Til Death Do Us Part: Marital Status and Mortality, 1986-2000

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Abstract

Although the meanings and prevalence of being married, divorced, separated, never-married, or widowed have changed significantly over the past several decades in the United States, we know very little about whether and how the association between marital status and mortality has changed over time. Analysis of data from the National Health Interview Survey Linked Mortality Files 1986-2000 shows that mortality gap between the married and each of the unmarried groups—including the widowed, divorced, separated and never married widened across the 1986-2000 survey cohorts. Those trends toward widening morality gaps by marital status do not depend on gender or race. Implications for public policies on population health and marriage are discussed.

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The marriage advantage in longevity was detected as early as 1858 by Williams Farr in his study among the French population (Farr 1858). This issue caught increased scholarly and policy attention after Durkheim (1897, 1951) published his classic study on suicide where he found the married commit suicides much less often than the single. In the context of rapid changes in family and marriage, one would expect change in the costs and benefits of marriage, yet the research literature reveals little about how the association between marital status and mortality has changed over historical time in the United States.

The main objective of the present study is to document whether and how the association between marital status and mortality has changed over time in the context of a general retreat from formal marriage and an overall decline in mortality risk. I emphasize that documenting historical trends in the overall association is an important first step toward understanding changes in the relationship between marital status and mortality over time. Given long-standing observations about gender and race differences in marriage and mortality, the second objective of this study is to consider gender and race variation in the marital status-mortality trends. To address these aims, I adopt a survey cohort perspective and use data from the National Health Interview Survey-Multiple Cause of Death 1986-2000 files to analyze the potentially changing relationship between marital status and mortality over historical time.

The importance of this study is highlighted in the context of current political and scholarly debates about the benefits of marriage for health/mortality. While some scholars suggest that marriage should be encouraged because it is beneficial to health and reduces the risk of mortality (Waite and Gallagher 2000), other scholars argue that marriage is not as beneficial to individual well-being as it was in the past as alternatives to marriage (e.g. cohabitation) become more common and social acceptable (Musick and Bumpass 2006). An analysis of trends in marital status and mortality over time should shed light on this debate and has important implications for both population health and marriage policies.

Changes in Marriage and Family: Implications for Marital Status and Mortality Trend

During recent decades, the United States has witnessed tremendous changes in all social institutions, of which marriage is one of the most often documented. Average age at first marriage increased; cohabitation and marital dissolution rose dramatically; and the proportion of never married (especially for African Americans) increased (Teachman, Tedrow and Crowder 2000; Casper and Bianchi 2001). All of these changes indicate that Americans' norms and values on marriage and family have been changing (Bumpass 1990).

Marriage has received substantial theoretical and empirical attention because it is a fundamental institution in society and because substantial research evidence shows that involvement in marriage is associated with improved health and reduced risk of mortality. This has been the case since the earliest sociological studies and continues today with studies of marriage that rely on up-to-date, sophisticated statistical techniques and longitudinal data (House, Landis and Umberson 1988). Recent changes in marriage and family challenge this long-standing assumption about the marriage benefit to health and mortality. In the context of rapid social changes in marriage and family as well as an overall decline in human mortality, there are several reasons to expect that the association between marital status and mortality has changed over time.

First, the trend toward a retreat from formal marriage indicates that the benefit of being married may have declined over time. Marriage protects health and enhances longevity through either social psychological (i.e. increasing access to social support and social control, enhancement a sense of personal control, etc.) or economic mechanisms (Ross, Mirowsky and Goldsteen 1990). However, as the division of household labor decreases with increases in women's education and employment, economic gain from marriage may diminish over time (Becker 1981). Marriage becomes less valued as a source of economic stability (Teachman et al. 2000). Although documentation on changes in social psychological resources of marriage is less clear, one study conducted by Glenn and Weaver (1988) shows that happiness associated with marriage seemed to have waned between 1972 and 1986—suggesting that the psychological benefits of marriage may have decreased over time. Another study by Waite (2000) finds marginally significant (p=.076) evidence for a shrinking health difference between married and never married men along with a stable trend in marriage benefits on several other dimensions of well-being such as happiness over the 1972-1996 period. Nevertheless, trends in economic and social psychological resources suggest that mortality differences between the married and unmarried groups may have narrowed over time.

Second, the increased occurrence of divorce, separation or never marrying in the United States suggest that the cost associated with these unmarried statuses may have diminished over time. As divorce, separation and being never married become more common and normative, attitudes toward these statuses may have changed. The status of being divorced or never married may carry less stigma and stress, which leads to less harmful effects on health and mortality. Taken together, those literatures on recent changes in marriage and family lead to a "convergence" hypothesis—that is, mortality gaps by marital status may have narrowed over time.

Previous Empirical Evidence

Recent changes in marriage and family suggest reasons to expect the married and unmarried groups to experience convergent trends in mortality. However, previous empirical evidence, mostly based on European mortality data, does not support this view (Poppel and Joung 2001; Martikainen 2005; Valkonen, Martikainen and Blomgren 2004). Most of these European studies argue that the excess mortality of the unmarried (including the never-married, widowed, and divorced) relative to the married has increased over time and conclude that this occurs primarily because of more pronounced improvements among the married (Poppel and Joung 2001).

An earlier study conducted by Hu and Goldman (1990) also includes U.S. mortality data along with data from several other developed countries, mostly European. This study also revealed a widened mortality gap between the married and each of the unmarried groups including the never-married, widowed, and divorced in the United States between 1950s and 1980s. Another study examined mortality trends by marital status in the United States (Mergenhagen, Lee and Gove 1985) used two datasets to compare marital status differences in mortality among whites between 1959-1961 and 1979. Different from the findings of Hu and Goldman (1990), Mergenhagen, Lee and Gove (1985) found that the relative mortality difference between the divorced compared with the married declined between 1959-1979 while the opposite was true when comparing the widowed and never married. The authors speculate that the reason for the decreased disadvantage of the divorced relative to the married was greater social acceptability of divorce in the more recent years.

Hu and Goldman (1990) and Mergenhagen, Lee and Gove (1985) are the only two studies that considers marital status trends in mortality over historical time in the United States. As useful as they are, both studies are quite dated. Moreover, neither considers potential social group differences, while at least some grounds exist to expect potential differences in the martial status and mortality trends by race and gender—as I discuss in the following sections. Nevertheless, based on previous empirical evidence that generally (although not exclusively) finds widening trends in marital status differences in mortality, I expect an alternative "divergence" hypothesis regarding the marital status-mortality trends—that is, mortality gaps by marital status may have widened over time.

Gender and Race Variation

In general, married men enjoy more benefit from marriage than married women in terms of reduced risk of mortality, The adverse effects of marital dissolution on health/mortality are also greater for men than for women (Gove 1973; Rogers 1995; Williams and Umberson 2004). However, this gender difference in the relationship between marriage and mortality/health has been, and continues to be, challenged and contested. For example, a recent study by Zhang and Hayward (2006) found that marital loss results in a higher risk of cardiovascular disease in late midlife for women but not for men. More consistence exists on that marriage affects mortality risk in different ways depending on gender. Marriage is linked to mortality more through economic factors for women and socio-psychological factors for men (Ross, Mirowsky and Goldsteen 1990).

Because greater economic resources through marriage play a more important role in accounting for the marital advantage in mortality for women than for men (Lillard and Waite 1995), a decline in economic gains from marriage may reduce the marital advantage in mortality/health for women more than for men. Moreover, norms and attitudes about non-married statuses have changed more for women as a result of women's greater improvement in social and financial status over time (Thornton 1989). This may lead to a more modest negative effect of the non-married statuses on mortality risk for women than for men over time. These literatures lead to the following hypothesis regarding gender differences in trends: that is, mortality gaps by marital status are more likely to narrow and less likely to widen among women than men.

Marriage trends also vary across racial groups within the United States. Among whites, declines in marriage largely represent delays in marriage, whereas, among African Americans, declines reflect both delays and decreases in the probability of ever marrying (Oppenheimer 1997). Being African American is associated with a higher risk of union dissolution (Raley and Bumpass 2003) as well as a lower likelihood of transition into marriage (Oppenheimer 1997). Although the probability of divorce has remained constant since 1980 in the United States, this plateau in divorce exists among whites but not among African Americans (Raley and Bumpass 2003). According to Raley and Bumpass (2003), racial differences in the risk of union dissolution have increased over recent decades. The increasing racial difference in marital dissolution suggests that the marriage benefit may be declining more rapidly for African Americans than for whites. Indeed, in terms of economic benefits, African American women gain less from marriage than do white women (Farley 1988). Moreover, the more common occurrence of divorce, separation, cohabitation and never-married statuses among African Americans than whites suggest that being unmarried might be more acceptable to African Americans than to their white counterparts. This may result in more dampened negative effects of non-married statuses on health and mortality for African Americans than for whites. This suggests a hypothesis regarding race differences in the trends—that is, mortality gaps by marital status are more likely to narrow and less likely to widen among African Americans than whites.

