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The Validity of Race and Hispanic-origin Reporting on Death Certificates in the United States: An Update



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

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The Validity of Race and Hispanic-origin Reporting on Death Certificates in the United States: An Update

Data Evaluation and Methods Research

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

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Objectives

This report presents the findings of an updated study of the validity of race and Hispanic-origin reporting on death certificates in the United States, and its impact on race- and Hispanic origin-specific death rates.

Methods

The latest version of the National Longitudinal Mortality Study (NLMS) was used to evaluate the classification of race and Hispanic origin on death certificates for deaths occurring in 1999–2011 to decedents in NLMS. To evaluate change over time, these results were compared with those of a study based on an earlier version of NLMS that evaluated the quality of race and ethnicity classification on death certificates for 1979–1989 and 1990–1998. NLMS consists of a series of annual Current Population Survey files (1973 and 1978–2011) and a sample of the 1980 decennial census linked to death certificates for 1979–2011. Pooled 2009–2011 vital statistics mortality data and 2010 decennial census population data were used to estimate and compare observed and corrected race- and Hispanic origin-specific death rates.

Results

Race and ethnicity reporting on death certificates continued to be highly accurate for both white and black populations during the 1999–2011 period. Misclassification remained high at 40% for the American Indian or Alaska Native (AIAN) population. It improved, from 5% to 3%, for the Hispanic population, and from 7% to 3% for the Asian or Pacific Islander (API) population. Decedent characteristics such as place of residence and nativity affected the quality of reporting on the death certificate. Effects of misclassification on death rates were large for the AIAN population but not significant for the Hispanic or API populations.

Keywords: death rates • mortality • misclassification • National Vital Statistics System

The Validity of Race and Hispanic-origin Reporting on Death Certificates in the United States: An Update

by Elizabeth Arias, Ph.D., and Melonie Heron, Ph.D., National Center for Health Statistics; and Jahn K. Hakes, Ph.D., U.S. Census Bureau

Introduction

The death certificate is the primary source of mortality information in the United States. It is used with census population counts or estimates to derive the basic mortality measure: the death rate. Race- and ethnicity-specific death rates are essential indicators of health and mortality disparities across the various racial and ethnic populations in the United States. To estimate accurate and reliable death rates by race and ethnicity, it is imperative that the classification of race and ethnicity in both mortality and census population data is consistent.

The likelihood of inconsistency between racial and ethnic classification on numerators and denominators of death rates can be substantial, due to the distinct methods in which the information is collected in vital statistics mortality and census population data systems. Reporting of race and ethnicity in census data is usually done by a respondent who answers the question for him- or herself and other members in the household (“self-report” is hereafter used to refer to race and Hispanic-origin reporting on census and survey data). The classification of race and ethnicity in mortality data, on the other hand, is derived from responses to race and Hispanic-origin items on the death certificate, and, typically, the funeral director fills out these items. The funeral director is expected to collect this information by questioning the decedent’s next of kin but may instead rely only on observation.

Prior studies have shown a high degree of disagreement between census or survey self-report and death certificate proxy report of race and ethnicity for some U.S. populations (1–4). All previous studies have shown that agreement between the two sources has been excellent for the white and black race groups but poor for other groups, especially the American Indian or Alaska Native (AIAN) population. For these latter groups, the problem has been mainly net underascertainment on death certificates. For example, persons who self-identified with a particular group while alive are sometimes classified as belonging to a different group on their death certificates. The most recent such findings refer to deaths that occurred to National Longitudinal Mortality Study (NLMS) decedents in 1990–1998 (4).

This report presents the results of an updated evaluation study of the validity of race and Hispanic-origin reporting on death certificates in the United States, and its impact on race- and Hispanic origin-specific death rates. The latest NLMS version is used to update an evaluation study published in 2008. In that study, Arias et al. (4) examined the validity of race and Hispanic-origin reporting on death certificates by comparing race and Hispanic-origin classification on the death certificates of Current Population Survey (CPS) respondents (1973, 1978–1998) and a sample of 1980 decennial census respondents who died during the 1979–1998 period to their self-responses on the survey forms. The current study uses the latest version of NLMS, which includes CPS cohorts (1973, 1978–2011)

linked to death certificates for deaths occurring during 1979–2011, and explores the degree of misclassification for CPS respondents who died during the 1999–2011 period.

The current study explores change in the quality of race and Hispanic-origin reporting over three decades (1979–1989, 1990–1998, and 1999–2011). It updates previous findings (4) about the relationship between the quality of reporting on the death certificate and selected decedent characteristics, such as age, sex, nativity, geographic region of residence, and county-level racial and ethnic population concentration. The study also explores the effect on mortality estimates of racial and ethnic misclassification on death certificates by comparing two sets of race- and Hispanic origin-specific death rates. Using pooled 2009–2011 vital statistics mortality data and U.S. Census 2010 data, observed death rates by race and Hispanic origin are compared with death rates that have been corrected for death certificate misclassification. Census data quality and its effect on race- and ethnicity-specific death rates is briefly reviewed and evaluated.

Background

Previous findings on race and ethnicity misclassification on U.S. death certificates

Arias et al. (4) updated the findings of Sorlie et al. (2) and Rosenberg et al. (3), using NLMS with CPS files (1973 and 1978–1998) linked to death certificates for deaths occurring in 1979–1998. This study found that agreement between CPS self-report and death certificate proxy report was high for the black and white populations but considerably lower for other race groups, consistent with previous studies (2,3). Specifically, for the 1979–1989 period, the percentage of CPS respondents in a self-identified race group who were correctly identified on the death certificate were: 99.8% of white, 98.8% of black, 55.1% of AIAN, and 84.4% of Asian or Pacific Islander (API) persons. For the 1990–1998 period, the percentage

with correct identification on the death certificate were: 99.8% of white, 98.1% of black, 55.2% of AIAN, and 89.7% of API persons.

Furthermore, Arias et al. (4) found that the ratio of CPS race and Hispanic-origin death counts to death certificate counts, or classification ratio, was highly accurate for the white and black populations in both time periods and improved over time for the AIAN and API populations—although the improvement was not statistically significant. The classification ratios in 1979–1989 were: white, 1.00; black, 1.00; AIAN, 1.45; and API, 1.13. The ratios in 1990–1998 were: white, 1.00; black, 1.01; AIAN, 1.30; and API, 1.07. Changes in the ratios over the 2 decades were statistically significant only for the black population.

In addition to race classification, Arias et al. (4) used NLMS to update previous findings on death certificate coverage by Hispanic origin. The earlier study found that among self-identified Hispanic persons, 92.8% were correctly identified on the death certificate during 1979–1989, and 88.1% during 1990–1998. The percentages correctly identified by Hispanic subgroup for both periods were: Mexican, 79.2% for 1979–1989 and 86.0% for 1990–1988; Puerto Rican, 85.8% and 79.7%; Cuban, 82.1% and 86.6%; Central and South American, 32.3% and 64.3%; and Other Hispanic, 46.7% and 39.2%. CPS and death-certificate agreement improved significantly between the time periods for Mexican and Central and South American persons.

The classification ratios for 1979–1989 were: Hispanic, 1.04; Mexican, 1.17; Puerto Rican, 1.06; Cuban, 1.05; Central and South American, 2.35; and Other Hispanic, 0.50. The classification ratios for 1990–1998 were: Hispanic, 1.05; Mexican, 1.06; Puerto Rican, 1.07; Cuban, 1.04; Central and South American, 1.05; and Other Hispanic, 0.99. Classification ratios improved significantly between the time periods for Mexican, Central and South American, and Other Hispanic populations.

Arias et al. (4) expanded on previous studies by exploring factors associated

with death certificate misclassification. The study found variation in racial and ethnic misclassification on the death certificate by age, sex, geographic region, urban–rural residence, coethnic concentration, and nativity for the 1990–1998 period. Generally, classification ratios were relatively stable across age group, age–sex group, region, or urban–rural status for the white and black populations. However, ratios varied considerably across age group and age–sex group for the AIAN population and most Hispanic subgroups, although this was partly a function of small sample sizes. For the AIAN and API populations, ratios were highly variable by region, with better reporting in regions with greater numbers of AIAN and API residents. Furthermore, for the AIAN, total Hispanic, Mexican, and Central and South American populations, racial and ethnic reporting on the death certificate was better in counties with higher concentrations of persons from the same racial or ethnic group. Classification ratios also varied by nativity for the black population, with the U.S. born being more likely to be classified correctly, and for the total Hispanic and most Hispanic subgroups, with the foreign born being more likely to be classified correctly.

In summary, previous studies have found that incongruence between race and ethnicity self-report, in either a decennial census or CPS, and proxy report on death certificates has not been a problem for the white and black populations but has been substantial for other racial and ethnic groups. For some populations, racial and ethnic reporting on the death certificate has improved over time. Certain factors also play an important role in whether misclassification occurs and to what extent. The expansion of NLMS has made it possible to explore the following questions: Did the misclassification problem increase or decrease during the 1999–2011 period for the various racial and ethnic groups? Are the same factors associated with death certificate misclassification? To what extent are current death rates biased by race and ethnicity misclassification on death certificates?

Data and Methods

Evaluation of Race and Hispanic-origin Reporting on Death Certificates

Data

NLMS consists of data from the CPS Annual Social and Economic Supplement and a sample of the 1980 decennial census combined with death certificate information from the National Vital Statistics System (NVSS) to identify mortality status and cause of death. CPS is a multistage, stratified probability sample of the U.S. noninstitutionalized civilian population, with a response rate between 92% and 96% (5). NVSS consists of a voluntary contractual agreement between the National Center for Health Statistics (NCHS) and individual registration areas to collect the nation's birth and death information. NVSS coverage includes more than 99% of deaths that occur in all 50 states, the District of Columbia, and the U.S. territories (6).

To date, NLMS includes 38 CPS files and the April 1980 decennial census file covering 1973 and 1978–2011, adding up to 3.8 million records. Through linkage to NCHS' National Death Index for the 1979–2011 period, 559,007 deaths have been identified (7). For the analyses presented in this report, several files were excluded due to the poor quality of important variables. Both the race- and Hispanic origin-specific analyses exclude the April 1980 decennial census file because it is missing a necessary population weight variable. The race-specific analysis further excludes the March 1973, February 1978, March 1986, and March 1987 CPS files because the race variable is incomplete.

