Racial Differences in Marital Instability and Risks for Stroke in U.S. Older Adults

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ABSTRACT

Stroke is among the leading causes of disability and death in the United States and racial differences are greater for stroke than for all other major chronic diseases. Considering the equally sizeable racial disparities in marital instability and associated risks over the life course, the current study hypothesizes that black-white differences in marital history play an important role in the large racial inequalities in stroke. Using retrospective and prospective data from the Health and Retirement Study (n=22,553), results from discrete-time hazard models show that non-Hispanic (NH) blacks have significantly higher rates of marital instability, greater numbers of health-risk factors, and substantially higher rates of stroke at most ages compared with NH whites. Contrary to expectations, however, the effects of marital history are more pronounced for NH whites than for NH blacks. Risks for stroke were significantly higher in NH whites who were currently divorced, remarried, and widowed, as well as in those with a history of divorce or widowhood, compared with NH whites who were continuously married. In NH blacks, risks for stroke were only elevated in those who never married or had been widowed—with no significant risks attributable to divorce. The potential mechanisms underlying the associations are assessed and the implications of the findings are discussed in the context of cumulative disadvantage theory.

INTRODUCTION

Research over the past century has shown that marital status in an enduring institutional marker of adult health and well-being in the United States (Barrett 2001; Berkman and Breslow 1983; Durkheim [1897] 1997; Liu and Umberson 2008; Ross, Mirowsky, and Goldsteen 1990; Verbrugge 1979; Wade and Pevalin 2004; Waite and Gallagher 2000). It is now well documented that adults who are divorced or widowed generally have higher rates of chronic illness (e.g., Dupre and Meadows 2007; Eaker et al. 2007; Zhang and Hayward 2006), physical limitations and disability (e.g., Lee and Carr 2007; Pienta, Hayward, and Jenkins 2000; Verbrugge 1979), and mortality (e.g., Brockmann and Klein 2004; Molloy et al. 2009) compared to adults who are married. More recently, life course studies have increasingly identified the role of marital transitions—particularly marital dissolutions—as major sources of strain that are linked to multiple social, emotional, and physiological risks for poor health (Dupre, Beck, and Meadows 2009; Green et al. 2012; Hedblad et al. 2002; Hughes and Waite 2009; Williams and Umberson 2004).

Despite recent conceptual and empirical advances in the literature, we still know surprisingly little about how marital stability and change are associated with distinct disease processes over the life course. With few exceptions (c.f., Maselko et al. 2009; Zhang and Hayward 2006), existing research focuses primarily on marital status and marital histories (also referred to as marital trajectories or biographies) as they relate to general measures of health status—such as numbers of chronic conditions, functional limitations, self-rated health, and overall mortality. Although richly detailed in marital experiences, these studies lack disease specificity and thus are limited in providing insights into the direct mechanisms at play. Likewise, most studies of defined health outcomes (e.g., diabetes, myocardial infarction,

pulmonary diseases) lack specificity with regard to lifetime exposure to social stressors such as marital instability. Therefore, addressing the duality of these shortcomings is a critical step in understanding how social relationships produce adult health disparities.

According to the U.S. Census, more than a third of all adults will have divorced by age 50 and upwards of a quarter will have married two or more times by the same age (Kreider and Ellis 2011). Although overall rates of divorce have stabilized in recent decades, traditional martial continuity has continued to decrease over time as fewer adults enter marital unions, more adults delay 1st marriages to later ages, and overall marital longevity (duration) is shortened (Elliot and Simmons 2001; Kreider and Ellis 2011). Moreover, these statistics are significantly bifurcated by race. Compared to non-Hispanic whites in the United States, non-Hispanic blacks are much less likely to ever-marry and much more likely to be divorced, become widowed at a younger age, and spend overall less time married (Aughinbaugh, Robles, and Sun 2013; Bryant and Wickrama 2005; Kreider and Ellis 2011). Although the greater heterogeneity in marital experiences among U.S. blacks has recently been linked to major risk factors for cardiovascular diseases—including the use of tobacco and excess alcohol consumption (see Green et al. 2012)—it remains unclear to what extent marital life has a differential impact on health outcomes for whites and blacks.