Data and Sample

Data are from the public-use version of the National Health Interview Survey Linked Mortality Files 1986-2000 (www.cdc.gov/nchs/r&d/nchs_datalinkage/nhis_data_linkage_mortality_activities.htm). The National Health Interview Survey (NHIS) is a multistage probability survey conducted annually by the United States Department of Health and Human Services and the National Center for Health Statistics and is representative of the civilian noninstitutionalized population of the United States (U.S. Dept. of Health and Human Services, National Center for Health Statistics 2000). Data utilized heare are the linked files of the NHIS to the National Death Index (NDI) 1986-2000 with follow-up through December 31, 2002 (NCHS 2004). The public-use version of the data is similar to the restricted-use data but containing only a limited set of mortality variables (Lochner, Hummer, and Cox 2007). All NHIS participants are included in the linked mortality files, but only adult participants aged 18 and over were eligible for mortality follow-up (NCHS 2004). A variable indicating eligibility status is provided on the files. The mortality data supplies vital status, date of death for those who died and causes of death information for those who died among eligible persons included in the NHIS for the years 1986 through 2000.

Only adult sample aged 18 and over who were eligible for the mortality follow-up are included in the analyses. Additional analyses (not shown in the paper) including samples aged 25 and above or ages 25-84 reveal similar pattern. I restrict the analyses to those who are identified as non-Hispanic white or non-Hispanic black. Individuals from other racial and ethnic groups are dropped from the analysis because of their tremendous heterogeneity. In the remainder of the paper I refer to non-Hispanic whites as "whites" and to non-Hispanic African Americans as "African Americans". I further exclude cohabiting respondents from the analyses, who account for around one percent of the sample, because the NHIS did not collect information on cohabiting status prior to 1997. Missing cases on marital status when the surveys were conducted are also excluded. The total number of observations for the study across the 15 years of baseline data is 912,757. Among those individuals, 110,973 were determined to have died during the follow-up period. Weights are applied in the analysis to adjust for the complex sampling frame of NHIS. All significance tests are based on robust standard errors, which are further adjusted for THE primary sampling unit and strata employed in the sampling design.

Table 1 presents descriptive information on the composition for the total sample analyzed and shows that about 64 percent of the total sample was currently married at the time of the survey. The widowed and divorced each account for nearly eight percent of the sample. About two percent of the sample is separated and about eighteen percent is never married. The mean age of the sample is around 45 and more than half are women. Nearly thirteen percent of the sample is African American. In the total sample, about 18 percent have no high school diploma and about 38 percent are high school graduates. Those with some college but less than four years of college account for almost 23 percent of the sample. College graduates account for about 21 percent.

Table 1 about here

Table 2 provides eight age-specific matrixes of survey year by follow-up year. Those matrixes are based on eight age groups when the surveys were conducted. Within each age-specific matrix, each row represents survey year in a three-year unit and each column represents a three-year follow-up (the last column is a two-year follow-up). Three numbers are included in each cell of the matrix: 1) number surviving l(x), which represents the number of persons from the original survey year who survive to the beginning of each follow-up year interval; 2) number dying d(x), which shows the number of persons who died within the specified follow-up year interval; and 3) d(x)/l(x), which is the proportion of deaths among those who are interviewed in the specific survey years and within the specified follow-up year interval.

Table 2 about here

Three patterns can be observed from Table 2. First, the sample size within each cell is fairly large, even in the oldest group (i.e. aged 90 and above) and there is a fairly sizable number of deaths in each cell. Second, deaths are more likely to occur during later follow-up years, which is observed when we compare the cells within each row. For example, for those who are aged 18-29 at interview in 1986-1988, 0.12% of them died during 1986-1988, 0.33% died during 1989-1991, 0.38% died during 1992-1994, 0.39% died during 1995-1997, and 0.47% died during 1998-2000. The small decrease in the proportion of deaths that occurredin 2001-2002 (i.e. 0.37%) reflects the shorter follow-up duration of that interval. This increased proportion of deaths across follow-up years, partially if not fully, reflects the aging process for each age group. Third, the proportion of deaths increases across age groups by comparing cells across the eight age-specific matrixes. For example, the proportion of deaths during the follow-up period of 1995-1997 is 0.39% for the group who are interviewed during1986-1988 and aged 18-29 at that time. This proportion increased to 41.06% for their peers aged 90 and above at interview.

Variables

The outcome variable for this study is mortality/survival indicated the death risk of the participants from the date when the survey was conducted through the follow-up until December 31, 2002. For those who died within this observation window, mortality status is coded as 1. For those who survive the follow-up period, mortality status is coded as 0 and the data of death is right censored.

The main variable adopted to document the mortality trend is survey year cohort in this study and will be discussed in more detail in the "Analysis Strategy" section. The survey year cohort is coded as 0 for those who were interviewed in 1986, 1 for those who were interviewed in 1987, 2 for those who were interviewed in 1988 and so on.

Marital status is based on the survey question, "Are you now married, widowed, divorced, separated or never married?" Five categories of marital status are considered: married, widowed, divorced, separated, and never married, with the married as the reference group.

Other socio-demographic covariates in the analysis include gender (female=1, male=0), race (non-Hispanic African American=1, non-Hispanic white=0), age at survey (in one year units centered at the mean age of 45), and education (no high school diploma, high school graduate, some college, and college graduate with the last category as the reference group). The NHIS top coding for age at survey is 99 for interviews conducted in 1995 and before, 90 in 1996 and 85 in 1997 and afterward. I calculate these truncated ages due to top coding using survey year minus reported birth year. About one percent of observations have missing information on education and they are recoded at the mean value for the survey year.

Analysis Strategy

Most previous studies (e.g. Feldman et al. 1989; Pappas et al. 1993; Preston and Elo 1995)of social (mostly educational) differences in U.S adult mortality trends compare mortality rates between two or several time periods using a period trend perspective (with Lauderdale 2001 as an exception, which focuses on a cohort perspective). In this paper, I adopt a cohort perspective to study mortality trends by marital status.

NHIS participants are interviewed every year. Those who are interviewed in the same calendar year comprise one survey cohort, whose survival statuses are observed from the same calendar year through the follow-up until December 31, 2002. For example, the 1986 survey year cohort individuals were all interviewed and enter the observation window in 1986; their survival status is followed up until December 31, 2002. The 1986 NHIS sample— representing the civilian noninstitutionalized U.S. population of 1986—thus comprises the denominator of the mortality risk for the 1986 survey cohort. In this study I compare the mortality risk across these survey year cohorts, which indicates change in the mortality risk of the representative adult population across survey years. The survey year cohort serves as the main variable to document mortality trends.

I start with descriptive analyses of marital differences in mortality risk for four selected single survey year cohorts, i.e. 1986, 1990, 1995 and 2000. Then I estimate Cox proportional hazards models to better understand trends in the relationship between marital status and mortality, which can be specified as:

$$\log\frac{h_i(t)}{h_0(t)} = \alpha T + \sum \beta_j M_j + \sum \gamma_j M_j T + \sum \pi_k X_k$$

where $h_i(t)$ is the resultant death hazard and $h_0(t)$ is the baseline hazard. T represents the survey cohort and α is the coefficient; M_j represents the set of marital status dummy variables and β_j represents the corresponding coefficients ("married" is the reference group); γ_j represents the corresponding coefficients for the set of interaction terms between marital status and survey cohort; X_k stands for the other covariates included in the model (i.e. age at survey, gender, race and education) and π_k for the corresponding coefficients. γ_j is of greatest interest for this study because it reflects trends in mortality differences by marital status. Three-way interactions, i.e. cohortXmarital statusXgender and cohortXmarital statusXrace are added into the model when considering gender and race variations in the mortality trends.

I use participant's age (in one year units) as the time metric recording death, which is indicated by *t* in the above equation. Participants are interviewed at different ages so they enter the observation window and risk set at different ages. This late entry problem is adjusted by restricting each participant's risk set to start from the age when the survey was conducted to the age when the participant died or was censored. For example, person A was interviewed in 1989 at age 65 and died in 1997 at age 73. The time exposure (i.e. *t*) of person A in the observation widow is from age 65 to age 73. Person B was interviewed in 1995 at age 29 and survived the date of December 31, 2002 when he/she was 36. The time exposure (i.e. *t*) of person B in the observation widow is from age 29 to age 36.

Although no assumptions are made about the shape of the underlying hazard function, Cox proportional hazards model assumes that the ratio of the estimated hazards over time (i.e. age in this case) is constant for those individuals with particular values for the covariates (Singer and Willett 2003). This proportional hazards assumption is tested and none of the covariates analyzed violate this assumption. Results for the tests of the proportional hazards assumption are shown in Appendix A.