The race categories used in this study include white, black, AIAN, and API, based on the Office of Management and Budget's (OMB) 1977 Statistical Policy Directive 15, "Race and Ethnic Standards for Federal Statistics and Administrative Reporting" (8). This directive required federal agencies to collect, tabulate, and report at minimum the four single-race

categories listed. OMB's 1997 "Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity" (9) introduced two major changes. First, it increased the minimum number of race categories that can be presented from four to five by breaking the API category into two new categories: Asian and Native Hawaiian or Other Pacific Islander (NHOPI). Second, it required that federal statistical data systems allow respondents to select more than one race (9). The race categories in this report are based on the 1977 OMB directive to maintain consistency across the different data systems.

The U.S. Census Bureau implemented OMB's 1997 revision starting with the 2000 decennial census. CPS implemented the new revision beginning in 2003. NVSS registration areas also began implementing the new standard in 2003, with individual areas making the transition at different times over the ensuing years. NCHS adopted a bridging algorithm that reassigns multiple-race persons in mortality and census data to make the NVSS and Census data systems comparable and to produce race-specific mortality estimates (10,11). This bridging algorithm uses empirically derived probabilities of identification with 1977 OMB-standard race categories for persons reporting multiple racial ancestries, calculated from data based on responses to a question about primary racial identification posed to multiracial subjects of the National Health Interview Survey (11). This algorithm was also used to bridge the race categories in CPS 2003–2011 to the 1977 OMB standard for this study.

Hispanic-origin categories used in this study include total Hispanic, Mexican, Puerto Rican, Cuban, Central and South American, and Other Hispanic. The latter group includes persons not in any of the previous Hispanic categories, such as Dominican and Spanish persons, as well as Hispanic individuals for whom a specific country of origin was not ascertained on either CPS or the death certificate. The separation of Hispanic origin as a distinct ethnic, rather than racial, attribute that crosscuts race and is measured using a separate item is also

consistent with the 1977 directive (8).

The racial and ethnic classification system employed in federal population surveys and censuses differs from that employed by NVSS in an important way. Both systems are guided by OMB's standards regarding the racial and ethnic categories that should be used to obtain, tabulate, and report data by federal statistical and administrative systems. However, the two systems differ in the procedures used to collect the information. CPS, like the decennial census, relies on the report of persons responding for themselves and other members of their household, whereas the NVSS mortality data system relies on a proxy report provided by a funeral director based on responses from an available informant. (Demographic information on the death certificate, including race and ethnicity, is recorded by a funeral director, who is responsible for assuring the completion of the death certificate and registering it with state vital statistics offices. Information about cause of death is provided by the attending physician, medical examiner, or coroner.) Background information about CPS and NVSS mortality data, including the history of race and Hispanic-origin data collection and death certificate revisions, are detailed elsewhere (4,5,12–17).

Reporting and allocation of missing race and Hispanic origin

The percentage of records in NLMS with an unclassified race on CPS is 0.07%, because missing or unknown race is imputed in all of the post-1995 CPS files included in NLMS. CPS uses multiple imputation methods: relational imputation, which assigns missing race information from someone else in the same household or from the preceding record; longitudinal edits, which assign race based on a respondent's answer to the race question on a previous CPS; and "hot deck" allocation, a complex procedure in which race is allocated based on a hierarchy of highly correlated variables (5).

Race is imputed in approximately 5% of CPS records (18).

The level of unknown, not stated, or not classifiable race information on

original death certificate records has consistently been minimal, ranging from a high of 0.30% to a low of 0.07% between 1979 and 2011 (19). From 1992 through 2011, 0.01% to 0.49% of original death records were coded as “other races” (19). The percentage of NLMS decedents with missing race on their death certificates is zero, as a result of the NVSS practice of imputing unknown, not stated, or not classifiable race and, beginning in 1992, “other races” (19). The NVSS imputation technique uses the preceding record as the donor (20).

CPS began imputing unknown Hispanic origin in the mid-1980s using the same imputation methods used for imputing unknown race, but NLMS captured some of the CPS files prior to imputation. As a result, the percentage of CPS records with unknown Hispanic origin used in this study is 3% (5,18). NVSS imputes unknown Hispanic-origin subgroups for reporting states by using the state-of-birth item as a source of information. If the birthplace is Mexico, Puerto Rico, or Cuba, then the Hispanic origin is assigned accordingly. If the birthplace is elsewhere, then the code is “Other and Unknown Hispanic” or “Unknown” (20). As a result of this imputation, the percentage of unknown Hispanic origin in the files used in this study is 0.18%.

No adjustments were made for the imputation procedures used by CPS and NVSS, but the small fraction of records with unknown or unclassified race or Hispanic-origin information was excluded from the analysis. The final samples used for deaths occurring during the 1999–2011 period include 231,065 matched records for the race-specific analysis and 265,591 matched records for the Hispanic origin-specific analysis.

Methods

As in previous studies, race and Hispanic origin reported on CPS were used as the standard for comparison to the death certificate classification. Survey and census race and ethnicity classification are not without error (21–23). However, the assumption is made that the information provided by a respondent to a survey questionnaire

about race or Hispanic origin is, on average, more valid than proxy reporting conducted by a funeral director, who in most cases has little personal knowledge of the decedent. This decision was based on public policy embodied in the 1997 OMB revision, which emphasizes self-identification as the standard for collection of racial and ethnic identities.

To evaluate race and Hispanic-origin classification on the death certificate, two statistical estimates of death certificate misclassification were used. First, classification ratios were estimated. As defined in Arias et al. (4), these are ratios of CPS race and Hispanic-origin counts to death certificate counts for the sample of identified NLMS decedents. For example, the classification ratio for the white population is estimated as the number of decedents identified as white on CPS to the number identified as white on the death certificate. This is basically a ratio of row to column totals in a bivariate table of CPS (row) by death certificate (column) classification. It can be interpreted as the net difference in assignment of white between the two data collection systems. The classification ratios can be easily interpreted as adjustment factors to correct for the bias found in death certificates. Second, record-level agreement was estimated between CPS and the death certificates for individual decedents through a measure of sensitivity and predictive value positive. Sensitivity is the percentage of respondents in a CPS self-identified race and ethnicity group who are correctly identified on the death certificate; predictive value positive is the percentage of decedents identified by the death certificate in a specific race and ethnicity group who are self-identified in the same group on CPS (all statistics presented are weighted by CPS sample weights).

The classification ratios were estimated by decedents’ age, sex, nativity, urban–rural status, region of residence, and degree of coethnic geographic concentration at the time of death. As in Arias et al. (4), the variables used for bivariate analyses were derived from the death certificate and include age (0–24, 25–44, 45–54, 55–64, 65–74, and 75 and

over), sex, nativity (U.S. born compared with foreign born), urban–rural status, census region of residence, and degree of coethnic geographic concentration (see [Appendix Tables I–III](#) for sample sizes by analysis variables). “Degree of coethnic concentration” is a dichotomous variable indicating whether the decedent died in a county with high concentrations of coethnic populations, and it is used in the analysis of total Hispanic (and subgroups) and AIAN populations. Arias et al. (4) hypothesized that for these groups more than any other, reporting on the death certificate varies significantly by whether the death occurred in an area with significant numbers of the coethnic population. Because race and Hispanic-origin reporting on the death certificate is often based on the personal observation of the funeral director, correct identification for populations where the OMB race and ethnicity categories are problematic is probably improved if the funeral director is coethnic, or familiar with the population in question due to its high local concentration.

For the Hispanic population and component subgroups, the coethnic concentration indicator is defined as 1) decedent died in a county that is within the first 50th percentile of ethnic-specific ranked number of deaths by county between 1999 and 2011, and 2) decedent died outside of this list of counties (see [Appendix Table IV](#) for a list of counties for Hispanic subgroups). The concentration measure for the AIAN population is defined as 1) decedent died in one of the Indian Health Service’s Contract Health Service Delivery Areas (CHSDA) counties during 1999–2011, and 2) decedent died elsewhere. CHSDA is composed of 637 counties that contain federally recognized tribal land or are adjacent to tribal lands (24).

Effect of Death Certificate Race and Hispanic-origin Misclassification on Mortality Measures

To assess the effects on mortality measures of race and ethnicity misclassification on the death certificate, age-specific and age-adjusted death rates uncorrected and corrected for racial and ethnic misclassification on the death certificate were estimated and compared.

Data

Pooled numbers of deaths (bridged for states reporting multiple race) for 2009–2011 from NVSS were used for death rate numerators. NCHS bridged April 1, 2010, census population estimates for the four race groups and the total Hispanic population were used for rate denominators.

For rate denominators for Hispanic subgroups, the Census 2010 Summary File 2 was used (25). The NCHS bridged population file does not break down the Hispanic population by country of origin (11).

The validity and reliability of death rates is also affected by biases in population counts (the denominators of the rates). Racial and ethnic biases in census population counts can result from question nonresponse, question wording effects, and underenumeration (or net undercounts) (21–23,26,27). For the 2010 census, the Census Bureau reported an imputation rate for missing information of 4.5% for the Hispanic-origin item, and 4.1% for the race item (28). A related problem with the race data is that some respondents have preferred to check “some other race” instead of one of the listed OMB options on the census form. Following imputation of missing race and Hispanic origin, the Census Bureau produces a Modified Race Data Summary File that imputes records where the race response was “some other race” alone, or in combination with another race, into one of the OMB race groups (29). For Census 2010, the substitution rate for “some other race” was 2.8% of the total population (25). The Modified Race Data Summary File contains the data traditionally used by NCHS to estimate

death rates and to produce the bridged race file for data years 2000 and later (11). The impact of census allocation procedures on vital rate calculations was not evaluated.

As in previous decennial censuses, variation occurred in census coverage by race and Hispanic origin in the 2010 census. The Census 2010 postenumeration survey (Census Coverage Measurement Survey, or CCM) revealed net undercounts that were statistically different from zero for the non-Hispanic black population (2.07%), AIAN population on reservations (4.88%), and Hispanic population (1.54%) (30). A statistically significant net overcount (−0.84%) was found for the non-Hispanic white population. Net coverage error for the non-Hispanic Asian (0.08% undercount), AIAN off-reservation (1.95% overcount), and NHOPI (1.34% undercount) populations were not statistically significant from zero (30). The Census Bureau has no plans to use these CCM results to adjust population estimates, nor does it recommend such adjustment (30). Following the Census Bureau’s example, the census-based denominators were not adjusted for net undercount for the four race groups or the total Hispanic population.

