Socioeconomic Differences in Education Reporting and Their Effect on Estimates of Life Expectancy by Educational Attainment in the U.S.

Brian Rostron
National Center for Health Statistics

Introduction

Disparities in mortality and life expectancy by educational attainment in the United States have attracted considerable attention from researchers and government agencies in recent decades [1]. Accurate estimates of these differences for the U.S. population have been difficult to obtain because death counts and population counts, which provide the numerators and denominators for mortality rates, come from different sources, and the information in these sources may be inaccurate or come from different classification systems. Death counts by education level come from information on the death certificate, but death certificate education information is often inaccurate. Errors in education reporting on the death certificate usually occur when information is reported by a funeral director who may not have accurate information about the education of the deceased. Population counts by education level, on the other hand, come from information reported by individuals in censuses or social surveys about their own education or the education of fellow household members, and this information is considered to be generally accurate. Estimation of mortality measures is made even more difficult because different classification systems, typically categorizing educational attainment by year of education completed or degree completed, can be used on the death certificate and in social surveys, and the categories in one system may not correspond exactly to categories in other systems.

This paper analyzes education reporting on the death certificate by comparing educational attainment reported on the death certificate for decedents to their educational attainment reported in the Current Population Survey (CPS). Data come from participants in the

CPS from 1992 to 1998 who are included in the National Longitudinal Mortality Study (NLMS) and who died by the end of 1998. The paper evaluates education reporting on the death certificate and also examines the effect of the different classification systems used to categorize educational attainment on the death certificate and in social surveys. It also presents results of these analyses for selected race and ethnic origin groups. This is the first time that education reporting on the death certificate has been analyzed separately for some of these groups, such as Asian or Pacific Islander (API) and Hispanic [2].

This paper also uses NLMS data to calculate classification ratios comparing educational attainment reported in the CPS to educational attainment reported on the death certificate. These ratios are then used to produce adjusted estimates of mortality rates and life expectancy for the U.S. population that measure mortality differences by education level more accurately than unadjusted estimates. These classification ratios also allow for the estimation of mortality measures for more specific education levels, such as college graduate, than was possible in previous studies.

Previous Studies

Differences in mortality by educational attainment in the U.S. have been an important research topic for several decades. Kitagawa and Hauser published a landmark cross-sectional study of mortality differentials by measures of socioeconomic status including education in the U.S. in 1960 [3]. They found substantive differences in mortality by education level for both white males and females, with individuals with less education generally having higher levels of

mortality. Researchers subsequently reached this same general conclusion using longitudinal data from sources such as the NLMS [4-6], and found that mortality differentials by educational attainment decreased in size but still existed when controls for other socioeconomic factors such as income, employment, and marital status were included in the analyses [5, 6]. Researchers have also found that mortality differentials by educational attainment vary by sex, race, and ethnic group in the U.S., with differences being greater for males than females and for African-Americans than whites [7]. Studies using U.S. vital statistics data have typically estimated mortality differentials for two or three broad education levels because of concerns about the accuracy of death certificate education information for more specific levels [1, 8, 9]. Some studies using vital statistics data have also restricted analysis to ages 25-64 because of concerns about the accuracy of death certificate education information for people who died at older ages [9].

Because the death certificate is an important source of information about the relationship between education and mortality, researchers have also examined the accuracy of education information on death certificates. Sorlie and Johnson compared death certificate education information for over 10,000 people in the NLMS who died in 1989 to these individuals' education information in the CPS [2]. They found that educational attainment tended to be overreported on the death certificate compared to survey data. In particular, individuals who were identified as not having completed four years of high school in the CPS were often reported as having completed four years of high schools on the death certificate. Two smaller studies found similar results. Shai and Rosenwaike showed that educational attainment was often overreported on the death certificate for older males, based on comparison of death certificate

information from New York State and Utah from 1982 to 1986 and information reported in the American Cancer Society Cancer Prevention Study II (CPS-II) [10]. Makuc, Feldman, and Mussolino also concluded that educational attainment tended to be overreported on the death certificate, in their study of 800 participants in the first National Health and Nutrition Examination Survey (NHANES I) who died between 1989 and 1993 [11].

This paper expands upon previous research on education reporting on the death certificate by analyzing deaths from a longer and more recent period. It also introduces new variables into this analysis, in particular additional race and ethnic origin categories. The paper also shows how education reporting on the death certificate affects mortality measures for the U.S. by estimating life expectancy by education level with and without adjustment for misreporting.

Data and Methods

Evaluation of Education Reporting on Death Certificates

Data

The NLMS was used to analyze education reporting on the death certificate in the U.S. The NLMS is a longitudinal cohort study of mortality administered by the U.S. Census Bureau. It consists of records from participants in the Current Population Survey (CPS) and CPS Annual Demographic Supplements, dating back to 1973, as well as a subset of 1980 Census participants [12]. The U.S. Census Bureau conducts the CPS on a monthly basis as a complex probability sample of the civilian, non-institutionalized population to obtain demographic and economic information about the nation. The surveys, which are conducted by personal and telephone

interview, are administered to 60,000 occupied housing units and have a response rate of close to 96% [13]. CPS records in the NLMS are linked with death certificate information obtained through the National Vital Statistics System (NVSS). The NVSS is the voluntary contractual arrangement between the National Center for Health Statistics (NCHS) and registration areas to collect U.S. birth and death data. NVSS coverage includes over 99% of deaths that occur in the registration areas, which consist of the 50 states, the District of Columbia, New York City, and the U.S. territories [14].

The NLMS currently contains records for 2.3 million individuals from 26 cohorts of survey participants from the years 1973 and 1978-1998. These records are followed for mortality by periodically matching the records to the National Death Index (NDI), which contains death certificate information collected by the NVSS for all decedents in the U.S. since 1979. The NDI is maintained by NCHS. Approximately 250,000 deaths in the NLMS have been identified through linkage with the NDI for deaths from 1979 through the end of 1998 [12].