Descriptive Results

I start with reporting descriptive results by marital status for four selected single survey cohorts: 1986, 1990, 1995 and 2000. Figure 1 displays the Kaplan-Meier survival curves by marital status for the selected survey cohorts. From Figure 1, we can see that gaps in the survival curves between marital status groups are wider for the 2000 and 1995 survey cohorts than the 1986 and 1990 survey cohorts. For all of the four survey cohorts, the married enjoy survival advantage over each of the unmarried groups. Figure 2 and 3 show the similar pattern about wider mortality gaps by marital status in the recent two survey cohorts than the earlier two by displaying the Nelson-Aalen cumulative hazard curves and smoothed death hazard curves by marital status and survey cohort. To better understand trends in mortality differences by marital status, I turn to Cox hazards regression models next.

Results Cox Regression Models

Table 3 presents the regression coefficients from Cox proportional hazards models. For interpretation, the hazard ratios can be derived from the reported coefficients by exponentiation. Model A of Table 3 shows the general pattern of marital status differences in mortality without considering the differences across survey year cohorts and netting the effects of basic socio-demographic covariates and. Results from Model A of Table 3 show that the married have lower mortality risk than each of the unmarried groups including the widowed, divorced, separated and never married. This is consistent with the well-known relationships between marital status and mortality

Model B, C and D of Tables 3 shows the estimated mortality trend by marital status from the Cox proportional hazards regression models. Model B of Table 3 shows mortality trend by marital status for the total sample across the 1986-2000 survey cohorts. Model C and D of Table 3 present the results including gender and race interactions. The first set of covariates in Model B,C and D of Table 3 (i.e. the main effect of marital status variables) indicate the mortality difference between the specific marital group and the married for the baseline survey cohort (i.e. 1986 survey cohort). The second set of covariates in Model B,C and D (i.e. CohortXMarital Status) reflect marital status differences in mortality trend across survey cohorts. The main effect of "Cohort" indicates mortality trend for the married and the interaction terms of "Cohort" with other marital statuses represent the differences in mortality trend between each specific marital group and the married. The gender and race interaction terms included in Model C and D reflect social group variation in the trends. Specifically, the two-way interactions of Marital StatusXGender/Race indicate how marital differences in mortality risk vary across gender/race groups for the baseline, 1986 survey cohort. The two-way interaction of CohortXGender/Race reflects gender/race difference in mortality trend of the married. The three way interactions of CohortXMarital StatusXGender/Race reflect gender/race variation in changes in the martial differences in mortality risk across survey cohorts. Other covariates can be interpreted in the same way that coefficients in conventional Cox regression models are interpreted.

Table 3 about here

Estimated effects of all of the covariates are in the expected directions. Specifically, mortality risk increases with age at interview. Mortality risk is higher for African Americans compared to whites and lower for women compared to men. In comparison to college graduates, each of the lower education groups exhibits higher risk of death. All of the main effects of the marital status variables in Model B, C and D are significantly positive, suggesting that each of the unmarried groups—including the widowed, divorced, separated and never married—have higher mortality risk than the married in the baseline survey cohort (i.e. 1986 survey cohort) for the related reference group.

Trends for Total Sample

Model B of Table 3 shows the estimated trends in mortality differences by marital status for the total sample across the 1986-2000 survey cohorts, net of the effects of age, gender, race, and education. Based on the Cox regression results in Model B of Table 3, I calculate hazard ratios for each marital status group across survey year cohorts and graphically present them in Figure 4. Those adjusted hazard ratios compare the estimated risk score with the baseline risk score and indicate the mortality risk of a specific marital status group across survey year cohorts. The baseline risk score represents the mortality risk of the reference group in the model, i.e. the married who are interviewed in 1986 (and are also college graduate white men) for Model B. The hazard ratio for the reference group (i.e. the baseline risk score) is one indicated in Figure 4. All comparisons of the adjusted hazard ratios in Figure 4 are referred to this reference group.

These results show that the mortality risk decreased among the married across survey cohorts while it increased for each of the unmarried groups—including the widowed, divorced, separated and never married with the most rapid increase among the separated—leading to a widening mortality gap between the married and each of the unmarried groups across the 1986-2000 survey cohorts. In particular, the mortality risk of the married decreased 0.30% (i.e. [1-exp(-0.003)]*100%) across each one survey year cohort. In contrast, the mortality risk of the widowed, divorced, separated and never married increased 0.50% (i.e. [exp(-0.003+0.008)-1]*100%), 0.70% (i.e. [exp(-0.003+0.010)-1]*100%), 2.33% (i.e. [exp(-0.003+0.026)-1]*100%), 1.31% (i.e. [exp(-0.003+0.016)-1]*100%) respectively across each one survey year cohort.

Figure 4 about here

Gender and Race Variation

Model C and D of Table 3 present the estimated trends in mortality differences by marital status from the Cox hazards regression models with possible gender and race variation considered.

Gender. Model C of Table 3 shows the estimated trend in mortality by marital status across survey cohorts 1986-2000 including gender interactions. Based on the results in Model C of Table 3, I calculate hazard ratios for each marital status and gender group across survey year cohorts and graphically present them in Figure 5. Those adjusted hazard ratios compare the estimated risk score with the baseline risk score. The baseline risk score in Model C represents the mortality risk of married men who are interviewed in 1986 (and also are college graduate whites). The hazard ratio for this reference group (i.e. the baseline risk score) is one. All comparisons of the adjusted hazard ratios in Figure 5 are referred to the reference group.

These results show that mortality trend of each marital status group follows a similar pattern for men and women as for the total sample. In particular, mortality risk decreased across survey cohorts for both married men and women, while it increased among all of the unmarried groups for both men and women. Therefore, we see widening mortality gaps between the married and each of the unmarried groups for both men and women.

Although there is no significant gender difference in *change* of mortality across survey cohorts, there are two significant gender differences in those mortality trends catching attention. First, for all of the survey cohorts, women experience lower mortality risk than men for each marital status group; Second, the significant interaction effect of Never MarriedXWomen indicates that mortality gap between the married and never married was larger for men than for women for the baseline survey cohort (i.e. 1986) and this gender difference remained stable across all survey cohorts. These gender differences in mortality are illustrated in Figure 5.

Figure 5 about here

Race. Model D of Table 3 compares the estimated trend in mortality by marital status for whites and African Americans. Based on the results in Model D of Table 3, I calculate hazard ratios for each marital status and race group across survey year cohorts and graphically present them in Figure 6. Those adjusted hazard ratios compare the estimated risk score with the baseline risk score. The baseline risk score in Model D represents the mortality risk of married whites who are interviewed in 1986 (and also are college graduate men). The hazard ratio for this reference group (i.e. the baseline risk score) is one. All comparisons of the adjusted hazard ratios in Figure 6 are referred to the reference group.

These results show that mortality of each marital status group follows similar trends for African Americans and whites because of lack of statistical significance of the three-way interactions (i.e. CohortXMarital StatusXRace). In particular, mortality risk decreased across survey cohorts for both married African Americans and whites. For both race groups, mortality risk of the divorced and separated declined across survey cohorts at the same rate as their married counterparts—leading to stable gaps between the married and divorced/separated for both race groups. In contrast, the mortality risk of the never married, and to a less extent, of the widowed increased across survey cohorts—leading to widening gaps between the married and never married/widowed for both race groups.

Although there is no significant race difference in *change* of mortality risk across survey cohorts, some related race differences in mortality stand out from Model C of Table 3 (also illustrated in Figure 6). First, on average, African Americans suffered higher mortality risk than their white counterparts. Second, marital status differences in mortality level depend on race (indicated by the significant interaction effects of MaritalStatusXBlack). Although each of the unmarried groups suffer higher mortality risk than the married for whites, it is not the case for African Americans. The widowed African Americans actually have lower mortality risk than their married peers among the earlier survey cohorts, but this pattern reverses for the recent survey cohorts because of a decline in mortality risk among the married African Americans and an increased risk among the widowed African Americans. Moreover, the mortality disadvantage of the divorced African Americans relative to the married African Americans is much smaller than their white peers. In contrast, the never married African Americans suffered much higher mortality risk than the married African Americans. This difference between the never married and married is less pronounced among whites. Due to lack of significant three-way interactions (i.e. CohortXMarital StatusXRace), those racial differences in mortality level hold for all of the survey cohorts.

Figure 6 about here.