Methods

Age-specific and age-adjusted death rates by race and Hispanic origin were estimated as:

$$\text{Age-specific death rate (ASDR)}_i = [D_{i2009} + D_{i2010} + D_{i2011}] / [P_{i2010} \times 3]$$

and

$$\text{Age-adjusted death rate (AADR)} = \sum_i \{([D_{i2009} + D_{i2010} + D_{i2011}] / [P_{i2010} \times 3]) \times W_i\},$$

where D_{yr} are number of deaths in specific age group i and specific year yr , P_{i2010} is population in specific age group i and year 2010, and W_i is the age-specific weight based on the U.S. 2000 standard population (31).

Observed age-specific death rates were corrected with the age-specific classification ratios derived from NLMS, and then age-adjusted death rates were

re-estimated. The correction was limited to age because of the sample size restrictions posed by the study sample (Appendix Table II). Ideally, adjustments of death certificate misclassification that take into account all of the factors that may be correlated with such misclassification, such as nativity and place of residence, would be preferable. Adjustment was done as:

$$\text{ASDR}_i \times \text{CR}_i,$$

where ASDR_i is defined as noted earlier and CR_i is the age-specific classification ratio based on NLMS.

Finally, the observed and corrected death rates for minority populations are compared with those of the majority population to assess how disparities between the groups are affected by race and Hispanic-origin misclassification on death certificates.

Results

Evaluation of Race and Hispanic-origin Reporting on Death Certificates

Table 1 presents the record-level percent agreement and classification ratios for each defined race and Hispanic-origin group for deaths occurring during three periods: 1979–1989, 1990–1998, and 1999–2011. Estimates for the first two periods are from the Arias et al. 2008 study (4). Record-level agreement is close to 100% for both the white and black populations in all three periods. In contrast, record-level agreement for the AIAN population is lower in all three periods. Over the 3 decades, 51%–55% of decedents who self-identified as AIAN on CPS were correctly classified on the death certificate (sensitivity), and 72%–80% of decedents identified as AIAN on the death certificate had self-identified as such on CPS (predictive value positive). The majority of those who self-identified as AIAN but were misclassified on the death certificate were classified as white in all three periods (Figure 1). Record-level agreement measures are better for the API population overall for the 3 decades.

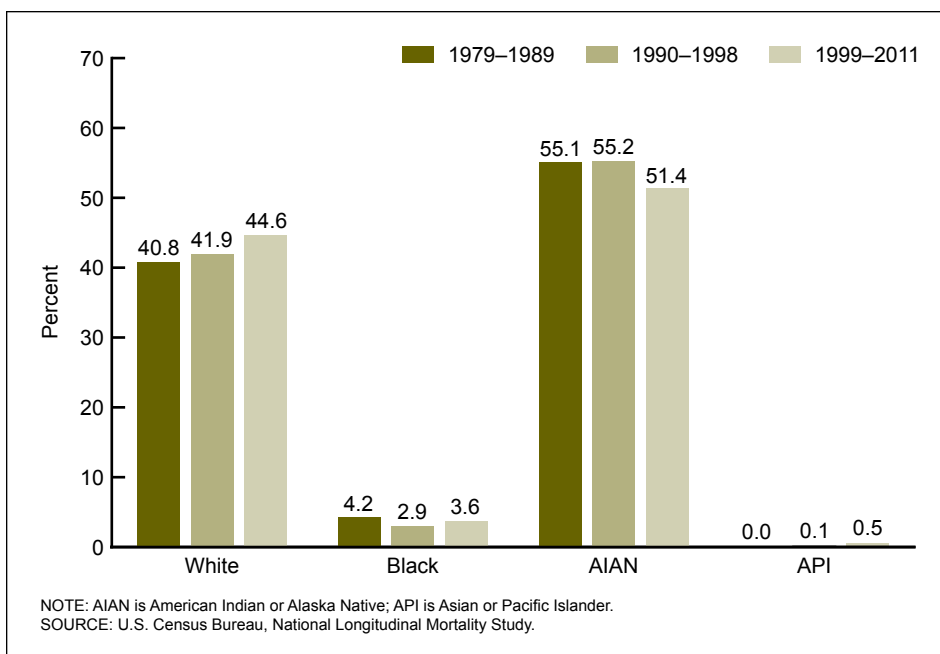


Figure 1. Race classification on death certificate of self-identified American Indian or Alaska Native persons on Current Population Survey: United States, 1979–1989, 1990–1998, and 1999–2011

Sensitivity increased from 84% to 91% and predictive value positive remained greater than 90%.

The classification ratios show nearly perfect agreement between CPS and death certificate counts for the white and black populations in all three periods. The ratios improved significantly for the API population, from 1.07 in 1990–1998 to 1.03 in 1999–2011. In contrast, the classification ratios for the AIAN population continued to show very poor agreement between CPS and death certificate counts—the classification ratios did not vary significantly from 1.45 to 1.40 over the 3 decades.

For the total Hispanic population, agreement between death certificate and survey identification remained at or near 90% across all three periods (Table 1). Sensitivity ranged from 93% to 88%, while predictive value positive ranged from 96% to 91%. The classification ratios improved significantly from 1.05 to 1.03 between 1990–1998 and 1999–2011 for the total Hispanic population.

Among Hispanic subgroups, agreement between death certificate and survey classification counts improved significantly between the first two periods and remained unchanged

between 1990–1998 and 1999–2011 for the Mexican population (1.06) (Table 1). The classification ratios declined for the Cuban (from 1.04 to 1.00) and Puerto Rican (from 1.07 to 1.01) populations between 1990–1998 and 1999–2011, although the changes were not statistically significant. The ratios worsened for the Central and South American (from 1.05 to 1.21) and the Other Hispanic (from 0.99 to 0.86) populations between 1990–1998 and 1999–2011, although the change was significant only for the latter. These two groups were much more likely to be misclassified as a different Hispanic-origin group or as non-Hispanic on the death certificate (Figure 2).

Age and sex

Table 2 presents classification ratios by age and sex for the 1999–2011 period. Among the four main race groups, there is barely any difference by sex. With regard to age, the white and black populations exhibit practically no variation in ratios across the age range. The age-specific classification ratios for the API population are also relatively constant across the age range. Some slight variation over the age range is seen

in the sex- and age-specific classification ratios. In contrast, both the sex-age and age-specific classification ratios of the AIAN population show considerably more variation over the age range.

For the total Hispanic population, males had a classification ratio of 1.04 and females 1.03. Variation across the age and sex-age distributions for the total Hispanic population is relatively stable. The same is the case for the Mexican population. On the other hand, large variation is seen for the Puerto Rican and Cuban populations in the younger age and sex-age groups. Considerable variation also is seen across the entire age range for the Central and South American group. The large differences in the ratios across these sex-age combinations for the various groups are in part a function of small sample sizes (Appendix Table II). Sex-age patterns for the non-Hispanic population by race are consistent with those for the main race groups.

Place of residence

Table 3 presents classification ratios by geographic region and urban-rural status of residence at time of death for all defined race and Hispanic-origin populations. For both the white and black populations, there is practically no misclassification or variability by either region or rural-urban status. In contrast, as hypothesized, considerable variability is seen across the categories of these geographic characteristics for the AIAN and API populations. In most cases, the variability in the quality of reporting is a direct result of the geographic distribution of these populations. For example, the ratio is perfect (1.00) and significantly different for the API population in the West than in the other three regions (around 1.08), consistent with this population's overwhelming concentration in the Western region of the United States.

Coethnic concentration

Table 3 presents classification ratios by coethnic geographic concentration for the AIAN and Hispanic populations. As described previously, this measure is a dichotomous indicator of whether

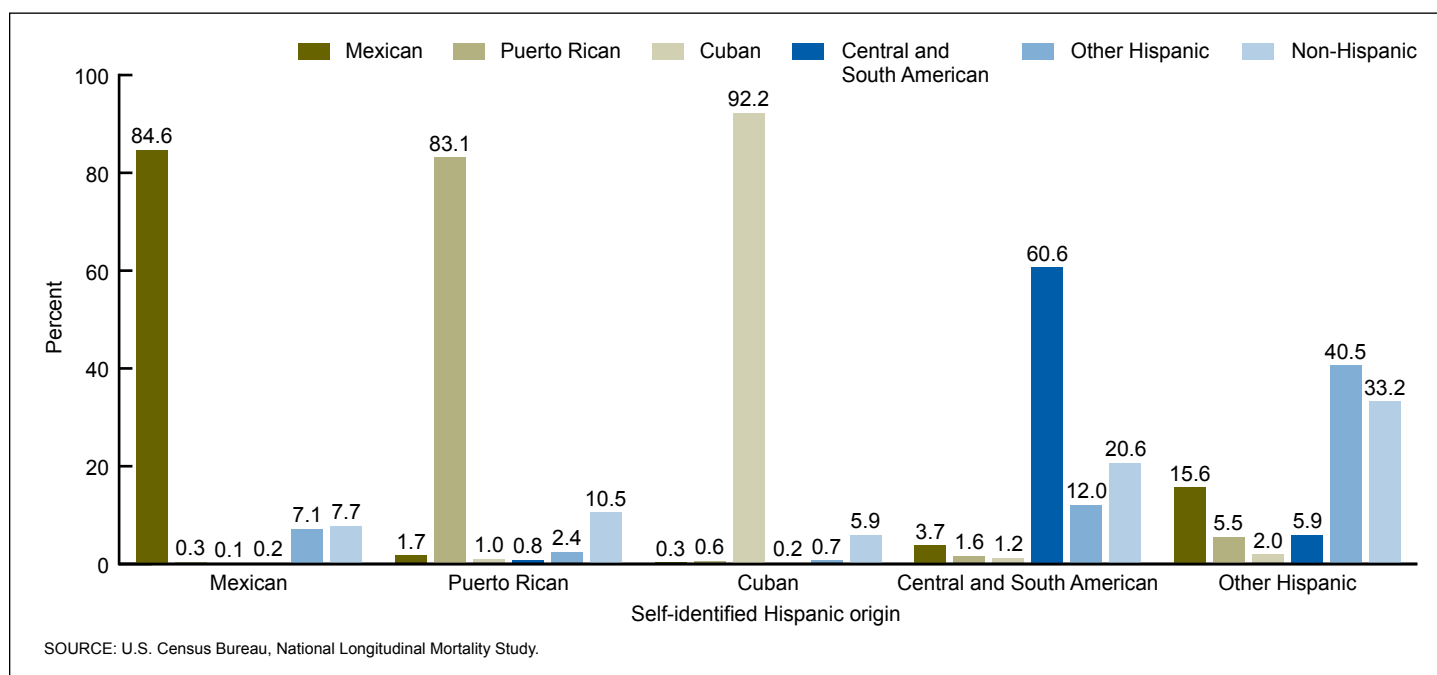


Figure 2. Hispanic-origin classification on death certificate of self-identified Hispanic persons on Current Population Survey: United States, 1999–2011

a person died in a county where a substantial number of coethnic deaths took place ([Appendix Table III](#)). These results show how geographic place of death affects death certificate race and Hispanic-origin misclassification for some populations. For the AIAN population, the ratios of CPS to death certificate counts vary significantly, from a low of 1.17 in areas of high coethnic concentration to a high of 1.79 in areas with low coethnic concentration. For the total Hispanic population, coethnic concentration also has an important effect, with a classification ratio of 1.01 in areas of high concentration—significantly different from a ratio of 1.06 outside these areas. The coethnic ratios were significantly different across domains for the Mexican (1.01 compared with 1.12) and Central and South American (1.11 compared with 1.34) populations. They were similar across domains for the Cuban (0.98 compared with 1.04) and Puerto Rican (0.99 compared with 1.03) populations.