Death certificate education information in the NLMS was reported using a year-based system. The U.S. Standard Certificate of Death included an item about educational attainment for the first time with the 1989 revision. Some registration areas including Utah, New York State, and Puerto Rico had previously added an education item to their death certificates in the 1970s [10]. The education item from the 1989 revision categorized educational attainment according to years of education completed: 0–12 years of primary and secondary education and 1–4 or 5+ years of college education [15]. Forty-five states and the District of Columbia included the education item on the death certificate in 1989, and in 33 of these areas the

education item on the death certificate was completed for at least 80% of deaths. By 1998, 47 states and D.C. included the item on the death certificate, and 47 of these areas had 80% completion of the item [16].

CPS education information in the NLMS was reported using a year-based or degree-based system. From the CPS's inception in the 1940s until 1992, survey participants were asked to identify the highest grade or year of school that they and each member of their household had attended and whether the grade or year had been completed [17]. Respondents could report 0-8 years of elementary school, 1-4 years of high school, or 1–6+ years at a college or university. Beginning in January 1992, the CPS education item was changed to ask for the highest level of school completed or degree received. Survey participants could report 0–12 years of education without graduating from high school; received a high school diploma or GED; attended some college without receiving a degree; or completed an associate's, bachelor's, master's, or professional or doctorate degree. The revised degree-based education item was tested in the February 1990 CPS [17]. Respondents were asked to report educational attainment in the year-based system as part of the regular survey and in the degree-based system in a follow-up question. In most cases, educational attainment was reported in the two systems at levels that were considered comparable in the CPS, such as four years of high school completed and high school graduate or four years of college completed and bachelor's degree. 11% of individuals, however, had their educational attainment reported in non-comparable categories in the two classification systems, based on analysis of responses using five education levels for each system. The largest number of non-comparable responses, 36%, occurred when individuals had

their educational reported as four years of high school completed in the year-based system and some college education, but no bachelor's degree in the degree-based system.

In this report, comparable levels in the year-based and degree-based classification systems will generally be defined as less than four years of high school completed and less than high school graduate; four years of high school completed and high school graduate; one to three years of college and some college including community college but no bachelor's degree; four years of college and bachelor's degree; and more than four years of college and graduate degree. These comparable levels are consistent with the more detailed comparable levels presented in the CPS report that explained the transition from the year-based classification system to the degree-based classification system in the survey [17].

Response rates for the education item in the CPS have been relatively consistent over time, with educational attainment missing for approximately 2.6% of participants in March 2003 and 2.8% participants in March 2009 [18]. Educational attainment is imputed for CPS participants who do not report this information using a "hot deck" procedure that assigns an education level based on the response in a record with similar demographic characteristics such as age, race, and sex [13].

Selection of NLMS Records for Analysis

Decedents in the NLMS who were included in the CPS between 1992 and 1998 and who were at least 25 years old at the time of survey were identified in mortality follow-up through the

end of 1998. These cohorts were selected for analysis so that decedents had their educational attainment reported in the CPS using a single, consistent classification system. Given that most education is completed by age 25, it was assumed that there was little change in educational attainment between the time of survey and the time of death for these individuals. 12,401 decedents meeting these criteria were identified and 2750 of them lacked death certificate education information. Decedents whose deaths occurred in states in years in which an education item was not included on the death certificate or in which completion of the education item did not reach 80% were then excluded from analysis. Additionally, death certificate education information for two states – Louisiana and New York – was not linked to the NLMS, and decedents from these states were also omitted. Table 1 lists the states by year for which decedents were removed for these reasons. After the removal of these decedents, 10,570 decedents remained and 1199 of them lacked death certificate education information.

Methods

Education reporting on the death certificate was analyzed by comparing education information reported on the death certificate for NLMS decedents to education information reported for these same individuals in the CPS. The analysis was conducted for decedents overall, and for decedents categorized by sex, race, and ethnic origin as reported in the CPS and age at death as calculated from the death certificate. All analyses in this report that used NLMS data were conducted with deaths weighted by the appropriate person weights from the CPS.

Differences in education reporting on the death certificate and in the CPS for NLMS decedents generally occur for one of two reasons. The first and most common reason is that the education information in one source is inaccurate, typically the death certificate. It is generally assumed that education information in the CPS is correct, given that education information for a person reported by that individual or a fellow household member is usually more accurate than information reported on the death certificate by a funeral director, who often has little personal knowledge of the decedent. Funeral directors are supposed to obtain education information from the decedent's next of kin, but sometimes this does not occur or the next of kin does not know this information. The second reason for differences in education reporting in the two sources is that the sources used different classification systems. Death certificate education information for NLMS decedents was classified using a year-based system, whereas CPS education information was classified using a degree-based system. These classification systems have similar categories, but as has been noted, testing in the CPS has shown that in some cases an individual's educational attainment can be accurately reported in the two classification systems in categories that are not considered comparable [17].

Because of the use of different classification systems in the sources, it was not possible in this study to distinctly identify differences in reported educational attainment that were due to misreporting on the death certificate, as opposed to discrepancies caused by classification differences. Data in the results section indicate that misreporting was responsible for a majority of the differences. Even so, only general inferences about education misreporting on the death certificate were made in this report because of the limitations of the data. These inferences were based on the NLMS data as well as findings in previous research on the topic.

NLMS data were also used to calculate classification ratios by education level. These ratios consist of the total number of decedents with a particular education level in the CPS divided by the total number of decedents with the comparable level on the death certificate. The ratios are similar to those produced by Arias et al. for race and ethnic reporting on death certificates [19]. The ratios can be used as adjustment factors to correct for bias in education reporting found in death certificates. The use of the classification ratios as adjustment factors will be described in greater detail in the section on the effect of death certificate education reporting on mortality measures.