Discussion and Conclusion

That the married are healthier than the unmarried and they live longer received substantial theoretical attention as well as empirical supporting evidence during the last three decades (Waite 1995; Umberson and Williams 1999). Recent changes in marriage and family challenge the long-standing assumptions about marriage benefit to health and mortality. However, little research has attempted to ascertain whether the association between marital status and mortality are invariant across historical time in the context of rapid social changes in marriage. This study, based on data from the National Health Interview Survey Linked Mortality Files 1986-2000, shows that mortality differences between the married and each of the unmarried groups—including the widowed, divorced, separated and never married have widened across survey cohorts. This is the case for both gender and race groups. These widened mortality gaps are mainly resulted from a decline in mortality risk among the married and an increased risk among the unmarried across survey cohorts.

In the context of overall improvement in population well-being, it is not unexpected to see that mortality of the married has declined over time. But why has the mortality risk of the unmarried increased over time? Additional analysis (not shown in the paper) indicates that change in family income can not explain this increasing inequality in mortality between the married and unmarried. One possibility is that over the past two decades, access to health insurance as well as level of coverage to the insured has diminished significantly (DeNavas-Walt, Proctor, and Lee 2006). Lacking a spouse with health insurance significantly decreases one's probability of having insurance (Berk and Taylor 1984). In this sense, being unmarried may reduce access to insurance coverage and this cost may have become greater, relative to the married, over time. Moreover, changes in marriage selection may play a role in those marital status and mortality trends. In the context of rapid social change, the relative number of individuals selected into or out of marriage changes—suggesting that marriage selection criteria may have changed over time. With more social acceptance of staying in singlehood, those who get or stay married may be more selective of individuals who really benefit from marriage and those who left out of marriage may be more disadvantaged over time. Nevertheless, various social, biological, psychological, and behavioral mechanisms work together to determine trends in the association between marital status and mortality in the context of rapid social changes. Future studies should seek to identify the mechanisms that explain these trends.

This study provides evidence supporting the current policies designed to encourage marriage. Those policies are based on an assumption that marriage should enhance individuals' well-being. Mortality is one of the most important facets of population well-being and this study shows that this assumption of marriage benefit is more salient now than ever before in terms of lowering the risk of mortality. In spite of a trend toward a retreating from formal marriage in the United States, marriage becomes more and more important over time, at least, in terms of reducing mortality risk.

Results from this study also have important implications for population health. One of the goals of *Healthy People 2010* is to “eliminate health disparities” *(http://www.healthypeople.gov/).* However, this study shows that the United States is heading to the opposite direction in terms of marital differences in mortality. The unmarried groups become more vulnerable in comparison to the married more so than ever before. In the context of overall improvement in population longevity, the married—who have already been advantaged—are better off while the unmarried—who have been disadvantaged are worse off. Special attention should be give to the increasing social inequality in mortality risk by marital status in order to achieve the general goal of enhancing population well-being. The unmarried groups, who represent the growing segment of the population, become more physically vulnerable now than in the past—which warrant special concern for population health. Future studies should seek to identify the mechanisms that explain increased mortality gaps by marital status and facilitate to implement policies and interventions to reduce the mortality risks associated with the unmarried status.

Appendix A.

Table A shows the results for investigating the proportional hazards assumption using STATA STPHTEST command. The nonsignificant results indicate that none of those variables analyzed violate this assumption. Figure A shows the –ln(-ln(survival probability)) across analysis time (i.e. age) for each marital status group. The relative parallel pattern between the lines in Figure A indicates no evidence for violation of the proportional hazards assumption for the marital status variable. Figures for examination of other covariates are similar and not shown in the paper.

Table A about here

Figure A about here

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TABLE 1. Descriptive Characteristics of Sample Composition Analyzed

	Mean	S.D.
Age at survey	45.13	17.82
Marital Status		Percent
Married		64.15
Widowed		7.52
Divorced		7.79
Separated		2.02
Never married		18.52
Gender		
Men		47.53
Women		52.47
Race		
Whites		87.49
African Americans		12.51
Education		
No High School Diploma		18.16
High School Graduate		37.66
Some College		23.03
College Graduate		21.15
N		912757

TABLE 2. Mortality Rate by Survey Cohort, Fellow-Up Year and Age

l(x)
d(x)
d(x)/l(x)

Fellow-Up Years

Survey Cohorts	Age at survey18-29						Age at survey 30-39						Age at survey 40-49						Age at survey 50-59					
	86-88	**89-91**	**92-94**	**95-97**	**98-00**	**01-02**	**86-88**	**89-91**	**92-94**	**95-97**	**98-00**	**01-02**	**86-88**	**89-91**	**92-94**	**95-97**	**98-00**	**01-02**	**86-88**	**89-91**	**92-94**	**95-97**	**98-00**	**01-02**
86-88	48541	48482	48322	48140	47951	47727	42695	42592	42343	42057	41740	41343	31809	31662	31329	30885	30343	29665	25172	24914	24188	23299	22298	21151
	59	160	182	189	224	176	103	249	286	317	397	327	147	333	444	542	678	530	258	726	889	1001	1147	935
	.0012	.0033	.0038	.0039	.0047	.0037	.0024	.0058	.0068	.0075	.0095	.0079	.0046	.0105	.0142	.0175	.0223	.0179	.0102	.0291	.0368	.0430	.0514	.0442
89-91	---	51002	50929	50734	50581	50410	---	50161	50025	49759	49424	49044	---	39771	39603	39137	38610	37937	---	28737	28422	27649	26729	25622
	---	73	195	153	171	142	---	136	266	335	380	309	---	168	466	527	673	537	---	315	773	920	1107	866
	---	.0014	.0038	.0030	.0034	.0028	---	.0027	.0053	.0067	.0077	.0063	---	.0042	.0118	.0135	.0174	.0142	---	.0110	.0272	.0333	.0414	.0338
92-94	---	---	44681	44588	44448	44307	---	---	48194	48079	47830	47533	---	---	40913	40721	40265	39721	---	---	27864	27560	26806	25910
	---	---	93	140	141	113	---	---	115	249	297	236	---	---	192	456	544	472	---	---	304	754	896	658
	---	---	.0021	.0031	.0032	.0026	---	---	.0024	.0052	.0062	.0050	---	---	.0047	.0112	.0135	.0119	---	---	.0109	.0274	.0334	.0254
95-97	---	---	---	26817	26776	26701	---	---	---	30501	30433	30246	---	---	---	29243	29103	28777	---	---	---	19666	19447	18937
	---	---	---	41	75	60	---	---	---	68	187	120	---	---	---	140	326	262	---	---	---	219	510	413
	---	---	---	.0015	.0028	.0022	---	---	---	.0022	.0061	.0040	---	---	---	.0048	.0112	.0091	---	---	---	.0111	.0262	.0218
98-00	---	---	---	---	25157	25114	---	---	---	---	27694	27622	---	---	---	---	29545	29415	---	---	---	---	22343	22107
	---	---	---	---	43	58	---	---	---	---	72	94	---	---	---	---	130	244	---	---	---	---	236	361
	---	---	---	---	.0017	.0023	---	---	---	---	.0026	.0034	---	---	---	---	.0044	.0083	---	---	---	---	.0106	.0163

	Age at survey 60-69						Age at survey 70-79						Age at survey 80-89						Age at survey 90 and above					
	86-88	**89-91**	**92-94**	**95-97**	**98-00**	**01-02**	**86-88**	**89-91**	**92-94**	**95-97**	**98-00**	**01-02**	**86-88**	**89-91**	**92-94**	**95-97**	**98-00**	**01-02**	**86-88**	**89-91**	**92-94**	**95-97**	**98-00**	**01-02**
86-88	24776	24172	22644	20862	18958	16702	16093	15345	13320	11165	8901	6666	5929	5396	4075	2796	1753	1035	756	641	379	207	122	94
	604	1528	1782	1904	2256	1576	748	2025	2155	2264	2235	1404	533	1321	1279	1043	718	280	115	262	172	85	28	8
	.0244	.0632	.0787	.0913	.1190	.0944	.0465	.1320	.1618	.2028	.2511	.2106	.0899	.2448	.3139	.3730	.4096	.2705	.1521	.4087	.4538	.4106	.2295	.0851
89-91	---	27172	26459	24790	22845	20607	---	19109	18148	15841	13272	10495	---	7285	6527	4875	3343	2092	---	866	702	400	239	156
	---	713	1669	1945	2238	1578	---	961	2307	2569	2777	1770	---	758	1652	1532	1251	601	---	164	302	161	83	30
		.0262	.0631	.0785	.0785	.0766		.0503	.1271	.1622	.2092	.1687		.1040	.2531	.3143	.3742	.2873		.1894	.4302	.4025	.3473	.1923
92-94	---	---	24894	24200	22733	20954	---	---	18528	17571	15311	12809	---	---	7423	6628	4956	3304	---	---	992	812	450	239
	---	---	694	1467	1779	1406	---	---	957	2260	2502	1745	---	---	795	1672	1652	917	---	---	180	362	211	70
			.0279	.0606	.0783	.0671			.0517	.1286	.1634	.1362	---		.1071	.2523	.3333	.2775			.1815	.4458	.4689	.2929
95-97	---	---	---	15718	15309	14362	---	---	---	12516	11856	10365	---	---	---	5392	4844	3470	---	---	---	427	310	155
	---	---	---	409	947	696	---	---	---	660	1491	1118	---	---	---	548	1374	845	---	---	---	117	155	55
				.0260	.0619	.0485				.0527	.1258	.1079				.1016	.2836	.2435				.2740	.5000	.3548
98-00	---	---	---	---	15470	15059	---	---	---	---	12572	11940	---	---	---	---	6333	5591	---	---	---	---	0	0
	---	---	---	---	411	602	---	---	---	---	632	981	---	---	---	---	742	1005	---	---	---	---	---	---
					.0266	.0400					.0503	.0822					.1172	.1798						