Nativity

[Table 3](#) also presents classification ratios by nativity. For the white population, there is a very small but

statistically significant difference by nativity: 1.00 for the U.S. born compared with 0.99 for the foreign born. A significant difference is noted for the black population (1.01 compared with 1.06), but no significant differences by nativity are seen for the AIAN or API populations.

Among the Hispanic population, nativity has a significant effect on death certificate classification. As expected, the foreign born are more likely to be correctly classified on the death certificate, with a classification ratio of 1.01 compared with 1.05 for the U.S. born. The differences are significant for the Mexican, Central and South American, and Other Hispanic populations. The better reporting among the foreign born is not surprising because inquiring about the decedent's place of birth increases the probability that the funeral director will correctly assign specific Hispanic origin.

In summary, race classification on the death certificate for the white and black populations continued to be highly accurate. Reporting improved significantly over time for the API, total Hispanic, and some Hispanic subgroup populations, although classification became worse for the Central and South

American and Other Hispanic subgroups across the latter two periods, 1990–1998 and 1999–2011. Classification on the death certificate remained very poor for the AIAN population. Although the standard of comparison used in this study is census and survey self-report, it is important to note that this standard is not without error. For the AIAN population in particular, self-report is affected by significant variation over time and place in how people self-identify (32,33).

The results of the bivariate analyses support the hypothesis that there are some decedent characteristics that play an important role in whether the death certificate classification agrees with self-report, as previously reported by Arias et al. (4). Among the Hispanic population, nativity had an important effect on Hispanic-origin classification on the death certificate. Similarly, among the AIAN, API, and Hispanic populations, place of residence also had an important effect. Residence in areas where coethnics were numerous had a positive effect on the quality of race and Hispanic-origin classification on the death certificate.

Death Certificate Misclassification Effects on Mortality Estimates

The effects of death certificate race and ethnicity misclassification on observed death rates are explored in this section. Tables 4 and 5 present age-specific and age-adjusted death rates and death rate ratios by race and Hispanic origin uncorrected and corrected for death certificate misclassification, using the age-specific classification ratios discussed earlier.

Correction for death certificate misclassification makes a large difference to both age-specific and age-adjusted death rates for the AIAN population. The age-adjusted death rate for the AIAN population climbs from 84% to 116% of that of the white population (Table 4). It is possible that overall mortality for the AIAN population is even greater than the adjustment suggests. The AIAN death rates, even after correction, are extremely low for the older age groups. The corrected ratio to the white death rate drops from 1.45 for age group 65–74, to 1.04 for age group 75–84, and further to 0.86 for age group 85 and over. Table 4 presents uncorrected and corrected ratios of AIAN to white age-specific death rates, showing the rapid and steep decline in the ratios over the age range. The drop in the AIAN age-specific death rates could be a function of age misreporting, which has been shown to disproportionately affect and bias downward mortality at the oldest ages (34). It could also be a result of changes in self-identification over time, as noted earlier. Several studies have documented that the growth in the AIAN population over the past several decades has not been solely a function of true demographic change (births, deaths, and migration), but a result of increases in the number of persons who self-identify as AIAN (32,33). It may also reflect the much higher mortality at younger ages for the AIAN population, which results in only the hardest surviving to the oldest ages (35).

Adjustment has little effect on both age-specific and age-adjusted death rates for the API population. The age-adjusted death rate for this group changes

minimally from 57% to 59% of the rate of the white population. The ratios of API to white age-specific death rates do not decline with age but rather present a U-shaped distribution that remains well below 1.00 throughout the entire age range.

With respect to the Hispanic population, two findings emerge (Table 5). As Arias et al. (4) found, overall mortality, as measured by the age-adjusted death rate, remained significantly lower than that of the non-Hispanic white population after correction for death certificate misclassification. The age-adjusted death rate for the total Hispanic population increased from 74% to 76% of that of the non-Hispanic white population after correction. The age-adjusted death rate for Hispanic subgroups also remained lower than the rate for the non-Hispanic white population after correction for death certificate misclassification. The rate ratio increased from 0.76 to 0.81 for the Mexican population, from 0.89 to 0.90 for the Puerto Rican population, from 0.78 to 0.79 for the Cuban population, and from 0.51 to 0.62 for the Central and South American population. The ratio declined from 0.70 to 0.60 for the Other Hispanic population. The two groups most affected by the correction for misclassification were the Central and South American and Other Hispanic populations.

Second, the Hispanic mortality advantage has a U-shaped pattern and is highest between ages 25 and 54; however, the advantage at the oldest ages, where death rates are highest, is greater than at the youngest ages, as shown in the Hispanic to non-Hispanic white age-specific death rate ratios (Figure 3). Among the specific subgroups, this pattern is also observed in the Mexican population. Although the age pattern in the Central and South American population is somewhat different, the mortality advantage for this group as well is higher at the oldest ages than at the youngest. The older age advantage could be a reflection of the salmon bias (return migration) effect or age misreporting, but neither of these possibilities was investigated (32,36). These exercises are

beyond the focus of this study.

Summary and Conclusions

The updated evaluation study described in this report produced several important findings. Most notable is that classification of race and ethnicity on death certificates improved significantly over time for the API and Hispanic populations, including several Hispanic subgroups. The quality of racial and ethnic reporting on death certificates for these two populations is now almost as good as that of the white and black populations, for which reporting has been found to be excellent since the 1960s. Unfortunately, other notable findings of this study are that the quality of reporting for the AIAN population remains poor, with a classification ratio of 1.40, and that the quality of reporting declined for two Hispanic subgroups.

This study also confirms the Arias et al. (4) findings that select decedent characteristics—such as nativity, and the racial and ethnic composition of place of residence at death—have important effects on the quality of death certificate race and ethnicity classification for populations that contain significant numbers of foreign-born or coethnic members. If the country of birth is foreign, then the likelihood of being correctly classified increases, because funeral directors need to complete the place-of-birth item on the death certificate. Similarly, in areas with high numbers of persons of a particular race or Hispanic origin, the likelihood of correct classification increases as a function of increased familiarity with the particular population by funeral directors, or the increased probability that funeral directors will be of the same racial or ethnic background in these communities.

This study also shows that correction for death certificate misclassification has different effects on mortality estimates for the various racial and ethnic populations studied. The effect of death certificate misclassification on mortality estimates for the AIAN population was substantial. As reported by Arias et al.

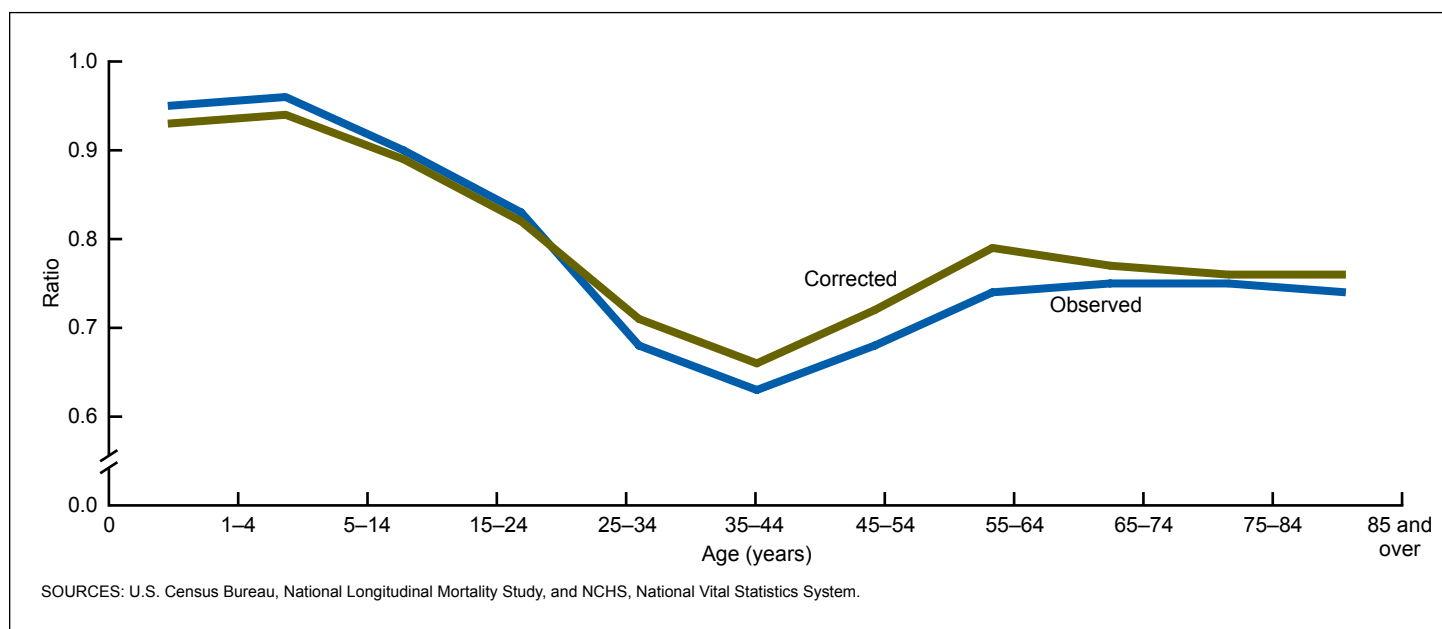


Figure 3. Ratio of Hispanic to non-Hispanic white death rate, uncorrected and corrected for death certificate misclassification, by age group: United States, 2009–2011

(4), correction changed a relatively large AIAN-to-white mortality advantage to a relatively large disadvantage. However, the effect of correction was minimal for the API and Hispanic populations, both of which maintained a rather large mortality advantage compared with the majority population.