Of the leading causes of adult disability and death in the United States—i.e., heart disease, cancer, and stroke—racial differences are greatest for stroke (National Center for Health Statistics [NCHS] 2013). In 2010, U.S. black men and women were nearly twice as likely to have a stroke compared to U.S. white men and women (NCHS 2013); and the risk of dying due to stroke was double for blacks than for whites (National Stroke Association 2013; NCHS 2013). Strokes often occur at younger ages for blacks than for whites and their strokes tend to be more

severe and disabling than in their white counterparts (National Stroke Association 2013). Previous studies on the factors attributable to racial disparities in stroke are abundant yet inconclusive. The prevailing view is that black-white differences in the prevalence of hypertension and diabetes mellitus are the major contributing factors for racial differences in stroke incidence. However, research consistently shows that the disparities in stroke largely persist despite accounting for racial inequalities in hypertension, diabetes, and many other previously identified risk factors—such as elevated cholesterol, inactivity, smoking, and an assortment of socioeconomic indicators (e.g., Bravata et al. 2005; Gorelick 1998; Kittner et al. 1990).

Currently, racial differences in marital history and stroke are well documented in separate bodies of literature. However, there are several reasons why bridging these associations has potential importance. First, stroke is a widely prevalent and preventable condition that signals an acute presentation of cardiovascular disease that occurs with the progression of vascular risk at older ages (Go et al. 2014). As with most degenerative diseases, the etiological pathways of stroke are largely attributable to lengthy patterns of acquired risk exposure and life course disadvantages that have accumulated over time. Second, and relatedly, the major risk factors for stroke that have been previously identified—e.g., poor health behaviors, inadequate socioeconomic resources, and coexisting health conditions—are also strongly correlated with marital status and marital history (Gallo et al. 2003; McFarland, Hayward, and Brown 2013; Molloy et al. 2009; Ross, Mirowsky, and Goldsteen 1990; Waite 1995). Most notably, studies show that never married, divorced, and widowed adults generally have fewer resources and social controls to manage pre-existing conditions such as diabetes (e.g., August and Sorkin 2010; Peyrot, McMurry, and Kruger 1999), have higher (or less controlled) blood pressure (e.g., Bell,

Thorpe, and LaVeist 2010; Kamon et al. 2008; Trivedi et al. 2008), have less access to health care (e.g., Becker 1981; Zuvekas and Tallaferro 2003), and are less equipped to maintain an overall healthy lifestyle (e.g., Di Castelnuovo et al. 2009; Meyler, Stimpson, and Peek 2007)—which are known contributors to excess stroke risks (Go et al. 2014; National Stroke Association 2013). Third, blacks are impacted by social adversity and stroke disproportionately more than any other racial group in the United States (Grusky 2000; National Stroke Association 2013). Despite the apparent intersection of these several factors, it is currently unknown whether and to what extent black-white differences in marital history have implications for the development of stroke in older adults.

This study is the first prospective investigation of the long-term impact of marital instability on risks for stroke in U.S. white and black older adults. Data from a nationally representative sample of middle-aged and older adults (1992 to 2010) was used to address three primary research objectives. First, describe the racial differences in the incidence of stroke among U.S. adults at older ages. Second, examine whether and to what extent marital status and marital history contribute to racial disparities in stroke. Third, examine whether socioeconomic, psychosocial, behavioral, and/or physiological risk factors explain the findings. The associations are also assessed for differences by gender and across age. The implications of the findings are discussed in the context life course inequalities in chronic disease and directions for future research.

BACKGROUND

For the past several decades, the life course perspective and the applications of its central tenets have increasingly shaped the landscape of sociological research on aging and health disparities. Central to this theoretical orientation is an emphasis on individual biographies that

reflect long-term patterns of stability and change in social statuses over the life course (Elder 1985; George 1999; Giele and Elder 1998; Hagestad 1990). Perhaps more than any other area of inquiry, research has increasingly demonstrated the importance of marital history as it relates to the health and well-being of adults in later life (e.g., Barrett 2000; Brockmann and Klein 2004; Dupre et al. 2009; Williams and Umberson 2004;). These contributions notwithstanding, only a few studies have examined how marital history relates to specific health conditions over the life course (e.g., Maselko et al. 2009; Zhang 2006); and none have investigated whether marital history plays a role in racial differences in adult chronic diseases.

To date, much of the research on life course inequalities in health rests upon theoretical variations of cumulative disadvantage (Dupre 2007; Ferraro and Shippee 2009; O'Rand and Hamil-Luker 2005; Ross and Wu 1996). Originally termed the *Matthew effect* (Merton 1968), the principal hypothesis of cumulative disadvantage theory is that socioeconomic disadvantage places individuals in diverging trajectories of achievement or hardship over the life course. Those situated near the top of the social and economic hierarchy will generally add to their resources over time; whereas individuals situated at the bottom of the hierarchy will increasingly face hardship relative to their advantaged counterparts. In terms of health, the theory posits that social disadvantages trigger a proliferation of adversities and acquired risks that result in accelerated rates of disease, disability, and death relative to the more advantaged (see Ferraro and Kelley-Moore 2003; Hayward and Gorman 2004; Kuh and Ben-Shlomo 1997).