TABLE 3. Trends in Marital Status Differences in Mortality from Cox Hazard Regression Models 1986-2000

	Model A	Model B	Model C	Model D
Marital Status(0=Married)				
Widowed	0.1855***	0.143***	0.1089***	0.1722***
Divorced	0.3375***	0.285***	0.3257***	0.3223***
Separated	0.3690***	0.240***	0.2462***	0.2689***
Never Married	0.3724***	0.295***	0.3521***	0.2518***
CohortXMaritial Status(0=Married)				
Cohort		-0.003*	-0.0042*	-0.0036*
CohortXWidowed		0.008***	0.0088*	0.0068**
CohortXDivorced		0.010**	0.0127*	0.0076
CohortXSeparated		0.026***	0.0226*	0.0208
CohortXNeverMarried		0.016***	0.0150**	0.0143***
Gender Interactions				
WidowedXWomen			0.0377	
DivorcedXWomen			-0.0752	
SeparatedXWomen			-0.0147	
NeverMarriedXWomen			-0.1213**	
CohortXWomen			0.0019	
CohortXWidowedXWomen			-0.0015	
CohortXDivorcedXWomen			-0.0061	
CohortXSeparatedXWomen			0.0075	
CohortXNeverMarriedXWomen			0.0002	
Race Interactions				
WidowedXBlack				-0.2410***
DivorcedXBlack				-0.2303***
SeparatedXBlack				-0.0874
NeverMarriedXBlack				0.2302***
CohortXBlack				0.0017
CohortXWidowedXBlack				0.0108
CohortXDivorcedXBlack				0.0144
CohortXSeparatedXBlack				0.0102
CohortXNeverMarriedXBlack				0.0003
Sociodemographic Variables				
Age at survey	0.0141***	0.014***	0.0138***	0.0136***
Women	-0.5163***	-0.516***	-0.5126***	-0.5168***
African Americans	0.1708***	0.170***	0.1720***	0.2054***
Education (0=College Graduate)				
No High School Diploma	0.5097***	0.510***	0.5075***	0.5067***
High School Graduate	0.3400***	0.339***	0.3375***	0.3353***
Some College	0.2406***	0.240***	0.2384***	0.2367***
F-value	982.95	658.11	421.98	436.52
N	912757			

Two-tailed tests: ***p<0.001; **p<0.01; *p<0.05.

TABLE A. Test of Proportional Hazards Assumption using STATA STPHTEST				
	rho	chi2	df	Prob>chi2
Widowed	-0.0208	0.00	1	0.9979
Divorced	-0.0202	0.00	1	0.9980
Separated	-0.0160	0.00	1	0.9982
Never Married	-0.0612	0.00	1	0.9942
Year	0.0273	0.00	1	0.9977
Age at survey	-0.0390	0.00	1	0.9959
Female	0.0147	0.00	1	0.9984
Black	-0.0669	0.00	1	0.9929
Some College	-0.0354	0.00	1	0.9963
High School Graduate	-0.0566	0.00	1	0.9943
No High School Diploma	-0.0837	0.00	1	0.9920

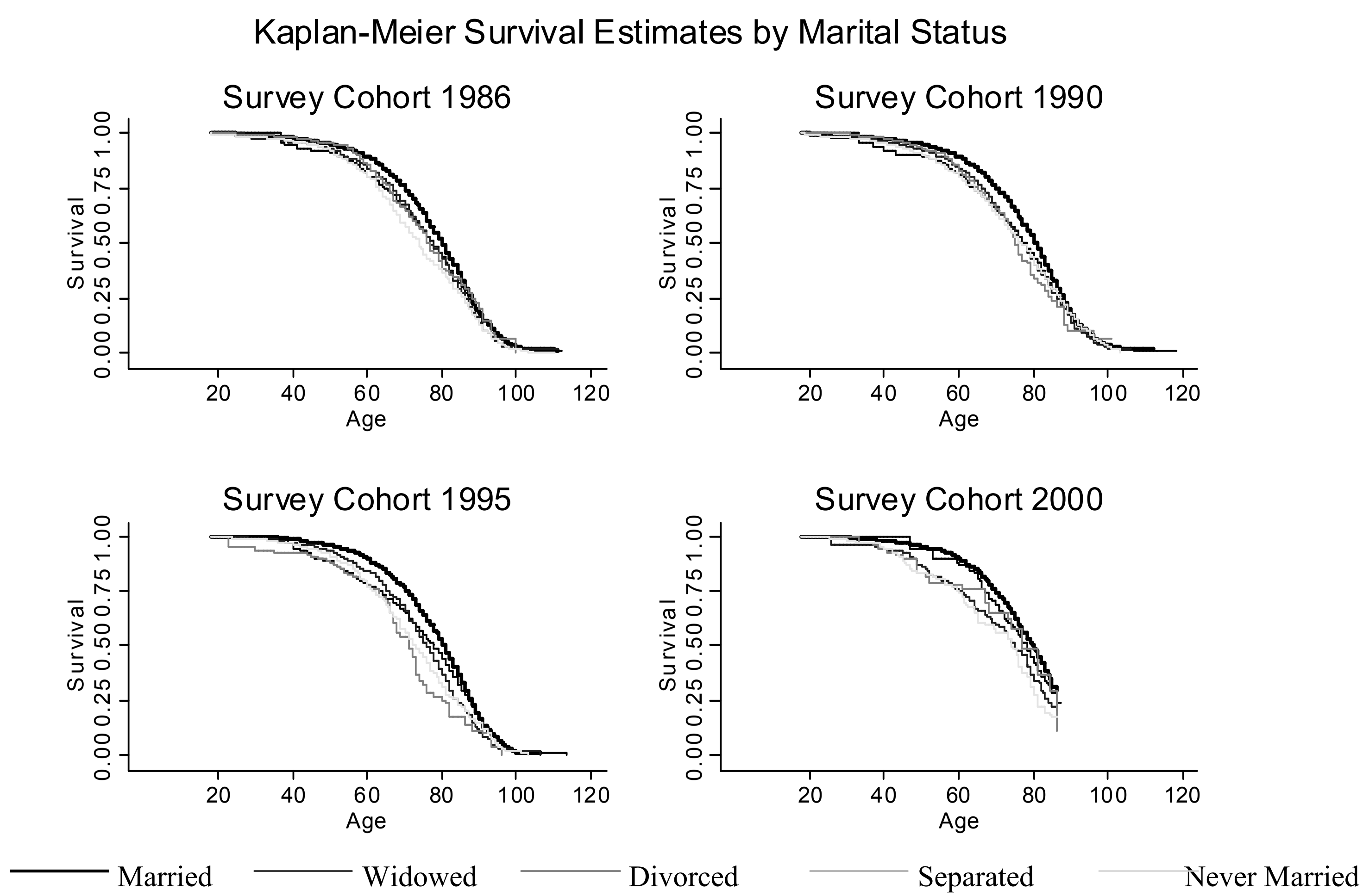

Figure 1. Kaplan-Meier Survival Curves By marital Status and Selected Survey Year Cohorts