This study provides the most up-to-date status of the quality and validity of race and Hispanic-origin reporting on U.S. death certificates. As a result, it is possible to produce mortality estimates for numerous race and Hispanic-origin populations with confidence. In addition, the information generated by this study can be used to correct relatively minor errors in reporting for some groups. The study also confirms that much work needs to be done to improve reporting for the AIAN population, or that alternative data sources, such as linked data systems, will be needed to produce valid and reliable mortality estimates for this population. NCHS, in collaboration with the Census Bureau, is undertaking a project that will link all persons who self-identified as AIAN in the 2010 decennial census with NVSS mortality data to both estimate mortality measures for the 2010 census cohort and develop adjustment factors that can be used to correct future NVSS mortality data.

Notwithstanding the positive nature of this study and its findings, it has important limitations. First, CPS data pertain only to the noninstitutionalized U.S. population. Second, the effects of age misreporting were not addressed, which may be a factor in the findings regarding the AIAN and Hispanic populations. Third, the effects of changes over time in how persons self-report race and ethnicity were not explored. This limitation is of particular importance for the AIAN population. Finally, the study addresses issues that pertain to the 1977 OMB directive regarding race. Full implementation of OMB's 1997 revision, which mandates the collection and recording of multiple race by NVSS, will add a complex challenge to the production of high-quality U.S. race-specific mortality estimates.

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Table 1. Sensitivity, predictive value positive, and classification ratios, by race and Hispanic origin: National Longitudinal Mortality Study, for deaths occurring in 1979–1989, 1990–1998, and 1999–2011

Race and Hispanic origin	Sensitivity ¹			Predictive value positive ¹			Classification ratio ¹ of CPS ² to death certificate		
	1979–1989	1990–1998	1999–2011	1979–1989	1990–1998	1999–2011	1979–1989	1990–1998	1999–2011
Race	Percent¹						Ratio¹ (standard error)		
White	99.8	99.8	99.6	99.6	99.5	99.2	1.00 (0.0004)	1.00 (0.0004)	1.00 (0.0003)
Black	98.8	98.1	97.2	98.8	98.9	98.0	1.00 (0.002)	[†] 1.01 (0.002)	1.01 (0.002)
AIAN ³	55.1	55.2	51.4	80.2	71.7	72.1	1.45 (0.096)	1.30 (0.062)	1.40 (0.039)
API ⁴	84.4	89.7	90.8	94.9	95.7	93.2	1.13 (0.029)	1.07 (0.016)	[†] 1.03 (0.008)
Hispanic origin									
Total Hispanic	92.8	88.1	88.4	95.9	92.5	91.3	1.04 (0.010)	1.05 (0.008)	[†] 1.03 (0.005)
Mexican	79.2	86.0	84.6	93.2	91.4	89.9	1.17 (0.021)	[†] 1.06 (0.011)	1.06 (0.007)
Puerto Rican	85.8	79.7	83.5	88.8	85.0	84.6	1.06 (0.047)	1.07 (0.036)	1.01 (0.018)
Cuban	82.1	86.6	92.2	87.0	90.5	92.6	1.05 (0.069)	1.04 (0.026)	1.00 (0.011)
Central and South American	32.3	64.3	60.8	75.9	67.1	73.7	2.35 (0.432)	[†] 1.05 (0.063)	1.21 (0.038)
Other Hispanic	46.7	39.2	40.7	22.3	38.7	35.2	0.50 (0.042)	[†] 0.99 (0.045)	[†] 0.86 (0.027)
Non-Hispanic by race									
Non-Hispanic white	99.6	99.6	99.3	99.1	99.2	99.2	1.00 (0.001)	1.00 (0.001)	1.00 (0.0003)
Non-Hispanic black	98.7	98.4	97.6	98.6	98.9	98.1	1.00 (0.004)	1.01 (0.002)	1.00 (0.002)
Non-Hispanic AIAN ³	57.1	55.9	55.1	86.5	71.3	73.3	1.51 (0.209)	1.28 (0.066)	1.33 (0.038)
Non-Hispanic API ⁴	77.2	89.5	90.5	97.5	95.4	93.5	1.27 (0.077)	[†] 1.07 (0.017)	[†] 1.03 (0.009)

¹ Difference in ratios between the 1979–1989 and 1990–1998 periods and between the 1990–1998 and 1999–2011 periods is significant at the 1% level.

[†] Difference in ratios between the 1979–1989 and 1990–1998 periods and between the 1990–1998 and 1999–2011 periods is significant at the 5% level.

¹Based on weighted data.

²Current Population Survey.

³American Indian or Alaska Native.

⁴Asian or Pacific Islander.

Table 2. Classification ratios, by race and Hispanic origin, sex, and age: National Longitudinal Mortality Study, for deaths occurring in 1999–2011

Race and Hispanic origin and sex	Total	Age group (years)					
		0–24	25–44	45–54	55–64	65–74	75 and over
Race		Ratio¹ (standard error)					
White	1.00 (0.0003)	0.98 (0.007)	0.99 (0.003)	0.99 (0.002)	1.00 (0.001)	0.99 (0.001)	1.00 (0.0003)
Male	1.00 (0.0004)	0.99 (0.008)	0.99 (0.003)	0.99 (0.002)	1.00 (0.001)	0.99 (0.001)	1.00 (0.0005)
Female	1.00 (0.0004)	0.98 (0.014)	0.99 (0.005)	0.99 (0.002)	1.00 (0.002)	0.99 (0.001)	1.00 (0.0004)
Black	1.01 (0.002)	1.04 (0.019)	1.01 (0.007)	1.01 (0.005)	1.00 (0.004)	1.01 (0.004)	1.01 (0.002)
Male	1.01 (0.002)	1.02 (0.018)	1.01 (0.009)	1.01 (0.007)	1.00 (0.006)	1.01 (0.005)	1.01 (0.004)
Female	1.01 (0.002)	1.08 (0.052)	1.01 (0.012)	1.01 (0.006)	1.01 (0.005)	1.01 (0.005)	1.01 (0.003)
AIAN ²	1.40 (0.039)	1.10 (0.125)	1.32 (0.088)	1.52 (0.123)	1.38 (0.095)	1.57 (0.096)	1.32 (0.063)
Male	1.44 (0.056)	1.02 (0.138)	1.37 (0.107)	1.50 (0.171)	1.51 (0.133)	1.47 (0.121)	1.44 (0.107)
Female	1.36 (0.055)	*1.35 (0.255)	1.21 (0.150)	1.54 (0.174)	1.24 (0.136)	1.69 (0.153)	1.24 (0.077)
API ³	1.03 (0.008)	1.12 (0.203)	1.07 (0.057)	1.05 (0.037)	1.03 (0.031)	1.08 (0.023)	1.00 (0.009)
Male	1.04 (0.012)	*1.22 (0.302)	1.04 (0.067)	1.07 (0.052)	1.08 (0.047)	1.08 (0.031)	1.01 (0.013)
Female	1.01 (0.011)	*0.95 (0.214)	1.12 (0.104)	1.01 (0.052)	0.97 (0.039)	1.08 (0.035)	1.00 (0.012)
Hispanic origin							
Total Hispanic	1.03 (0.005)	0.98 (0.045)	1.04 (0.021)	1.06 (0.018)	1.06 (0.013)	1.03 (0.010)	1.02 (0.007)
Male	1.04 (0.007)	0.94 (0.055)	1.06 (0.028)	1.04 (0.021)	1.05 (0.017)	1.05 (0.014)	1.02 (0.010)
Female	1.03 (0.007)	1.08 (0.075)	1.01 (0.031)	1.10 (0.033)	1.07 (0.022)	1.01 (0.015)	1.02 (0.009)
Mexican	1.06 (0.007)	1.01 (0.053)	1.06 (0.029)	1.09 (0.026)	1.11 (0.020)	1.06 (0.015)	1.04 (0.010)
Male	1.08 (0.010)	1.00 (0.060)	1.09 (0.040)	1.09 (0.032)	1.12 (0.026)	1.08 (0.021)	1.05 (0.015)
Female	1.04 (0.010)	1.04 (0.107)	0.99 (0.038)	1.08 (0.043)	1.08 (0.030)	1.04 (0.022)	1.04 (0.014)
Puerto Rican	1.01 (0.018)	*1.43 (0.301)	0.81 (0.069)	1.09 (0.062)	1.01 (0.043)	1.04 (0.040)	1.01 (0.026)
Male	1.01 (0.025)	*1.72 (0.466)	0.78 (0.082)	1.02 (0.071)	1.00 (0.063)	1.11 (0.058)	1.01 (0.036)
Female	1.01 (0.026)	*1.04 (0.330)	0.85 (0.118)	1.23 (0.116)	1.01 (0.054)	0.97 (0.055)	1.02 (0.037)
Cuban	1.00 (0.011)	*0.41 (0.205)	1.14 (0.209)	1.13 (0.083)	0.98 (0.045)	1.01 (0.029)	1.00 (0.012)
Male	0.99 (0.017)	*0.13 (0.118)	*1.30 (0.339)	1.23 (0.142)	0.96 (0.059)	0.99 (0.042)	0.98 (0.017)
Female	1.02 (0.015)	*1.42 (0.509)	*0.98 (0.247)	1.01 (0.068)	1.03 (0.061)	1.03 (0.039)	1.02 (0.017)
Central and South American	1.21 (0.038)	*1.87 (0.630)	1.87 (0.301)	1.22 (0.119)	1.17 (0.101)	1.09 (0.063)	1.21 (0.057)
Male	1.19 (0.051)	*1.13 (0.322)	1.89 (0.398)	1.16 (0.109)	1.22 (0.130)	1.07 (0.083)	1.16 (0.085)
Female	1.24 (0.057)	–	*1.84 (0.455)	1.32 (0.288)	1.11 (0.158)	1.12 (0.097)	1.25 (0.075)
Other Hispanic	0.86 (0.027)	0.60 (0.177)	0.86 (0.115)	0.76 (0.086)	0.87 (0.076)	0.83 (0.065)	0.90 (0.038)
Male	0.84 (0.038)	*0.54 (0.199)	0.80 (0.133)	0.62 (0.095)	0.78 (0.085)	0.85 (0.095)	0.93 (0.060)
Female	0.89 (0.039)	*0.73 (0.352)	0.99 (0.226)	0.97 (0.162)	1.05 (0.153)	0.81 (0.089)	0.88 (0.049)
Non-Hispanic by race							
Non-Hispanic white	1.00 (0.0003)	1.00 (0.010)	1.00 (0.003)	1.00 (0.002)	1.00 (0.001)	1.00 (0.001)	1.00 (0.0003)
Male	1.00 (0.0005)	1.01 (0.011)	1.00 (0.004)	1.00 (0.002)	1.00 (0.002)	1.00 (0.001)	1.00 (0.001)
Female	1.00 (0.0004)	0.97 (0.019)	1.00 (0.005)	1.00 (0.003)	1.00 (0.002)	1.00 (0.001)	1.00 (0.0004)
Non-Hispanic black	1.00 (0.002)	1.02 (0.018)	1.00 (0.006)	1.00 (0.004)	1.00 (0.004)	1.01 (0.003)	1.01 (0.002)
Male	1.00 (0.002)	1.01 (0.017)	1.00 (0.007)	1.00 (0.007)	1.00 (0.006)	1.01 (0.005)	1.01 (0.004)
Female	1.01 (0.002)	1.06 (0.049)	1.00 (0.009)	1.00 (0.005)	1.00 (0.005)	1.01 (0.005)	1.01 (0.003)
Non-Hispanic AIAN ²	1.33 (0.038)	1.02 (0.127)	1.25 (0.079)	1.42 (0.119)	1.28 (0.090)	1.49 (0.091)	1.27 (0.061)
Male	1.34 (0.052)	1.00 (0.146)	1.25 (0.094)	1.37 (0.162)	1.36 (0.125)	1.38 (0.112)	1.36 (0.103)
Female	1.32 (0.054)	*1.07 (0.254)	1.25 (0.145)	1.47 (0.175)	1.21 (0.131)	1.61 (0.148)	1.20 (0.075)
Non-Hispanic API ³	1.03 (0.009)	1.13 (0.213)	1.08 (0.057)	1.07 (0.040)	1.03 (0.028)	1.08 (0.022)	1.01 (0.010)
Male	1.05 (0.013)	*1.22 (0.314)	1.07 (0.068)	1.11 (0.054)	1.07 (0.044)	1.08 (0.030)	1.02 (0.014)
Female	1.02 (0.012)	*0.98 (0.228)	1.10 (0.103)	1.01 (0.059)	0.98 (0.035)	1.09 (0.033)	1.01 (0.013)