Death certificate education information was imputed for NLMS decedents without this information for the calculation of the classification ratios. The classification ratios have death counts by education level from the death certificate as their denominators, so missing death certificate data would have caused the ratios to be centered around a value greater than 1.0. NLMS decedents without death certificate education information generally had lower educational attainment in the CPS than decedents with death certificate education information. For example, 49% of decedents without death certificate education information did not graduate from high school according to the CPS compared to 35% of decedents with death certificate education information. Because of these differences, simply omitting decedents without death certificate education information for the calculation of the classification ratios or assigning them the same education distribution as decedents with death certificate education information would have tended to bias the ratios. Instead, educational attainment for the death certificate was imputed for decedents without death certificate education information based on the decedent's

educational attainment as reported in the CPS. The imputation process assigned decedents without death certificate education information and with a particular CPS education level the same proportional distribution of educational attainment for the death certificate that was observed in the NLMS for decedents with death certificate education information who also had this same CPS education level.

Effect of Death Certificate Education Reporting on Mortality Measures

Data

The classification ratios were used with 2005 mortality and population data to estimate mortality measures by educational attainment for the U.S. Death counts by education level for the U.S. were obtained from death certificate information collected by the NVSS. Deaths were classified by state of occurrence, given that state of occurrence determined which state's death certificate was used to categorize educational attainment. In 2005, states used one of two education items on their death certificates – the year-based item from the 1989 revision of the standard death certificate or a degree-based item from the 2003 revision of the certificate. The degree-based item from the 2003 revision categorized educational attainment according to the highest level or degree of education completed [15], using the same classification system used in the CPS since 1992. In 2005, 31 states used the year-based education item from the 1989 revision of the standard death certificate, and 17 states used the degree-based education item from the 2003 revision. Two states – Georgia and Rhode Island – did not include either education item on their death certificates, and the District of Columbia switched to use of the

2003 education item during the year. For the sake of convenience, states using the education item from the 1989 revision of the standard death certificate in 2005 will be referred to as the "1989 unrevised states" in the remainder of this report and states using the education item from the 2003 revision will be referred to as the "2003 revised states." Overall in 2005, 2.4% of death certificates from the 1989 unrevised states and 1.9% of death certificates from the 2003 revised states were missing education information. All of the 1989 unrevised states and 2003 revised states had at least 80% completion of the education item used on their death certificates [16].

Population counts by education level used to calculate U.S. mortality measures for 2005 came from the CPS's Annual Social and Economic Supplement (formerly the Annual Demographic Supplement), which is conducted each March. This supplement obtains additional demographic information such as marital status, geographic mobility, work status and occupation, and educational attainment. The supplement is administered to approximately 39,000 housing units in addition to the 60,000 units eligible for the basic monthly CPS to obtain more reliable data for certain minority groups [20]. Weighted sample results from the CPS are adjusted to agree with independent estimates of the civilian, non-institutionalized population by age, sex, race, Hispanic origin, and state of residence. Population estimates from the CPS are adjusted to match mid-year resident population totals for reporting states when used by NCHS to calculate mortality rates by education level [9].

Methods

Mortality rates by education level for the U.S. in 2005 were calculated from these death and population counts, with and without adjustment for education misreporting on the death certificate. Because of the different classification systems used on death certificates, mortality rates were calculated separately for the 1989 unrevised and 2003 revised states. This division of states by classification system is customary in vital statistics reports that present mortality measures by educational attainment [9]. For each group of states, death counts by education level from the death certificate were multiplied by the appropriate classification ratio obtained from the NLMS to produce counts adjusted for education misreporting. This adjustment process can be represented for each education level *i* in the following manner:

$$\text{Observed Death Count}_i * \text{Classification Ratio}_i = \text{Adjusted Death Count}_i.$$

These adjusted death counts were then divided by the corresponding population counts by education level from the CPS,

$$\frac{\text{Adjusted Death Count}_i}{\text{Population Count}_i} = \text{Adjusted Mortality Rate}_i,$$

to calculate adjusted mortality rates by education level.

Mortality rates for 2005 were calculated for more specific education levels for the 1989 unrevised states than for the 2003 revised states. The 1989 unrevised states used the same year-based education item on their death certificates that was used on the death certificates of the NLMS decedents. Death counts by education level for the 1989 unrevised states were thus produced with the same classification system used to produce the death counts used as the denominators of the classification ratios. The adjustment process therefore converted death

counts by education level for these states (US) from the year-based system used on their death certificates (DC) to the degree-based system in the following manner:

(Observed Death Count $_i$) (Classification Ratio $_i$) (Adjusted Death Count $_i$)

$$\text{US DC Deaths in Year - Based System } i * \frac{\text{NLMS CPS Deaths in Degree - Based System } i}{\text{NLMS DC Deaths in Year - Based System } i} = \text{US DC Deaths in Degree - Based System } i.$$

The adjusted death counts were then divided by CPS population counts, also categorized using the degree-based system, to calculate adjusted mortality rates by education level. This agreement in classification systems allowed adjusted mortality rates for the 1989 unrevised states to be estimated for five degree levels – less than high school graduate, high school graduate or equivalent, some college but no degree or associate's degree, bachelor's degree, and graduate degree.

This type of consistent agreement between sources did not exist for the 2003 revised states, which used the degree-based education item. Death counts for these states were also adjusted for education misreporting by multiplying them by the appropriate classification ratios:

(Observed Death Count $_i$) (Classification Ratio $_i$) (Inexact Adjusted Death Count $_i$)

$$\text{US DC Deaths in Degree - Based System } i * \frac{\text{NLMS CPS Deaths in Degree - Based System } i}{\text{NLMS DC Deaths in Year - Based System } i} = \text{US DC Deaths in Degree - Based System } i.$$

These adjustments were not exact, however, because the death counts for these states and the death counts in the denominators of the classification ratios were categorized using different classification systems. Adjusted mortality rates for the 2003 revised states were therefore calculated for broader education levels – less than high school graduate, high school graduate, and more than high school graduate. This more general classification system is often used for mortality measures by educational attainment when vital statistics and population data use different classification systems, thus producing inexact estimates of mortality rates [9].

Approximately 2% of deaths in 2005 in both the 1989 unrevised states and 2003 revised states lacked death certificate education information, and these deaths were proportionally allocated to the various education levels for the calculation of mortality rates. It was assumed that the education distribution for U.S. decedents without death certificate education information was the same as the education distribution for U.S. decedents with death certificate education information. This allocation procedure for U.S. deaths differed from the imputation procedure used in the calculation of classification ratios with NLMS data. The procedure for U.S. deaths was used because of the small proportion of deaths without death certificate education information and the absence of additional education information in U.S. mortality records that could be used to infer an education level for the death certificate.