It is hypothesized that black-white differences in marital history play a role in the large racial inequalities in stroke. According to cumulative disadvantage theory, the onset of stroke will occur over the life course at a faster rate for those with cumulative exposure to marital instability compared with those without a history of marital dissolution. Whether the cumulative

effect of marital life differs by race, however, is not known. On one hand, black older adults with a history of marital instability face multiple adversities—much like "double jeopardy"—that may significantly accelerate the onset of stroke relative to white older adults (see Ferraro and Farmer 1996; Kuh and Ben-Shlomo 1997). In this regard, marital loss may trigger or exacerbate material and economic losses that are compounded in black adults who generally face greater socioeconomic adversities than white adults (see Addo and Lichter 2013). On the other hand, cumulative exposure to marital loss may have less of an impact on blacks than on whites because of a potential resilience that some black adults may have acquired from a life course of disadvantage (see Affleck and Tennen 1996; Mullings 2006; Smith 2006; Suedfeld 1997). Likewise, it also may reflect that marital instability is less prevalent and less normative for whites, and thus more consequential—in terms of psychological distress and maladaptive behaviors—than for blacks (see Brown et al. 2012; Kreider and Ellis 2011).

The following sections describe the significance of stroke in the United States, discuss the major factors hypothesized to explain the associations among race, marital history, and stroke, and summarize the central hypotheses proposed for analysis.

Cardiovascular Disease and Stroke

More than 80 million Americans—approximately 1 in 3 adults—currently live with one or more forms of cardiovascular disease (CVD) and more than 7 million hospitalizations occur each year because of CVD-related illnesses (Go et al. 2014; NCHS 2013). Stroke is the 4th leading cause of death in the United States and the number one cause of adult disability.[1] According to recent estimates, stroke and stroke-related disabilities cost the United States an estimated $37 billion in health care services, prescription drugs, and lost productivity in 2010 (Go et al. 2014). Moreover, the total direct medical costs related to stroke are projected to nearly triple, from

$71.6 billion to $184.1 billion, over the next 15 years. These human and societal costs are further staggering when it is estimated that upwards of 80% of strokes are preventable (National Stroke Association 2013).

Of the leading causes of adult disability and death in the United States, racial differences are shown to be greatest for stroke (Gorelick 1998; NCHS 2013). Compared to whites, strokes generally occur at younger ages and are more severe, disabling, and deadly among blacks (National Stroke Association 2013; NCHS 2013). There is also evidence to suggest that racial differences in stroke are more pronounced in middle adulthood than in later adulthood (Chong and Sacco 2005; Giles et al. 1995; Go et al. 2014; National Stroke Association 2013). According to some estimates, middle-aged blacks are two-to-four times more likely to die from stroke than middle-aged whites (Morgenstern et al. 1997; Wang and Wang 2013).

Dozens of studies have also been published on the association between marital status and many forms of cardiovascular disease, including stroke. In general, most of this research includes marital status as a static background adjustment in analyses of cardiovascular risk and prognosis (e.g,. Gallo et al. 2003; Hedblad et al. 2002; Luttik et al. 2006; Molloy et al. 2009). With regard to stroke, the results of these studies generally show that married adults have significantly lower rates of stroke incidence and survival; whereas those who are divorced or widowed are much more likely to have a stroke (and die sooner from the disease) than those who are married (Boden-Albala et al. 2005; Engström et al. 2004; Maselko et al. 2009). For example, a recent large-scale study of middle-aged and older adults showed that risks for stroke were significantly elevated following divorce and widowhood compared with those who were married (Engström et al. 2006). Studies also find that risks for stroke are higher in adults who never married relative to those who are married (Maselko et al. 2009).

Less documented, however, is whether the effect of marital loss on stroke accumulates over the life course. Although direct evidence is limited, research shows that adults with a history of divorce have higher rates of chronic illness (including stroke) compared with adults who are continuously married over time (Dupre and Meadows 2007; Zhang and Hayward 2006); and those with a history of multiple marital losses incurred monotonically higher risks of disease (Dupre and Meadows 2007; Hughes and Waite 2009). Indeed, Zhang (2006) shows that rates of stroke are especially high in those two or more past marital dissolutions—regardless of current marital status—relative to those who remained stably married. Studies also demonstrate strong associations between cumulative marital losses and many of the leading risk factors for stroke, including smoking, heavy alcohol consumption, and metabolic status (e.g., Green et al. 2012; McFarland et al. 2013).

Collectively, the evidence is clear that race and marital life have consequences for cardio-vascular health and subsequent stroke over the life course. Yet, studies have stopped short of integrating the associations among race, marital history, and the differential rates of stroke in older adults. Furthermore, no existing studies have explored the underlying mechanisms for excess stroke in white and black adults with a history of marital discontinuity. The following section describes the key factors hypothesized to explain how race and marital instability relate to the incidence of stroke.