* Figure does not meet standards of reliability or precision. Ratio is unreliable because either the unweighted number of Current Population Survey deaths or the unweighted number of death certificate deaths, or both, are based on fewer than 20 deaths.

– Quantity zero.

¹Based on weighted data.

²American Indian or Alaska Native.

³Asian or Pacific Islander.

Table 3. Classification ratios, by race and Hispanic origin, region, urban–rural status, coethnic concentration, and nativity: National Longitudinal Mortality Study, for deaths occurring in 1999–2011

Region, urban–rural status, coethnic concentration, and nativity	Race				Hispanic origin						Non-Hispanic by race			
	White	Black	AIAN ²	API ³	Total	Mexican	Puerto Rican	Cuban	Central and South American	Other Hispanic	White	Black	AIAN ²	API ³
Region	Ratio ¹ (standard error)													
Northeast	1.00 (.001)	1.03 (.006)	2.42 (.448)	1.09 (.036)	1.05 (.016)	1.46 (.309)	0.99 (.019)	1.11 (.044)	1.13 (.059)	1.08 (.109)	1.00 (.001)	1.01 (.005)	2.20 (.426)	1.10 (.035)
Midwest	1.00 (.0004)	1.01 (.003)	1.17 (.067)	1.08 (.048)	1.02 (.026)	1.10 (.035)	1.07 (.078)	0.93 (.131)	1.80 (.378)	0.56 (.092)	1.00 (.0005)	1.01 (.003)	1.12 (.066)	1.07 (.049)
South	1.00 (.0005)	1.00 (.002)	1.50 (.081)	1.08 (.041)	1.04 (.007)	1.02 (.010)	1.06 (.047)	0.99 (.011)	1.21 (.060)	1.31 (.107)	1.00 (.001)	1.00 (.002)	1.42 (.078)	1.11 (.042)
West	0.99 (.001)	1.01 (.007)	1.40 (.056)	1.00 (.008)	1.02 (.008)	1.09 (.011)	1.00 (.077)	0.96 (.071)	1.27 (.083)	0.75 (.027)	1.00 (.001)	1.01 (.007)	1.33 (.053)	1.01 (.008)
Urban–rural status														
Urban	1.00 (.0003)	1.01 (.002)	[†] 1.74 (.089)	1.03 (.009)	[†] 1.03 (.005)	[†] 1.06 (.008)	1.01 (.018)	1.00 (.011)	1.19 (.038)	0.87 (.031)	[†] 1.00 (.0004)	[†] 1.00 (.002)	[†] 1.64 (.088)	1.03 (.009)
Rural	1.00 (.001)	1.01 (.004)	1.17 (.035)	1.01 (.032)	1.07 (.016)	1.11 (.021)	1.16 (.122)	1.37 (.246)	*2.33 (.620)	0.85 (.053)	1.00 (.001)	1.01 (.004)	1.13 (.033)	1.04 (.035)
Coethnic concentration														
Yes	[†] 1.17 (.036)	...	[†] 1.01 (.005)	[†] 1.01 (.008)	0.99 (.020)	0.98 (.009)	[†] 1.11 (.046)	0.87 (.035)	...	...	...	...
No . . . . .	...	...	1.79 (.091)	...	1.06 (.009)	1.12 (.013)	1.03 (.030)	1.04 (.027)	1.34 (.064)	0.86 (.042)	...	...	...	...
Nativity														
U.S. born	[†] 1.00 (.0003)	[†] 1.01 (.002)	1.39 (.039)	1.01 (.015)	[†] 1.05 (.008)	[†] 1.10 (.010)	1.11 (.068)	1.10 (.193)	[†] 2.51 (.458)	[†] 0.82 (.028)	[†] 1.00 (.0003)	1.00 (.002)	1.33 (.038)	1.02 (.015)
Foreign born	0.99 (.002)	1.06 (.024)	*2.35 (.806)	1.04 (.011)	1.01 (.005)	0.99 (.007)	0.98 (.015)	0.99 (.009)	1.14 (.035)	1.08 (.085)	1.01 (.003)	0.99 (.022)	*1.46 (.694)	1.04 (.011)

[†] Difference in ratios across the variable categories is significant at the 1% level.

^{*} Difference in ratios across the variable categories is significant at the 5% level.

* Figure does not meet standards of reliability or precision. Ratio is unreliable because either the unweighted number of Current Population Survey deaths or the unweighted number of death certificate deaths, or both, are based on fewer than 20 deaths.

... Category not applicable. Ratios were not estimated for these racial or ethnic groups.

¹Based on weighted data.

²American Indian or Alaska Native.

³Asian or Pacific Islander.

Table 4. Age-specific and age-adjusted death rates and rate ratios, uncorrected and corrected for death certificate misclassification, by race and age: United States, 2009–2011

Age (years)	Rate (standard error)					Rate ratio			
	As reported on death certificate			With correction for misclassification		AIAN ¹ to white		API ² to white	
	White	AIAN ¹	API ²	AIAN ¹	API ²	Uncorrected	Corrected	Uncorrected	Corrected
0	541.4 (2.5)	471.6 (14.2)	392.8 (7.6)	518.8 (15.6)	440.0 (8.5)	0.87	0.98	0.73	0.83
1–4	24.8 (0.3)	27.5 (1.7)	15.9 (0.8)	30.3 (1.9)	17.8 (0.8)	1.11	1.25	0.64	0.73
5–14	12.5 (0.1)	14.2 (0.8)	9.0 (0.4)	15.6 (0.9)	10.1 (0.4)	1.14	1.27	0.72	0.82
15–24	65.6 (0.3)	82.6 (1.9)	30.1 (0.6)	90.9 (2.1)	33.7 (0.7)	1.26	1.41	0.46	0.52
25–34	100.6 (0.3)	122.1 (2.5)	38.6 (0.7)	161.2 (3.3)	41.3 (0.7)	1.21	1.62	0.38	0.41
35–44	168.4 (0.4)	211.1 (3.5)	68.1 (0.9)	278.6 (4.6)	72.8 (1.0)	1.25	1.67	0.40	0.44
45–54	396.1 (0.6)	412.5 (5.1)	169.9 (1.6)	626.9 (7.7)	178.4 (1.6)	1.04	1.60	0.43	0.45
55–64	825.0 (1.0)	772.4 (8.6)	397.4 (2.8)	1,065.8 (11.9)	409.3 (2.9)	0.94	1.29	0.48	0.50
65–74	1,850.6 (1.8)	1,694.4 (18.6)	970.9 (6.0)	2,660.3 (29.1)	1,048.5 (6.5)	0.92	1.45	0.52	0.57
75–84	4,824.2 (3.7)	3,813.0 (42.6)	2,873.8 (14.5)	5,033.2 (56.2)	2,873.8 (14.5)	0.79	1.04	0.60	0.60
85 and over	14,111.6 (9.8)	9,238.6 (120.4)	9,448.4 (46.2)	12,194.9 (159.0)	9,448.4 (46.2)	0.65	0.86	0.67	0.67
Age adjusted	743.6 (0.3)	621.6 (3.2)	425.2 (1.1)	858.9 (4.4)	435.1 (1.1)	0.84	1.16	0.57	0.59

¹American Indian or Alaska Native.

²Asian or Pacific Islander.