Calculated mortality rates were then used to estimate life expectancy by educational attainment in the U.S. in 2005. Standard life table techniques were used [21], with mortality rates for advanced ages calculated for the open-ended age group of 85+.

Results

Evaluation of Education Reporting on Death Certificates

Results validate concerns about education reporting on the death certificate and illustrate the effects of different classification systems in the data sources. The overall distribution of educational attainment on the death certificate for NLMS decedents is shown by CPS education level in Table 2. Educational attainment is shown using comparable five-level classification

systems for death certificate information, reported in the year-based system, and CPS information, reported in the degree-based system. The table suggests considerable disagreement in education reporting in the two sources. Overall, 28% of decedents had educational attainment reported on the death certificate at a level that did not correspond to their education level in the CPS. Given that 11% of individuals in the February 1990 CPS had their educational attainment classified in non-equivalent categories using the different classification systems, this result suggests that at least 60% of the differences in reported educational attainment for the decedents were due to misreporting on the death certificate. This figure is probably a conservative estimate of the relative effect of misreporting compared to classification differences on differences in reported educational attainment for decedents, given that more differences in reporting with the two classification systems should be expected in the CPS for two main reasons. First, as noted, the single largest source of differences in reported educational attainment with the two classification systems in the CPS occurred when individuals' educational attainment was reported as four years of high school in the year-based system and some college but no degree in the degree-based system [17]. Some of these differences in reporting are probably due to individuals having completed college-level coursework at community colleges or as part of job training, even if they have never been enrolled full-time at a college or university for at least a year, and these types of education programs have become more common over time [17]. Second, individuals participating in the CPS were probably more likely to make subtle distinctions in reporting educational attainment than are funeral directions when completing the death certificate. The second largest source of disagreement in education reporting with the two classification systems in the CPS occurred when individuals were reported to have completed five or more years of college in the year-based system and received a bachelor's degree in the

degree-based system [17]. Some of these differences in reporting probably occurred because individuals accurately reported in the CPS that they or members of their household took longer than the customary four years of college to complete a bachelor's degree. Funeral directors may be more likely to report that a decedent with a bachelor's degree completed four years of college and not ask the next of kin about the actual length of the decedent's college studies.

The correspondence between death certificate and CPS education reporting seen here is consistent with the results found by Sorlie and Johnson for deaths of NLMS participants that occurred in 1989 [2]. A slight increase in correspondence at most education levels is found for these deaths from the 1992-1998 NLMS cohorts compared to the 1989 NLMS deaths, suggesting some improvement over time in education reporting on the death certificate.

The results also indicate important differences in education reporting for particular education levels. For example, 19% of decedents with less than a high school education in the CPS were identified on the death certificate as having completed four years of high school. This result is consistent with findings in previous studies, which found that people not completing four years of high school were often misreported as having completed four years of high on the death certificate [2, 10, 11]. In addition, 28% of decedents with some college education but no bachelor's degree in the CPS were identified as having four years of high school completed as their educational attainment on the death certificate. Much of this particular difference in reporting is due to the use of different classification systems. Testing in the February 1990 CPS showed that 18% of individuals reported as having some college education but no bachelor's

degree with the degree-based item were also reported as having four years of high school completed as their educational attainment with the year-based item [17].

Sex and Age

Results assessing education reporting on the death certificate are also presented by key demographic characteristics. The distribution of educational attainment on the death certificate is shown by sex in Table 3, and Table 4 presents classification ratios by sex. The ratios again suggest that the less than high school graduate level is underrepresented and the high school graduate level overrepresented on the death certificate compared to CPS data. The ratios also suggest that the bachelor's degree level is overrepresented on the death certificate compared to CPS data, particularly for females. One reason for this result, as shown in Table 3, is that 22% of females with a graduate degree in the CPS were reported on the death certificate as having completed four years of college.

Table 5 presents the education distribution on the death certificate by age at death. The same patterns in agreement and disagreement between death certificate and CPS information seen in the overall data are generally observed for each of the three age groups. Educational attainment, however, is generally much higher at younger ages, with 20% of decedents aged 25-44 having less than a high school education in the CPS compared to 46% of decedents aged 65 and over (data not shown).

Race and Hispanic Origin

Tables 6 and 7 identify differences in education reporting on the death certificate for race and Hispanic origin groups, and these differences are especially noticeable at the high school graduate level. Educational attainment from the death certificate and the CPS are classified using comparable three-level classification systems because of the small numbers of deaths for education levels such as bachelor's degree and graduate degree for some race and ethnic origin groups. Table 6 shows that blacks reported as high school graduates in the CPS were more likely to have their educational attainment reported as less than four years of high school completed on the death certificate (16%) than whites high school graduates (10%). The table also indicates that 22% of Asian or Pacific Islander high school graduates had their educational attainment reported as more than four years of high school completed on the death certificate, compared to 10% of whites. Table 7 shows that Hispanic high school graduates were more likely to have their education reported as less than four years of high school completed on the death certificate (14%) than non-Hispanic high school graduates (10%).

Effect of Death Certificate Education Reporting on Mortality Measures

The classification ratios shown in Table 4 were used to adjust death counts for education misreporting on the death certificate to improve mortality estimates. Tables 8 and 9 and Figures 1 and 2 present estimates of life expectancy at selected ages calculated from unadjusted and adjusted death counts for the U.S. in 2005. Estimates are given using a five-level classification system for the 1989 unrevised states, which used the year-based education item, and a three-level classification system for the 2003 revised states, which used the degree-based item.