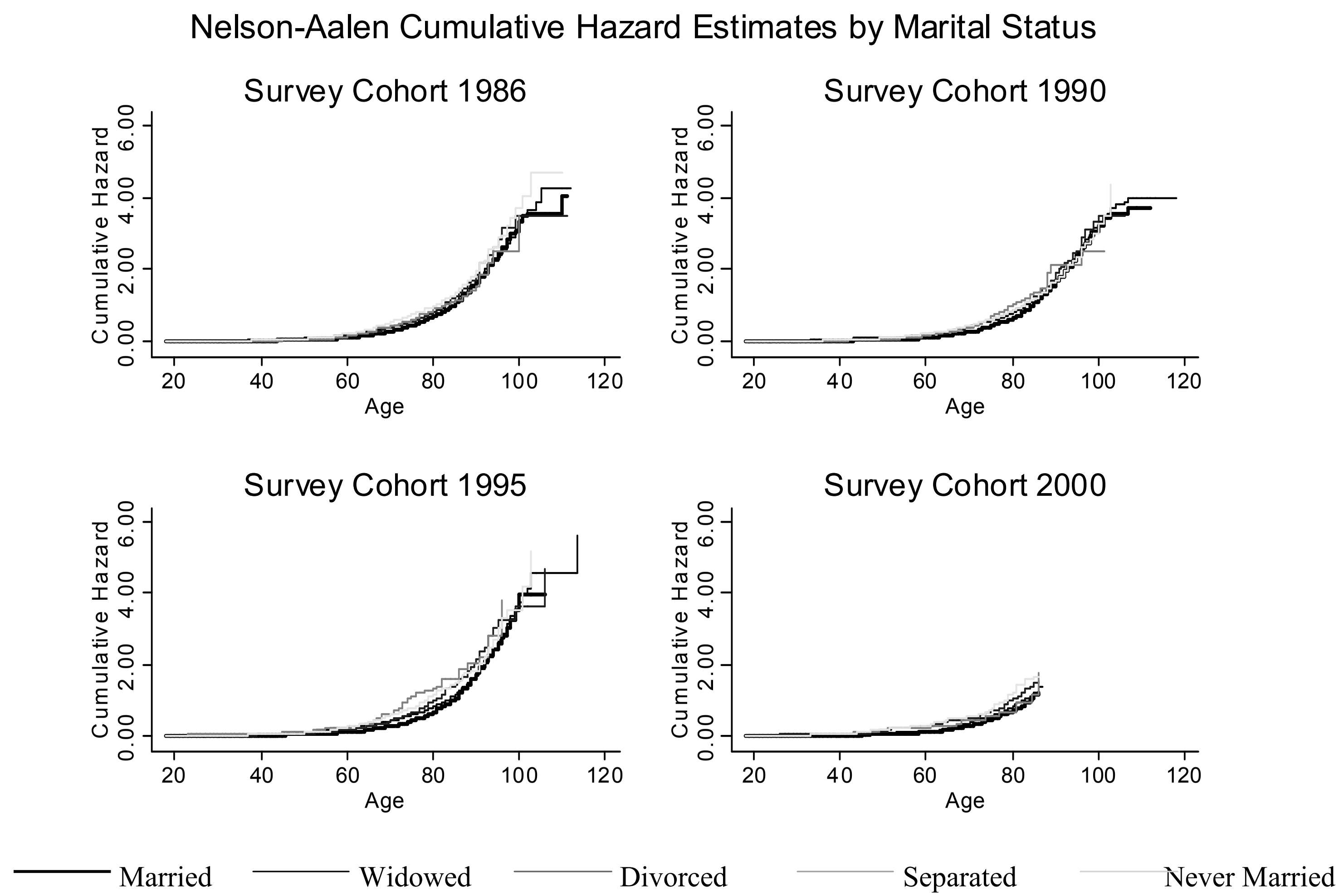

Figure 2. Nelson-Aalen Cumulative Hazard Curves by Marital Status and Selected Survey Year Cohorts

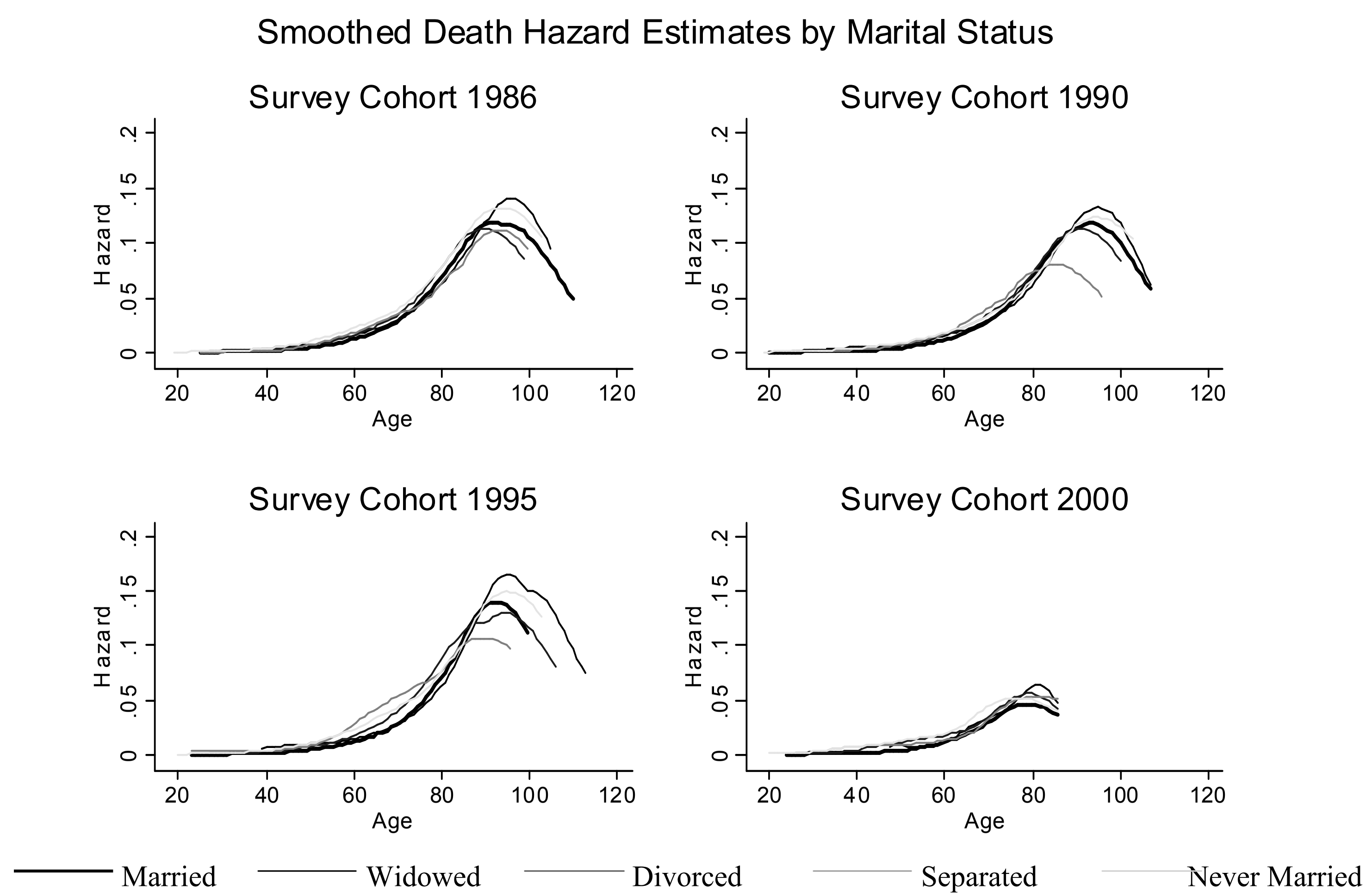

Figure 3. Smoothed Death Hazard Curves by Marital Status and Selected Survey Year Cohorts