Table 5. Age-specific and age-adjusted death rates and rate ratios, uncorrected and corrected for death certificate misclassification, by Hispanic origin and age: United States, 2009–2011

Age (years)	Non-Hispanic white	Total Hispanic	Hispanic subgroup										
			Mexican	Puerto Rican	Cuban	Central and South American	Other Hispanic						
Rate (standard error)													
0	535.7 (2.9)	507.6 (4.1)	504.4 (4.9)	556.0 (14.4)	372.2 (24.8)	466.9 (12.5)	550.2 (12.9)						
1–4	24.5 (0.3)	23.6 (0.4)	24.1 (0.5)	21.2 (1.4)	11.4 (2.2)	24.7 (1.4)	23.6 (1.3)						
5–14	12.6 (0.1)	11.4 (0.2)	11.5 (0.2)	11.0 (0.7)	8.4 (1.2)	10.8 (0.6)	11.7 (0.6)						
15–24	67.0 (0.3)	55.7 (0.5)	58.4 (0.6)	50.4 (1.4)	39.0 (2.3)	51.3 (1.3)	53.9 (1.3)						
25–34	106.9 (0.4)	72.9 (0.5)	73.1 (0.7)	91.3 (2.1)	57.5 (3.0)	61.8 (1.2)	78.4 (1.8)						
35–44	179.7 (0.5)	114.1 (0.7)	115.2 (0.9)	165.4 (3.0)	89.6 (3.3)	80.0 (1.5)	127.3 (2.4)						
45–54	409.8 (0.7)	278.8 (1.3)	290.1 (1.8)	392.9 (4.9)	257.2 (5.6)	162.5 (2.4)	301.7 (4.0)						
55–64	839.5 (1.0)	625.2 (2.5)	655.1 (3.5)	847.0 (9.0)	621.0 (10.6)	358.4 (4.9)	632.6 (7.3)						
65–74	1,879.8 (1.9)	1,401.6 (5.3)	1,485.6 (7.6)	1,769.2 (17.6)	1,442.2 (17.8)	870.7 (11.0)	1,303.9 (14.3)						
75–84	4,892.6 (3.9)	3,652.4 (11.9)	3,848.8 (17.2)	4,269.3 (39.0)	3,892.9 (34.3)	2,426.2 (27.7)	3,311.0 (30.6)						
85 and over	14,258.9 (10.1)	10,612.0 (36.2)	10,611.2 (51.5)	11,815.2 (118.4)	12,640.9 (103.3)	8,250.0 (96.5)	9,510.8 (89.0)						
Age adjusted	756.8 (0.3)	559.2 (0.9)	578.2 (1.3)	675.1 (3.0)	589.5 (2.9)	385.3 (2.2)	527.4 (2.4)						
Corrected for misclassification													
0	535.7 (2.9)	497.5 (4.0)	509.5 (5.0)	¹ 556.0 (14.4)	¹ 372.2 (24.8)	¹ 466.9 (12.5)	330.1 (7.7)						
1–4	24.5 (0.3)	23.1 (0.4)	24.4 (0.5)	¹ 21.2 (1.4)	¹ 11.4 (2.2)	¹ 24.7 (1.4)	14.1 (0.8)						
5–14	12.6 (0.1)	11.1 (0.2)	11.6 (0.3)	¹ 11.0 (0.7)	¹ 8.4 (1.2)	¹ 10.8 (0.6)	7.0 (0.4)						
15–24	67.0 (0.3)	54.6 (0.4)	58.9 (0.6)	¹ 50.4 (1.4)	¹ 39.0 (2.3)	¹ 51.3 (1.3)	32.4 (0.8)						
25–34	106.9 (0.4)	75.8 (0.6)	77.5 (0.7)	¹ 74.0 (1.7)	¹ 65.5 (3.4)	¹ 115.6 (2.3)	67.4 (1.5)						
35–44	179.7 (0.5)	118.6 (0.8)	122.1 (1.0)	¹ 134.0 (2.4)	¹ 102.2 (3.8)	¹ 149.6 (2.8)	109.5 (2.1)						
45–54	409.8 (0.7)	295.5 (1.4)	316.2 (1.9)	¹ 428.2 (5.4)	¹ 290.7 (6.4)	¹ 198.2 (3.0)	229.3 (3.1)						
55–64	839.5 (1.0)	662.7 (2.7)	727.2 (3.9)	¹ 855.4 (9.0)	¹ 608.6 (10.4)	¹ 419.4 (5.7)	550.4 (6.3)						
65–74	1,879.8 (1.9)	1,443.6 (5.5)	1,574.8 (8.1)	¹ 1,840.0 (18.3)	¹ 1,456.6 (18.0)	¹ 949.1 (12.0)	1,082.2 (11.9)						
75–84	4,892.6 (3.9)	3,725.4 (12.1)	4,002.8 (17.9)	¹ 4,312.0 (39.4)	¹ 3,892.9 (34.3)	¹ 2,935.7 (33.5)	2,979.9 (27.5)						
85 and over	14,258.9 (10.1)	10,824.2 (36.9)	11,035.7 (53.5)	¹ 11,933.4 (119.6)	¹ 12,640.9 (103.3)	¹ 9,982.5 (116.8)	8,559.8 (80.1)						
Age adjusted	756.8 (0.3)	574.8 (0.9)	609.3 (1.4)	¹ 681.6 (3.1)	¹ 597.0 (3.0)	¹ 468.9 (2.6)	454.6 (2.1)						
Rate ratios to non-Hispanic white													
	Hispanic subgroup												
	Total Hispanic corrected		Mexican corrected		Puerto Rican corrected		Cuban corrected		Central and South American corrected		Other Hispanic corrected		
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	
0	...	0.95	0.93	0.94	0.95	1.04	1.04	0.69	0.69	0.87	0.87	1.03	0.62
1–4	...	0.96	0.94	0.98	0.99	0.87	0.87	0.47	0.47	1.01	1.01	0.96	0.58
5–14	...	0.90	0.89	0.92	0.93	0.88	0.88	0.67	0.67	0.86	0.86	0.93	0.56
15–24	...	0.83	0.82	0.87	0.88	0.75	0.75	0.58	0.58	0.77	0.77	0.81	0.48
25–34	...	0.68	0.71	0.68	0.72	0.85	0.69	0.54	0.61	0.58	1.08	0.73	0.63
35–44	...	0.63	0.66	0.64	0.68	0.92	0.75	0.50	0.57	0.45	0.83	0.71	0.61
45–54	...	0.68	0.72	0.71	0.77	0.96	1.04	0.63	0.71	0.40	0.48	0.74	0.56
55–64	...	0.74	0.79	0.78	0.87	1.01	1.02	0.74	0.72	0.43	0.50	0.75	0.66
65–74	...	0.75	0.77	0.79	0.84	0.94	0.98	0.77	0.77	0.46	0.50	0.69	0.58
75–84	...	0.75	0.76	0.79	0.82	0.87	0.88	0.80	0.80	0.50	0.60	0.68	0.61
85 and over	...	0.74	0.76	0.74	0.77	0.83	0.84	0.89	0.89	0.58	0.70	0.67	0.60
Age adjusted	...	0.74	0.76	0.76	0.81	0.89	0.90	0.78	0.79	0.51	0.62	0.70	0.60

... Category not applicable.

¹Not corrected for misclassification because the classification ratios are not reliable.

Appendix. Supporting Tables

Table I. Number of deaths from Current Population Survey and death certificate, by race and Hispanic origin and period: National Longitudinal Mortality Study, for deaths occurring in 1979–1989, 1990–1998, and 1999–2011

Race and Hispanic origin and source of data	Number of deaths ¹		
	1979–1989	1990–1998	1999–2011
Race			
White:			
CPS	52,390	90,065	202,091
Death certificate	52,519	90,272	202,965
Black:			
CPS	5,993	10,010	22,542
Death certificate	5,994	9,941	22,384
AIAN ² :			
CPS	419	754	2,519
Death certificate	332	651	2,049
API ³ :			
CPS	516	1,155	3,903
Death certificate	473	1,120	3,851
Hispanic origin			
Total Hispanic:			
CPS	1,516	5,140	13,487
Death certificate	1,465	4,855	12,894
Mexican:			
CPS	1,018	2,887	7,470
Death certificate	864	2,622	6,778
Puerto Rican:			
CPS	150	527	1,401
Death certificate	144	496	1,378
Cuban:			
CPS	84	532	1,614
Death certificate	80	505	1,591
Central and South American:			
CPS	67	250	994
Death certificate	28	235	804
Other Hispanic:			
CPS	197	944	2,008
Death certificate	349	997	2,343
Non-Hispanic by race			
Non-Hispanic white:			
CPS	12,786	81,797	185,024
Death certificate	12,860	82,146	190,317
Non-Hispanic black:			
CPS	1,960	9,687	22,087
Death certificate	1,960	9,651	22,072
Non-Hispanic AIAN ² :			
CPS	94	663	2,293
Death certificate	77	588	1,973
Non-Hispanic API ³ :			
CPS	100	1,126	3,771
Death certificate	74	1,092	3,680

¹Based on unweighted data.

²American Indian or Alaska Native.

³Asian or Pacific Islander.

NOTE: CPS is Current Population Survey.

Table II. Number of deaths from Current Population Survey and death certificate, by race and Hispanic origin, age, and sex: National Longitudinal Mortality Study, for deaths occurring in 1999–2011

Race and Hispanic origin, sex, and source of data	Total	Age group (years)					
		0–24	25–44	45–54	55–64	65–74	75 and over
Race		Number of deaths					
White:							
CPS.....	202,091	1,228	6,312	12,083	21,162	34,733	126,572
Death certificate.....	202,965	1,251	6,378	12,203	21,289	34,976	126,867
Male:							
CPS.....	98,014	842	3,941	7,286	12,490	19,335	54,119
Death certificate.....	98,498	858	3,980	7,353	12,569	19,465	54,272
Female:							
CPS.....	104,077	386	2,371	4,797	8,672	15,398	72,453
Death certificate.....	104,467	393	2,398	4,850	8,720	15,511	72,595
Black:							
CPS.....	22,542	278	1,515	2,378	3,443	4,564	10,362
Death certificate.....	22,384	269	1,507	2,363	3,434	4,527	10,282
Male:							
CPS.....	10,307	203	823	1,217	1,792	2,264	4,006
Death certificate.....	10,251	199	827	1,212	1,796	2,245	3,970
Female:							
CPS.....	12,235	75	692	1,161	1,651	2,300	6,356
Death certificate.....	12,133	70	680	1,151	1,638	2,282	6,312
AIAN ¹ :							
CPS.....	2,519	70	274	331	440	568	835
Death certificate.....	2,049	63	239	260	364	429	693
Male:							
CPS.....	1,343	52	184	185	238	294	390
Death certificate.....	1,054	47	158	143	181	225	300
Female:							
CPS.....	1,176	18	90	146	202	274	445
Death certificate.....	995	16	81	117	183	204	393
API ² :							
CPS.....	3,903	33	168	267	465	673	2,297
Death certificate.....	3,851	32	169	260	448	639	2,303
Male:							
CPS.....	2,031	19	102	157	262	374	1,117
Death certificate.....	2,003	17	104	152	251	358	1,121
Female:							
CPS.....	1,872	14	66	110	203	299	1,180
Death certificate.....	1,848	15	65	108	197	281	1,182
Hispanic origin							
Total Hispanic:							
CPS.....	13,487	212	863	1,220	1,847	2,630	6,715
Death certificate.....	12,894	203	834	1,152	1,733	2,521	6,451
Male:							
CPS.....	6,997	139	560	742	1,098	1,442	3,016
Death certificate.....	6,682	137	534	716	1,026	1,369	2,900
Female:							
CPS.....	6,490	73	303	478	749	1,188	3,699
Death certificate.....	6,212	66	300	436	707	1,152	3,551
Mexican:							
CPS.....	7,470	141	564	728	1,099	1,491	3,447
Death certificate.....	6,778	135	511	660	960	1,346	3,166
Male:							
CPS.....	4,016	92	383	461	658	838	1,584
Death certificate.....	3,595	88	331	419	561	746	1,450
Female:							
CPS.....	3,454	49	181	267	441	653	1,863
Death certificate.....	3,183	47	180	241	399	600	1,716
Puerto Rican:							
CPS.....	1,401	25	93	165	238	299	581
Death certificate.....	1,378	17	107	149	237	296	572
Male:							
CPS.....	712	17	51	94	133	153	264
Death certificate.....	703	11	62	89	132	144	265
Female:							
CPS.....	689	8	42	71	105	146	317
Death certificate.....	675	6	45	60	105	152	307

See footnotes at end of table.