As indicated in Tables 8 and 9, estimates of U.S. life expectancy by education level calculated from adjusted data are more consistent and plausible than estimates from unadjusted data. The effect of adjustment is most apparent at the less than high school graduate and high school graduate levels, given that unadjusted estimates of life expectancy for individuals without a high school education are close to or higher than estimates of life expectancy for high school graduates at some ages. This pattern is particularly noticeable at older ages. This result is not found with adjusted data, nor has it been found in previous studies that used CPS education data to estimate life expectancy by educational level [4, 7]. Higher unadjusted values of life expectancy for individuals who are not high school graduates compared to high school graduates are generally caused by education misreporting on the death certificate. As suggested by Table 2, individuals with less than a high school education in survey data are often reported as high school graduates on the death certificate, and this misreporting tends to increase unadjusted life expectancy for people who are not high school graduates and decrease life expectancy for people who are high school graduates. Adjustment of death counts, however, corrects for misreporting on the death certificate and produces estimates of life expectancy that generally increase with greater educational attainment. Adjusted estimates consistently increase with greater educational attainment in both groups of states, indicating that adjustment for the 2003 revised states, although inexact due to classification differences, improves estimates by generally correcting for misreporting on the death certificate. Overall, adjusted life expectancy at age 25 in the U.S. in 2005 varied by education level by 10 to 12 years for females and 11 to 16 years for males.

Summary and Conclusion

This report has examined the reporting and classification of education information on the death certificate in the U.S. and found that educational attainment appears to be often misreported for decedents. By one measure, 28% of decedents had their educational attainment reported on the death certificate at a level that did not correspond to their educational attainment in survey data. These findings validate concerns about the general validity of mortality measures by education level from unadjusted death certificate data [9]. This report has also shown, however, that classification ratios obtained from the NLMS can be used to adjust for education misreporting and improve mortality estimates by education level.

Results presented here have also identified specific patterns of education misreporting on the death certificate in the U.S. that affect mortality estimates. This report supports the finding that it is common for individuals who did not complete high school to have their educational attainment reported on the death certificate at the high school graduate level. This result tends to validate a specific concern about U.S. mortality estimates calculated from death certificate data. NCHS typically publishes U.S. mortality rates by education level for ages 25-64 because of concerns about the accuracy of death certificate education information at older ages [9]. Given that the age group 65 and over in the U.S. has a higher proportion of people with less than a high school education than younger age groups, these results indicate that rates obtained from unadjusted mortality data for those 65 and over are particularly unreliable. This report has shown, however, that classification ratios can adjust for education misreporting at older ages, thus allowing the estimation of mortality measures for advanced ages.

This report has also examined patterns in education reporting and classification on the death certificate in the U.S. for race and ethnic origin groups. The classification systems used in the sources did not correspond exactly, but black and Hispanic high school graduates in the CPS appeared to be more likely than white or non-Hispanic high school graduates to have their educational attainment underreported on the death certificate. Asian or Pacific Islander high school graduates in the CPS also appeared to be more likely than white high school graduates to have their educational attainment overreported on the death certificate. Additional research is needed to verify these trends and to produce mortality rates and life tables by educational attainment for specific race and ethnic origin groups.

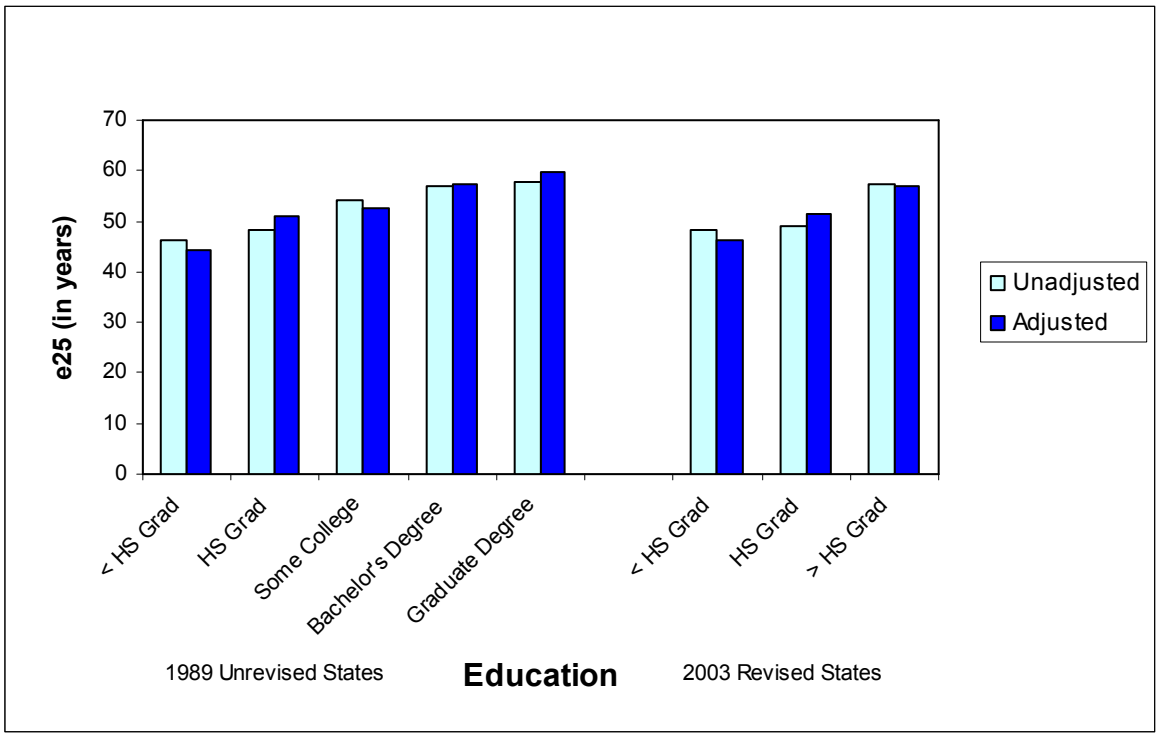
This report has also found the general pattern of mortality differentials by educational attainment observed previously, namely that life expectancy in the U.S. consistently increases with greater education and that differences in life expectancy by education level are greater for men than women. The range of values for U.S. life expectancy by education level found in this report is consistent with previously published results from death certificate data [1, 8], although the adjustment process used here to correct for education misreporting has increased the accuracy of results for particular education levels and allowed for the estimation of mortality measures for more specific education levels.