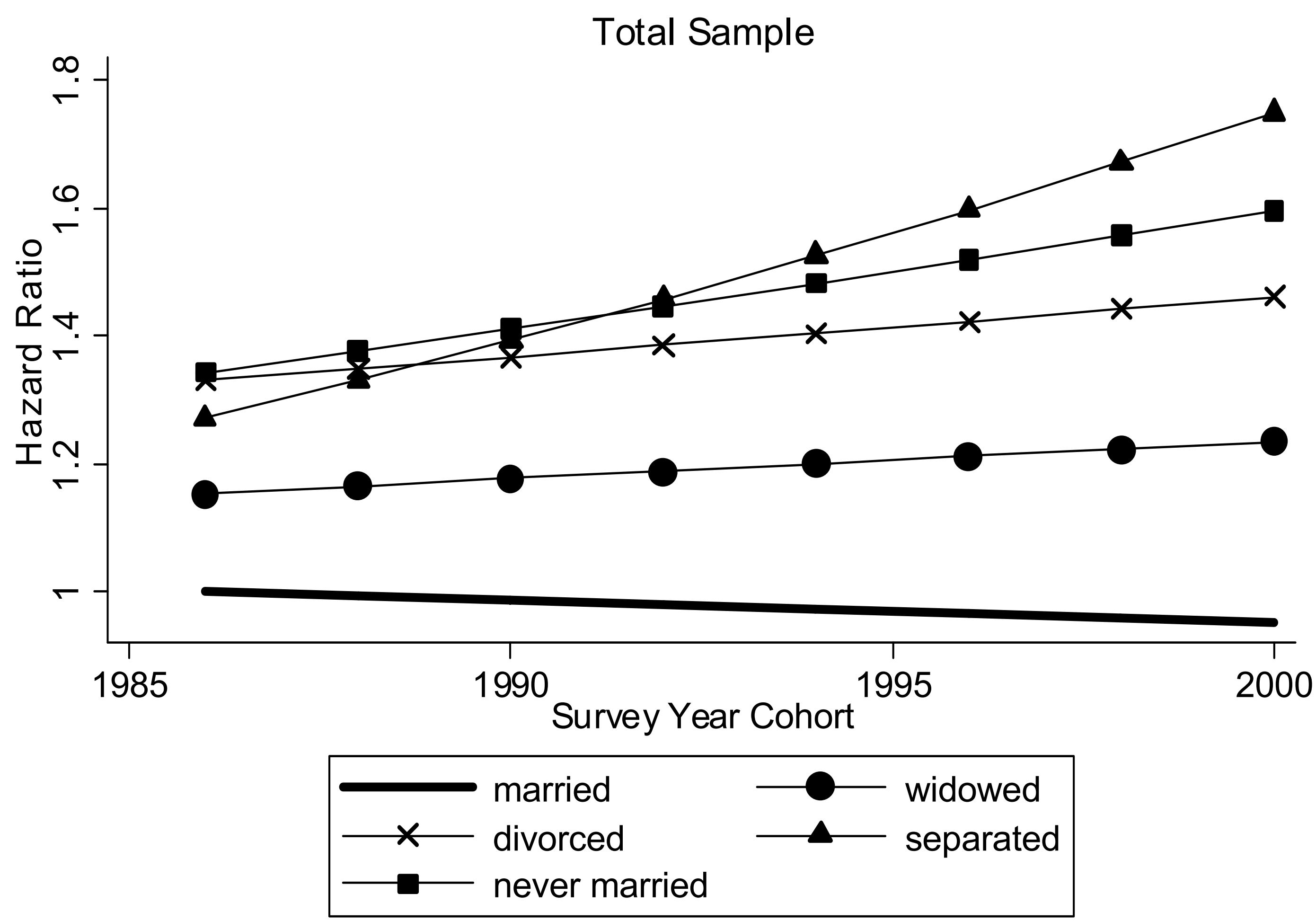

Figure 4. Predicted Trends in Death Hazard Ratios By Marital Status

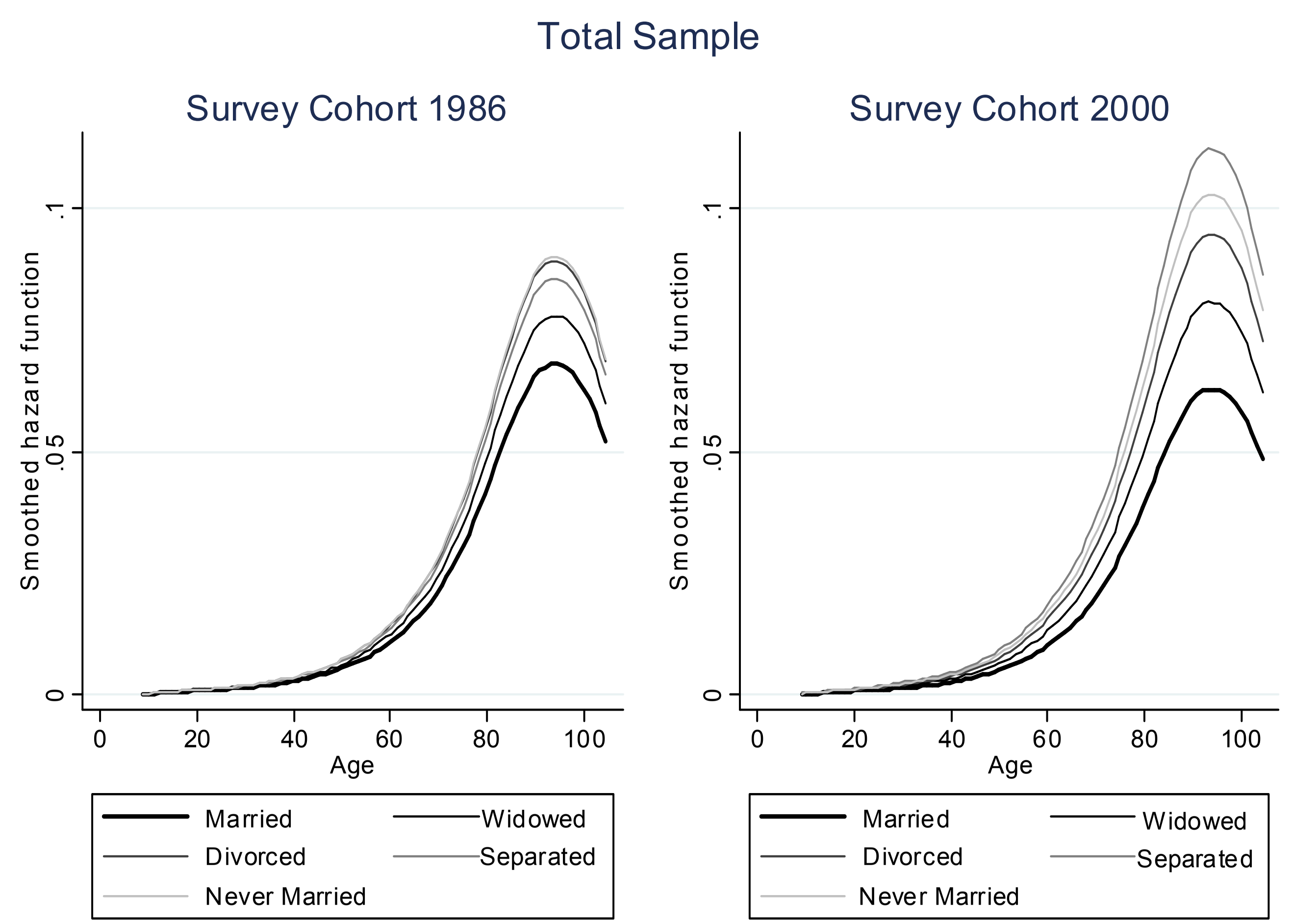

Figure 5. Estimated Death Hazard Function from Cox Regression Model by Marital Status and Selected Survey Cohorts
Note: The graphs are drawn based on predictions for the high school graduate white men.

