zinc	X	X
Albumin	X	X
Glucose tolerance 75 gram load at 0-, 1-, and 2-hour intervals		X
Vitamin C	X	X
Urine		
N-Multistix	X	X
Gonorrhea:		
30–40 years for both sexes	X	X
30–40 years for men		X
Microscopy		X
Specific gravity		X
Pesticides	X	

[1]Bilirubin, SGOT, and alkaline phosphatase performed only on those samples with elevated bile acids.

[2]Performed only on those samples with abnormal complete blood count, hemoglobin, hematocrit, or mean corpuscular volume.

NOTE: NHANES II is the Second National Health and Nutrition Examination Survey.

Appendix III

NHANES II baseline pesticide residue and metabolite determinations for participants 30–75 years of age (1976–80)

Serum	Urine
Hexachlorobenzene	*alpha* Monocarboxylic acid
trans Nonachlor	Dicarboxylic acid
DDT and Associated Analogs	3,5,6-Trichloro-2-pyridinol
alpha-BHC	Isopropoxyphenol
gamma-BHC	Carbofuranphenol
beta-BHC	3-Ketocarbofuran
delta-BHC	Dicamba
Aldrin	2,4-D
Dieldrin	Pentachlorophenol
Endrin	*para*-Nitrophenol
Heptachlor	*alpha*-Naphthol
Heptachlor Epoxide	DMTP
Oxychlordane	DETP
Mirex	DMDTP
	DEDTP
	DMP
	DEP
	2,4,5-T
	Silvex
	2,4,5-Trichlorophenol

NOTE: NHANES II is the Second National Health and Nutrition Examination Survey.

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