This report has also illustrated the complications introduced by the use of different classification systems for educational attainment in the data sources. The use of a year-based item on the 1989 revision of the standard death certificate, as opposed to the degree-based item on the 2003 revision and in the CPS, has made the evaluation of education reporting on the death

certificate and estimation of mortality measures for the 2003 revised states inexact. This situation should improve when data collected with the degree-based item of the 2003 revision are available in sufficient quantity to allow for the evaluation of education reporting on the death certificate and the calculation of classification ratios using data collected with a single classification system.

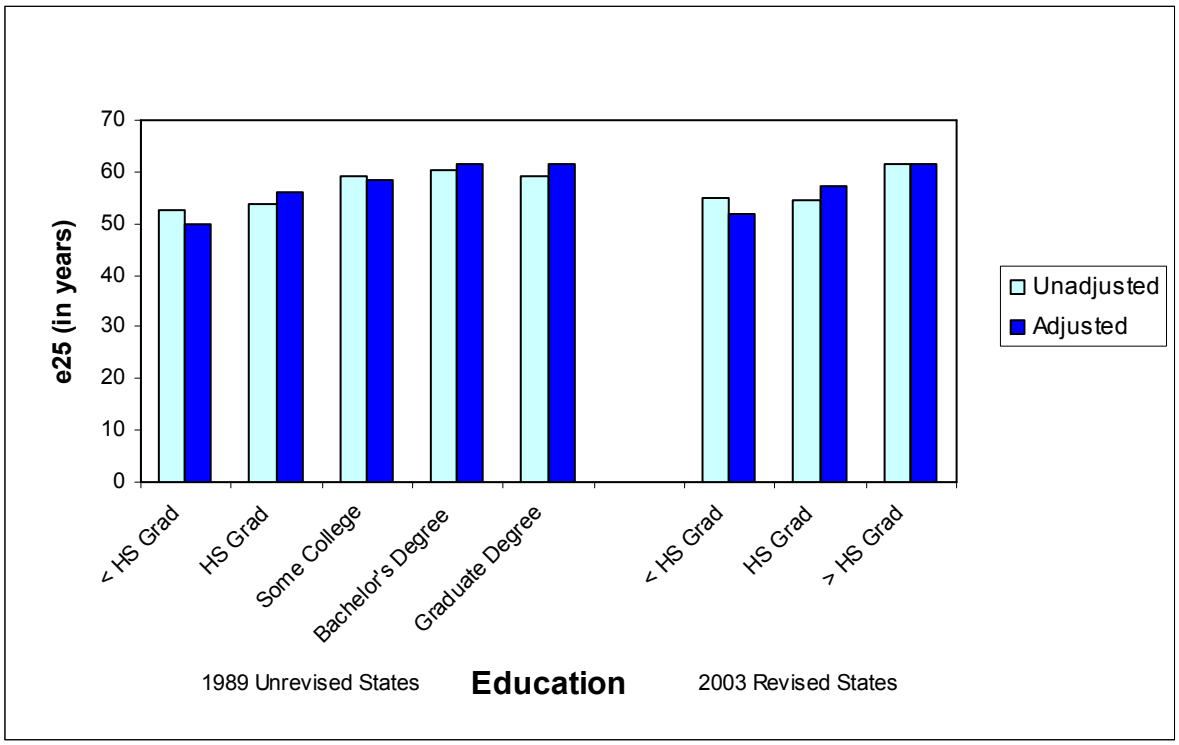
Finally, this analysis has other limitations that should be noted. Most notably, the classification ratios used to adjust for education misreporting on U.S. death certificates in 2005 were obtained using data from 1992 to 1998. Education reporting on the death certificate changes over time, so the classification ratios may not correct exactly for misreporting in more recent years. The classification ratios were also calculated from data that omitted decedents from certain states, and it is not known what effect, if any, these omissions had on the results.

Figure 1. Unadjusted and adjusted life expectancy at age 25 by educational attainment: U.S. males, 2005



Sources: National Longitudinal Mortality Study, National Vital Statistics System, and U.S. Census Bureau

Figure 2. Unadjusted and adjusted life expectancy at age 25 by educational attainment: U.S. females, 2005



Sources: National Longitudinal Mortality Study, National Vital Statistics System, and U.S. Census Bureau