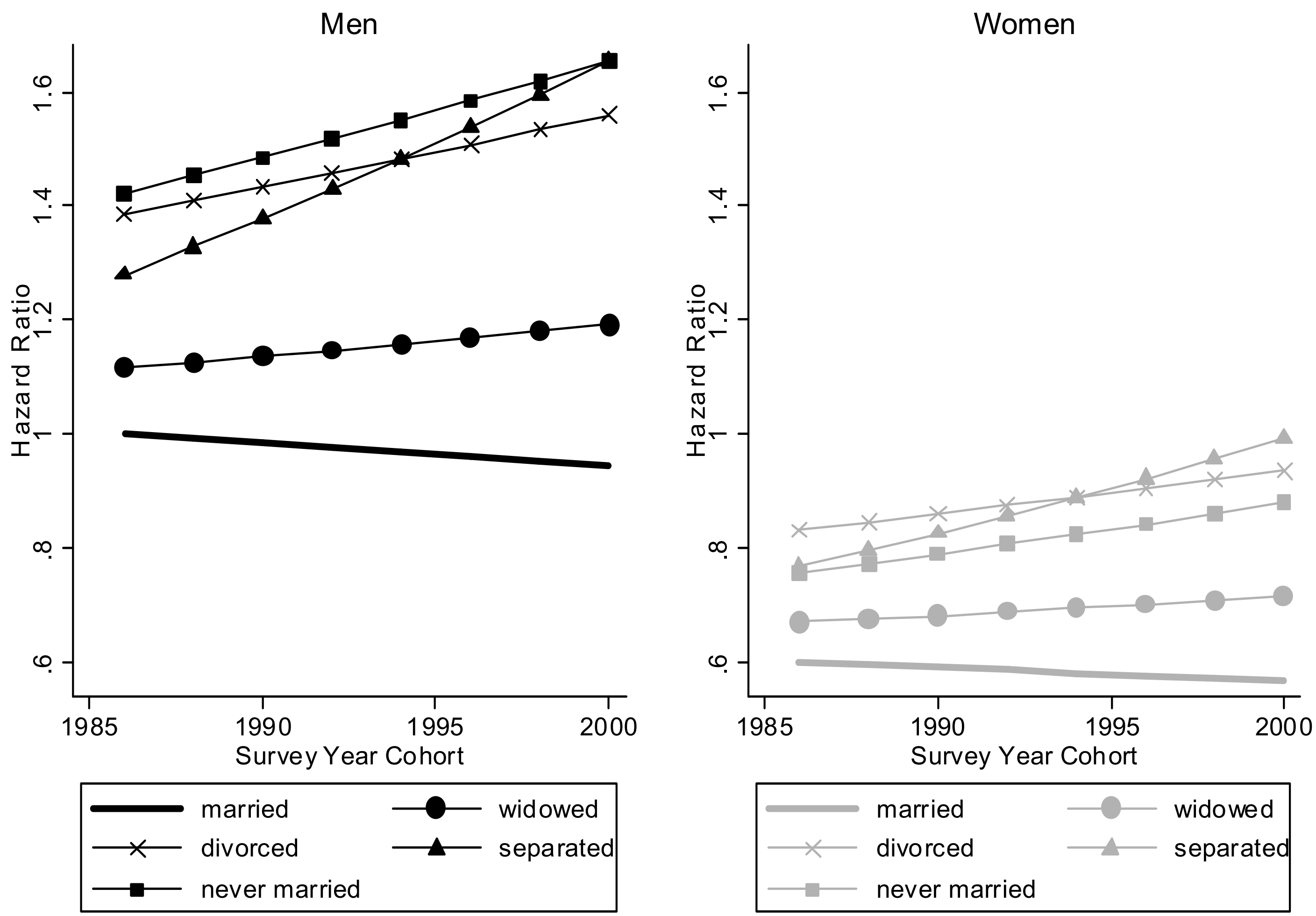

Figure 6. Predicted Trends in Death Hazard Ratios By Marital Status and Gender

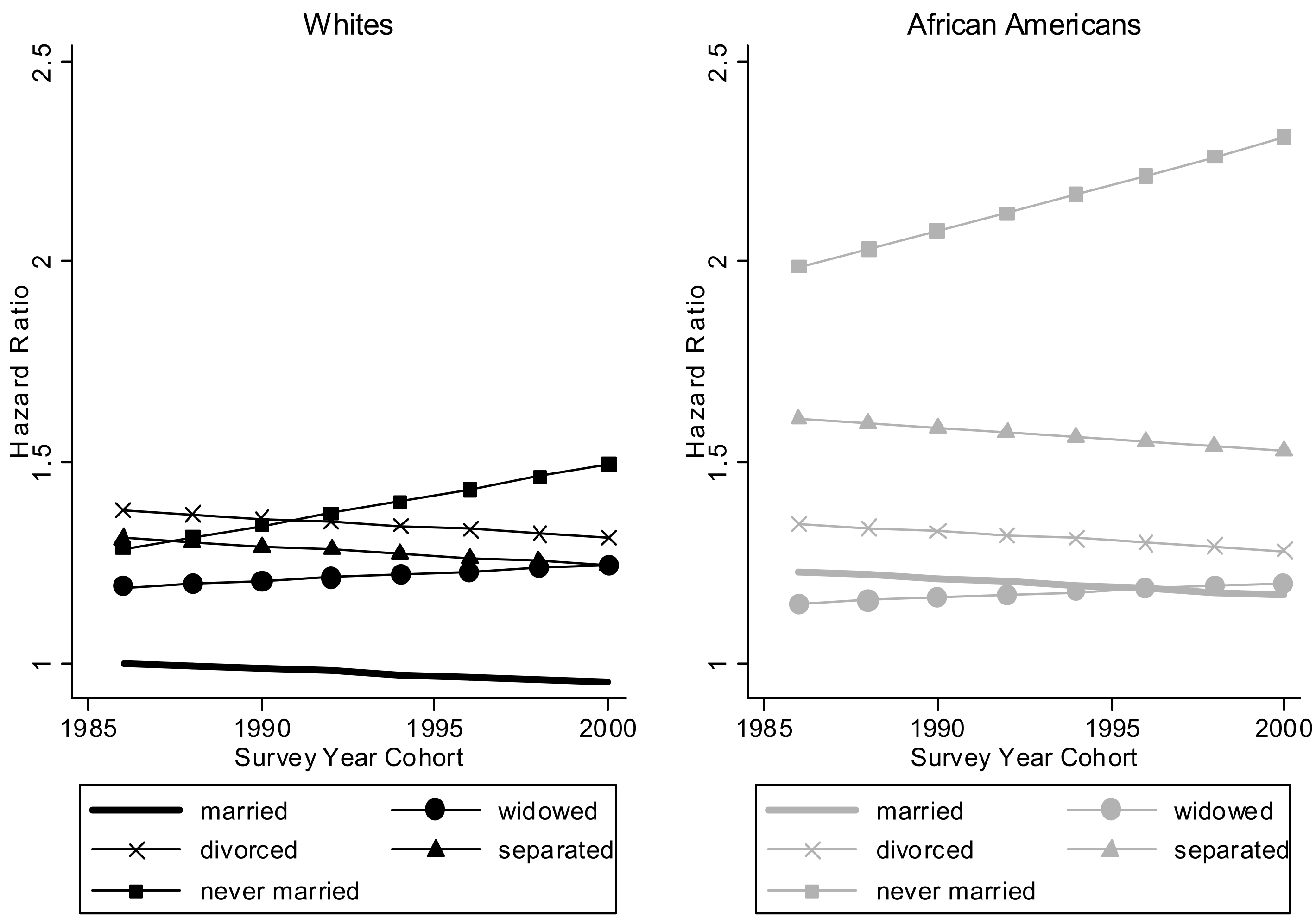

Figure 7. Predicted Trends in Death Hazard Ratios By Marital Status and Race

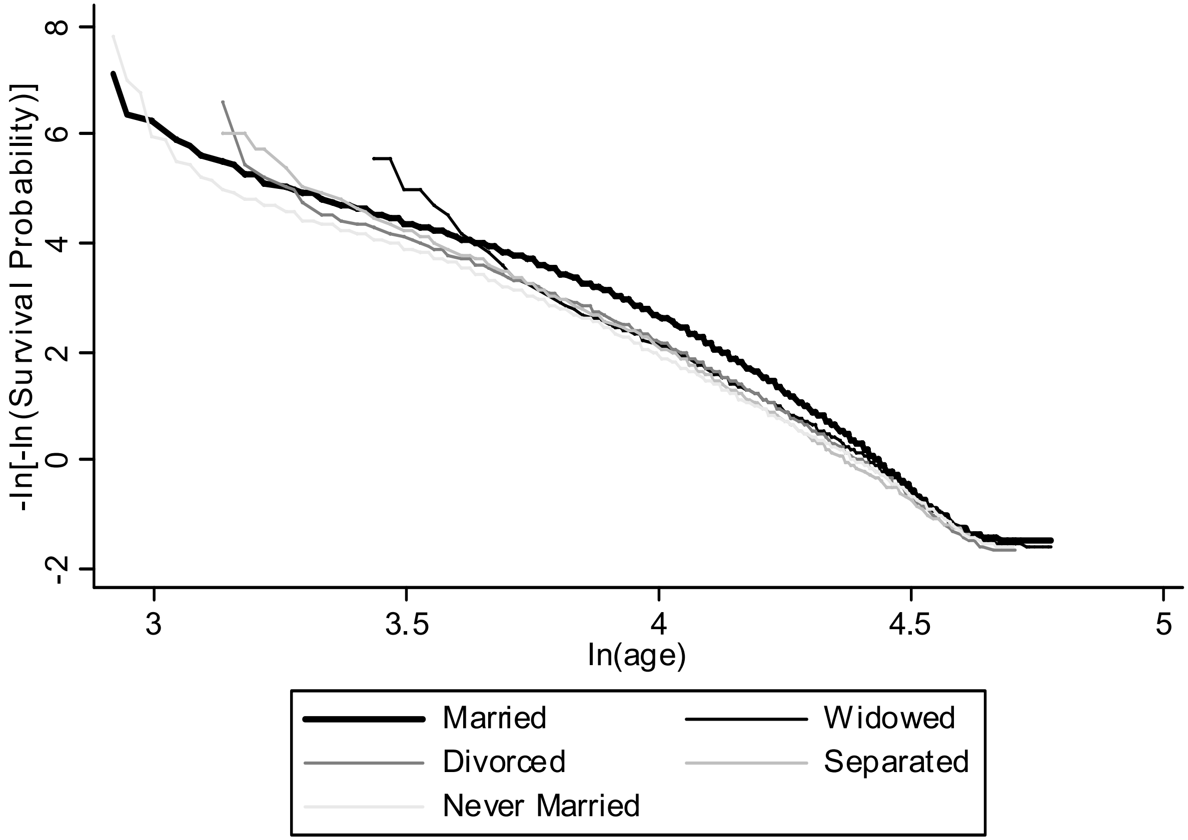

Figure A. Test for Proportional Hazard Assumption for Marital Status