Table II. Number of deaths from Current Population Survey and death certificate, by race and Hispanic origin, age, and sex: National Longitudinal Mortality Study, for deaths occurring in 1999–2011—Con.

Race and Hispanic origin, sex, and source of data	Total	Age group (years)					
		0–24	25–44	45–54	55–64	65–74	75 and over
Hispanic origin—Con.		Number of deaths					
Cuban:							
CPS.....	1,614	5	24	64	116	286	1,119
Death certificate.....	1,591	8	25	58	111	281	1,108
Male:							
CPS.....	759	2	13	34	73	159	478
Death certificate.....	764	6	13	30	71	158	486
Female:							
CPS.....	855	3	11	30	43	127	641
Death certificate.....	827	2	12	28	40	123	622
Central and South American:							
CPS.....	994	13	69	108	136	221	447
Death certificate.....	804	7	42	89	114	188	364
Male:							
CPS.....	494	8	40	67	82	116	181
Death certificate.....	402	7	24	58	65	101	147
Female:							
CPS.....	500	5	29	41	54	105	266
Death certificate.....	402	0	18	31	49	87	217
Other Hispanic:							
CPS.....	2,008	28	113	155	258	333	1,121
Death certificate.....	2,343	36	149	196	311	410	1,241
Male:							
CPS.....	1,016	20	73	86	152	176	509
Death certificate.....	1,218	25	104	120	197	220	552
Female:							
CPS.....	992	8	40	69	106	157	612
Death certificate.....	1,125	11	45	76	114	190	689
Non-Hispanic by race							
Non-Hispanic white:							
CPS.....	185,024	1,008	5,385	10,706	18,974	31,478	117,472
Death certificate.....	190,317	1,029	5,529	11,069	19,576	32,523	120,590
Male:							
CPS.....	89,227	702	3,340	6,421	11,149	17,468	50,146
Death certificate.....	91,907	709	3,426	6,663	11,548	18,110	51,450
Female:							
CPS.....	95,797	306	2,045	4,285	7,825	14,010	67,326
Death certificate.....	98,410	320	2,103	4,406	8,028	14,413	69,140
Non-Hispanic black:							
CPS.....	22,087	266	1,463	2,314	3,368	4,484	10,191
Death certificate.....	22,072	260	1,478	2,321	3,391	4,475	10,145
Male:							
CPS.....	10,093	195	798	1,184	1,747	2,228	3,940
Death certificate.....	10,103	191	810	1,192	1,772	2,223	3,913
Female:							
CPS.....	11,994	71	665	1,130	1,621	2,256	6,251
Death certificate.....	11,969	69	668	1,129	1,619	2,252	6,232
Non-Hispanic AIAN ¹ :							
CPS.....	2,293	61	254	295	395	518	769
Death certificate.....	1,973	58	231	249	347	416	671
Male:							
CPS.....	1,196	45	170	161	205	261	354
Death certificate.....	1,011	43	153	137	169	218	291
Female:							
CPS.....	1,097	16	84	134	190	257	415
Death certificate.....	962	15	78	112	178	198	380
Non-Hispanic API ² :							
CPS.....	3,771	28	157	256	440	644	2,246
Death certificate.....	3,680	29	155	242	425	603	2,226
Male:							
CPS.....	1,955	16	96	150	244	356	1,093
Death certificate.....	1,909	15	96	143	238	336	1,081
Female:							
CPS.....	1,816	12	61	106	196	288	1,153
Death certificate.....	1,771	14	59	99	187	267	1,145

¹American Indian or Alaska Native.²Asian or Pacific Islander.

NOTE: CPS is Current Population Survey.

Table III. Number of deaths from Current Population Survey and death certificate, by race and Hispanic origin, region, urban–rural status, geographic concentration, and nativity: National Longitudinal Mortality Study, for deaths occurring in 1999–2011

Region, urban–rural status, coethnic concentration, and nativity	Race				Total	Hispanic origin					Non-Hispanic by race			
	White	Black	AIAN ¹	API ²		Mexican	Puerto Rican	Cuban	Central and South American	Other Hispanic	White	Black	AIAN ¹	API ²
Region		Number of deaths												
Northeast:														
CPS	42,189	3,051	108	326	1,696	55	819	218	375	229	40,147	2,895	84	315
Death certificate	42,408	2,964	43	298	1,554	37	820	195	325	177	40,775	2,868	40	289
Midwest:														
CPS	52,779	4,330	628	216	828	577	107	36	44	64	50,510	4,286	595	212
Death certificate	52,898	4,306	578	201	767	499	98	36	25	109	51,953	4,268	560	194
South:														
CPS	64,277	13,489	524	321	5,189	2,910	333	1,254	334	358	57,389	13,292	461	307
Death certificate	64,551	13,467	349	297	4,908	2,828	307	1,248	266	259	59,875	13,314	339	279
West:														
CPS	42,846	1,672	1,259	3,040	5,774	3,928	142	106	241	1,357	36,978	1,614	1,153	2,937
Death certificate	43,108	1,647	1,079	3,055	5,665	3,414	153	112	188	1,798	37,714	1,622	1,034	2,918
Urban–rural status														
Urban:														
CPS	141,378	18,590	932	3,361	11,579	6,269	1,314	1,586	946	1,464	128,186	18,188	797	3,251
Death certificate	142,046	18,478	603	3,294	11,135	5,768	1,297	1,570	789	1,711	131,307	18,198	551	3,157
Rural:														
CPS	60,713	3,952	1,587	542	1,908	1,201	87	28	48	544	56,838	3,899	1,496	520
Death certificate	60,919	3,906	1,446	557	1,759	1,010	81	21	15	632	59,010	3,874	1,422	523
Coethnic concentration														
Yes:														
CPS .....	...	...	1,590	...	6,279	3,424	646	964	481	1,059	...	...	...	...
Death certificate .....	...	...	1,468	...	6,197	3,378	645	971	432	1,235	...	...	...	...
No:														
CPS .....	...	...	929	...	7,208	4,046	755	650	513	949	...	...	...	...
Death certificate .....	...	...	581	...	6,697	3,400	733	620	372	1,108	...	...	...	...
Nativity														
U.S. born:														
CPS	187,700	21,518	2,455	1,909	7,478	5,294	332	63	122	1,667	175,886	21,263	2,255	1,824
Death certificate	188,333	21,431	2,023	1,895	7,028	4,582	303	55	44	2,044	181,071	21,269	1,955	1,787
Foreign born:														
CPS	13,186	719	48	1,968	5,934	2,150	1,045	1,538	866	335	8,033	528	22	1,922
Death certificate	13,408	654	19	1,933	5,815	2,177	1,062	1,534	755	287	8,130	515	13	1,874

... Category not applicable.

¹American Indian or Alaska Native.²Asian or Pacific Islander.

NOTE: CPS is Current Population Survey.

Table IV. County and state of death, by Hispanic-origin subgroup: National Longitudinal Mortality Study, for deaths occurring in 1999–2011

Hispanic subgroup, county, and state	Percent of deaths
Mexican	
Los Angeles, CA	9.5
Bexar, TX	5.5
Fresno, CA	4.3
El Paso, TX	3.2
Harris, TX	2.5
San Bernardino, CA	2.2
Hidalgo, TX	2.2
Maricopa, AZ	2.1
San Diego, CA	2.1
Austin, TX	2.1
Cameron, TX	1.6
Orange, CA	1.6
Cook, IL	1.3
Riverside, CA	1.3
Webb, TX	1.3
Chambers, TX	1.3
Nueces, TX	1.2
Pima, AZ	1.2
Frio, TX	1.1
Ventura, CA	1.0
Santa Clara, CA	1.0
Alameda, CA	0.8
Total	50.4
Remainder of country	49.6
Cuban	
Miami-Dade, FL	62.4
Remainder of country	37.6
Puerto Rican	
Erie, NY	10.5
Bronx, NY	7.8
New York, NY	5.8
Kings, NY	5.4
Miami-Dade, FL	3.2
Queens, NY	2.7
Cook, IL	2.2
Philadelphia, PA	2.2
Orange, FL	1.8
Broward, FL	1.7
Los Angeles, CA	1.3
Hartford, CT	1.3
Camden, NJ	1.2
Essex, NJ	1.2
Hillsborough, FL	1.2
Milwaukee, WI	0.9
Total	50.4
Remainder of country	49.6
Central and South American	
Los Angeles, CA	9.0
Miami-Dade, FL	8.5
Queens, NY	6.9
New York, NY	3.4
Fresno, CA	3.3
Erie, NY	2.9
Kings, NY	2.6
Bronx, NY	2.6
Broward, FL	2.2
Calhoun, FL	1.9
San Francisco, CA	1.4
Hudson, NJ	1.1
Jefferson, LA	1.0
Contra Costa, CA	1.0
Montgomery, MD	1.0
Essex, NJ	0.9
Palm Beach, FL	0.9
Total	50.6
Remainder of country	49.4

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