References

1. Meara, E.R., S. Richards, and D.M. Cutler, *The Gap Gets Bigger: Changes in Mortality and Life Expectancy, by Education, 1981-2000.* Health Affairs, 2008. **27**(2): p. 350-360.
2. Sorlie, P.D. and N.J. Johnson, *Validity of Education Information on the Death Certificate.* Epidemiology, 1996. **7**(4): p. 437-439.
3. Kitagawa, E.M. and P.M. Hauser, *Differential Mortality in the United States: A Study in Socioeconomic Epidemiology*. 1973, Cambridge, MA: Harvard University Press.
4. Rogot, E., P.D. Sorlie, and N.J. Johnson, *Life Expectancy by Employment Status, Income, and Education in the National Longitudinal Mortality Study.* Public Health Reports, 1992. **107**(4): p. 457-461.
5. Preston, S.H. and I.T. Elo, *Are Educational Differentials in Adult Mortality Increasing in the United States?* Journal of Aging and Health, 1995. **7**(4): p. 476-496.
6. Elo, I.T. and S.H. Preston, *Educational Differentials in Mortality: United States, 1979-85.* Social Science and Medicine, 1996. **42**(1): p. 47-57.
7. Lin, C.C., et al., *A Further Study of Life Expectancy by Socioeconomic Factors in the National Longitudinal Mortality Study.* Ethnicity and Disease, 2003. **13**(Spring): p. 240-247.
8. Molla, M.T., J.H. Madans, and D.K. Wagener, *Differentials in Adult Mortality and Activity Limitation by Years of Education in the United States at the End of the 1990s.* Population and Development Review, 2004. **30**(4): p. 625-646.
9. Kung, H.-C., et al., *Deaths: Final Data for 2005*. 2008, National Center for Health Statistics: Hyattsville, MD.
10. Shai, D. and I. Rosenwaike, *Errors in Reporting Education on the Death Certificate: Some Findings for Older Male Decedents from New York State and Utah.* American Journal of Epidemiology, 1989. **130**(1): p. 188-192.
11. Makuc, D.M., J.J. Feldman, and M.E. Mussolino. *Validity of Education and Age as Reported on Death Certificates*. in *1996 Proceedings of the Social Statistics Section*. 1997: American Statistical Association.
12. U.S. Census Bureau. *NLMS Project Description*. 2009; Available from: http://www.census.gov/nlms/projectDescription.html.
13. U.S. Bureau of Labor Statistics and U.S. Census Bureau, *The Current Population Survey: Design and Methodology.* 2002: Washington, DC.
14. National Center for Health Statistics, *Vital Statistics of the United States: Mortality, 1999, Technical Appendix*. 2004: Hyattsville, MD.
15. National Center for Health Statistics. *U.S. Standard Death Certificate*. 2003; Available from: http://www.cdc.gov/nchs/nvss/mortality_methods.htm.
16. National Center for Health Statistics, *Mortality Multiple Cause of Death File*. 2008: Hyattsville, Md.
17. Kominski, R. and A. Adams, *Educational Attainment in the United States: March 1993 and 1992*. Current Population Reports, P20-476. 1994: US Census Bureau.
18. U.S. Bureau of Labor Statistics and U.S. Census Bureau, *Current Population Survey Annual Social and Economic Survey Data File*. 2003-2009: Washington, D.C.
19. Arias, E., et al., *The Validity of Race and Hispanic Origin Reporting on the Death Certificates in the United States.* Vital and Health Statistics, 2008. **2**(148).

20. U.S. Census Bureau. *Source and Accuracy of the Data for the March 2005 Current Population Survey Microdata File*. 2005; Available from: http://www.census.gov/apsd/techdoc/cps/cpsmar05.pdf.
21. Preston, S.H., P. Heuveline, and M. Guillot, *Demography*. 2001, Malden, MA: Blackwell.

Table 1. Education reporting on the death certificate by state, 1992-1998

Year	States without Education Item on the Death Certificate	States with Less than 80% Completion of Education Item on the Death Certificate	States with Death Certificate Education Information Not Linked to NLMS
1992	Georgia, Oklahoma, Rhode Island, South Dakota	Connecticut, Kentucky, New York, West Virginia	Louisiana, New York
1993	Georgia, Oklahoma, Rhode Island, South Dakota	Kentucky, New York, West Virginia	Louisiana, New York
1994	Georgia, Oklahoma, Rhode Island, South Dakota	Kentucky	Louisiana, New York
1995	Georgia, Oklahoma, Rhode Island, South Dakota	Kentucky	Louisiana, New York
1996	Georgia, Oklahoma, Rhode Island, South Dakota	Kentucky	Louisiana, New York
1997	Georgia, Rhode Island, South Dakota	Kentucky	Louisiana, New York
1998	Georgia, Rhode Island, South Dakota	Kentucky	Louisiana, New York

Sources: National Vital Statistics System and National Longitudinal Mortality Survey (NLMS)

Table 2. Education distribution on the death certificate by Current Population Survey (CPS) education level: National Longitudinal Mortality Study (NLMS) deaths from 1992-1998 cohorts

CPS Education Level	Death Certificate Education Level						Total	
	% HS 0-3 Years	% HS 4 Years	% College 1-3 Years	% College 4 Years	% College 5+ Years	% Unknown	% of Weighted Deaths by CPS Education Level	# of Deaths by CPS Education Level
Less than HS Grad	66	19	1	0	0	13	41	4389
High School Grad	10	69	9	1	0	10	32	3349
Some College	3	28	49	9	2	10	15	1611
Bachelor's Degree	1	5	11	60	14	9	8	792
Graduate Degree	1	2	2	16	70	9	4	429
% of Total Weighted Deaths by Death Certificate Education	31	35	12	7	4	11	100	10570

Table 3. Education distribution on the death certificate by Current Population Survey (CPS) education level and sex: National Longitudinal Mortality Study (NLMS) Deaths from 1992-1998 cohorts

CPS Education Level	Death Certificate Education Level											
	Female						Male					
	% HS 0-3 Years	% HS 4 Years	% College 1-3 Years	% College 4 Years	% College 5+ Years	% Unknown	% HS 0-3 Years	% HS 4 Years	% College 1-3 Years	% College 4 Years	% College 5+ Years	% Unknown
Less than HS Grad	63	21	1	0	0	14	69	18	1	0	0	12
HS Grad	10	70	8	1	0	11	11	68	10	1	0	10
Some College	3	28	49	8	1	11	3	28	48	9	2	9
Bachelor's Degree	1	5	12	61	13	9	2	5	11	59	14	9
Graduate Degree	2	1	2	22	64	9	1	3	2	14	72	8
% of Total Weighted Deaths on Death Certificate	30	37	11	7	3	12	32	32	12	8	6	10

Table 4. Classification ratios of Current Population Survey (CPS) deaths to death certificate deaths by education level and sex: National Longitudinal Mortality Study (NLMS) deaths from 1992-1998 cohorts

Education Level (CPS / Death Certificate)	Females	Males
Less than HS Grad / Less than 4 Years of HS	1.23 (.021)	1.17 (.018)
HS Grad / 4 Years of HS	0.81 (.017)	0.82 (.018)
More than HS Grad / More than 4 Years of HS		
Overall	1.00 (.021)	1.03 (.018)
- Some College / 1-3 Years of College	1.09 (.041)	1.16 (.043)
- Bachelor's Degree / 4 Years of College	0.91 (.047)	0.97 (.043)
- Graduate Degree / 5+ Years of College	0.80 (.066)	0.84 (.038)

Note: Standard errors in parentheses.

Table 5. Education distribution on the death certificate by Current Population Level (CPS) education level and age at death: National Longitudinal Mortality Study (NLMS) deaths from 1992-1998 cohorts

CPS Education Level	Death Certificate Education Level											
	25-44						45-64					
	% HS 0-3 Years	% HS 4 Years	% College 1-3 Years	% College 4 Years	% College 5+ Years	% Unknown	% HS 0-3 Years	% HS 4 Years	% College 1-3 Years	% College 4 Years	% College 5+ Years	% Unknown
Less than HS Grad	61	21	2	0	1	14	65	22	1	0	0	12
HS Grad	8	73	9	1	0	9	9	72	10	1	0	9
Some College	1	27	56	7	1	8	3	27	50	9	1	9
Bachelor's Degree	0	1	10	70	11	8	1	6	12	62	10	7
Graduate Degree	0	0	0	12	72	15	1	2	2	15	71	9
% of Total Weighted Deaths on Death Certificate	16	40	20	10	4	10	25	38	14	8	5	10

Death Certificate Education (continued)					
65 and over					
% HS 0-3 Years	% HS 4 Years	% College 1-3 Years	% College 4 Years	% College 5+ Years	% Unknown
66	19	19	1	0	13
11	68	9	2	0	11
3	29	46	9	2	10
1	6	11	58	15	9
1	3	2	17	69	8
35	33	10	7	4	12

Table 6. Education distribution on the death certificate by Current Population Survey (CPS) education level and race: National Longitudinal Mortality Study (NLMS) deaths from 1992-1998 cohorts

CPS Education Level	Death Certificate Education Level															
	White				Black				American Indian or Alaska Native[1]				Asian or Pacific Islander			
	% < 4 Years HS	% 4 Years HS	% > 4 Years HS	% Un-known	% < 4 Years HS	% 4 Years HS	% > 4 Years HS	% Un-known	% < 4 Years HS	% 4 YearsHS	% > 4 Years HS	% Un-known	% < 4 Years HS	% 4 Years HS	% > 4 Years HS	% Un-known
Less than HS Grad	67	20	2	12	61	18	2	19	67	13	1	20	74	19	0	7
HS Grad	10	70	10	10	16	60	12	11	5	58	7	30	6	69	22	3
More than HS Grad	2	18	71	9	2	23	63	12	0	11	80	9	0	9	87	5
% of Total Weighted Deaths on Death Certificate	30	35	24	11	39	30	15	16	42	26	11	22	30	26	39	5

[1] Distributions for American Indian or Alaska Native for HS Grad and More than HS Grad in the CPS are based on fewer than 20 unweighted deaths.

Table 7. Education distribution on the death certificate by Current Population Survey (CPS) education level and Hispanic origin: National Longitudinal Mortality Study (NLMS) deaths from 1992-1998 cohorts

CPS Education Level	Death Certificate Education							
	Hispanic				Non-Hispanic			
	% < 4 Years HS	% 4 Years HS	% > 4 Years HS	% Unknown	% < 4 Years HS	% 4 Years HS	% > 4 Years HS	% Unknown
Less than HS Grad	61	13	3	23	66	20	1	12
HS Grad	14	48	7	31	10	70	11	10
More than HS Grad	2	22	62	13	2	18	71	9
% of Total Weighted Deaths on Death Certificate	44	21	13	23	30	35	24	11

Table 8. Unadjusted and adjusted life expectancy by educational attainment for selected ages: U.S. males, 2005.

Education Level on Death Certificate	e25		e45		e65	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Unrevised States with 1989 Year-Based Education Item						
< HS Grad	46.3	44.2	29.0	27.2	15.7	14.3
HS Grad	48.3	50.9	30.5	32.8	15.5	17.3
Some College	54.2	52.5	35.4	33.8	18.5	17.2
College Grad	57.0	57.3	37.6	38.0	20.2	20.5
Graduate Degree	57.7	59.8	38.4	40.5	20.5	22.4
Revised States with 2003 Degree-Based Education Item						
< HS Grad	48.4	46.2	30.9	29.0	16.6	15.1
HS Grad	49.0	51.5	30.9	33.2	16.1	17.8
> HS Grad	57.4	57.0	38.3	37.9	21.1	20.8

Note: Death counts used in the calculation of life expectancy by education level came from death certificate information. The education item from the 2003 revision of the U.S. Standard Certificate of Death was used in 2005 in California, Connecticut, Florida, Idaho, Kansas, Michigan, Montana, Nebraska, New Hampshire, New Jersey, New York, Oklahoma, South Carolina, South Dakota, Utah, Washington, and Wyoming. Georgia and Rhode Island were excluded from the analysis because an education item was not included on the their death certificates, and the District of Columbia was excluded because it transitioned from use of the 1989 item to use of the 2003 item during the year.

Sources: Classification ratios for adjustment were obtained from the National Longitudinal Mortality Study. See Table 6. Mortality data came from the National Vital Statistics System. Population data came from unpublished Current Population Survey estimates provided by the U.S. Census Bureau.

Table 9. Unadjusted and adjusted life expectancy by educational attainment for selected ages: U.S. females, 2005

Education Level on Death Certificate	e25		e45		e65	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Unrevised States with 1989 Year-Based Education Item						
< HS Grad	52.6	49.9	34.4	32.0	18.9	16.9
HS Grad	53.6	56.2	35.0	37.4	18.4	20.4
Some College	59.3	58.3	40.0	39.1	22.3	21.4
College Grad	60.3	61.5	40.8	41.9	22.7	23.8
Graduate Degree	59.3	61.6	39.8	42.0	21.4	23.4
Revised States with 2003 Degree-Based Education Item						
< HS Grad	54.8	52.0	36.3	33.8	20.3	18.3
HS Grad	54.7	57.3	35.9	38.4	19.3	21.4
> HS Grad	61.6	61.6	42.1	42.2	24.3	24.3

Note: See Note to Table 10.

Sources: Classification ratios for adjustment were obtained from the National Longitudinal Mortality Study. See Table 6. Mortality data came from the National Vital Statistics System. Population data came from unpublished Current Population Survey estimates provided by the U.S. Census Bureau.