Race, Marital Instability, and Risks for Stroke

Although numerous studies have investigated racial differences in stroke, the factors contributing to these disparities are still poorly understood. A body of literature too large to summarize here consistently identifies racial differences in many of the major risk factors for stroke—such as poor health behaviors, inadequate socioeconomic and psychosocial resources,

and coexisting health conditions (e.g., Axon et al. 2011; Bell et al. 2010; Gorelick 1998; Pandey and Gorelick 2005; Sacco et al. 2001; Worrall et al. 2002; Zhang and Rodriguez-Monguio 2012). By and large, the majority of research focuses on racial differences in rates of hypertension and diabetes as the suspected underlying causes of black-white differences in stroke incidence. However, these studies generally find that racial disparities in stroke largely persist despite accounting for differential rates of hypertension, diabetes, and other classical risk factors for stroke (e.g., Bravata et al. 2005; Gorelick 1998; Kittner et al. 1990).

Noticeably lacking in the literature is attention to how social stress accumulates over the life course to increase risks of a detrimental yet preventable health event such as stroke. Indeed, the risk factors associated with race have also been linked to marital status and marital instability (see Gallo et al. 2003; McFarland, Hayward, and Brown 2013; Molloy et al. 2009; Ross, Mirowsky, and Goldsteen 1990; Waite 1995). Below, I summarize the key mechanisms proposed to explain how marital history may relate to the onset of stroke.

Socioeconomic Factors: Socioeconomic status and its resources are widely recognized as key factors contributing to why married adults generally have better health than unmarried adults. The conventional argument is that marriage provides a shared context of acquired financial and material resources and that marital dissolution severs these socioeconomic bonds (Duncan and Hoffman 1985; McManus and DiPrete 2001; Wilmoth and Koso 2002). Indeed, studies show that the stably married have more wealth, better occupations, and less unemployment than those with marital disruptions (Addo and Lichter 2013; Smith 1994; Waite 1995). Married couples also have greater access to health resources, such as medical insurance and prescription drug coverage, through work or their spouse's employment (Becker 1981; Fletcher 1988; Waite 1995; Zuvekas and Tallaferro 2003).

Psychosocial Factors: Psychosocial background is a second category of mechanisms that is important to the development of stroke and overall cardiovascular health. The prevailing argument is that marriage confers emotional well-being, social support, family cohesion, coping resources, and a shared sense of problem solving that are important for preventing, detecting, and treating illness (Brown and Smith 1992; Gerstel, Riessman, and Rosenfield 1985; Ross and Mirowsky 1989; Watcherman and Sommers 2006). Indeed, studies show that unmarried adults are typically more vulnerable to stress because they are less socially and psychologically equipped to minimize the harmful effects of adversity compared to married adults (Peters and Liefbroer 1997; Ross, Mirowsky, and Goldsteen 1990). However, marriage is not a universal indicator of spousal support and psychological capital (Waite, Luo, and Lewin 2009). An increasing body of work also shows that marital stress and poor marital quality can have detrimental effects on cardiovascular risks and prognoses (Baker et al. 2003; Gallo et al. 2003; Luttik et al. 2006; Trivedi et al. 2008).

Behavioral Factors: Behavioral factors are a related class of mechanisms that are often correlated with psychosocial attributes and psychological disposition. The most frequently cited behaviors are smoking, diet, exercise, and alcohol consumption (Bogart et al. 2005; Franks, Pienta, and Wray 2002; Pettee et al. 2006; Power, Rodgers, and Hope 1999; Umberson 1992). The effects of most health practices on cardiovascular health are well established and fairly intuitive, but their distributions across marital groups are not always straightforward (Berkman and Breslow 1983; Kaplan and Keil 1993). For example, studies generally show that marriage promotes social control and obligations to others that encourage a healthy diet, regular medical checkups, moderate alcohol consumption, and the avoidance of smoking (e.g., Husaini et al. 2001; Kamon et al. 2008; Umberson 1992). Indeed, recent research shows that spouses with

concordant dispositions toward health regularly motivate each other to maintain healthy lifestyles to avoid premature illness and death (Di Castelnuovo 2009; Meyler, Stimpson, and Peek 2007). However, there also is evidence to suggest that married adults, particularly men, exercise less and are more overweight than unmarried adults (Grzywacz and Marks 2001; Kahn and Williamson 1990; Sobal, Rauschenbach, and Frongillo 2003).

Physiological factors: The most proximate mechanisms linking marital history to cardiovascular events such as stroke are physiological status and pre-existing conditions. Diabetes, hypertension, hyperlipidemia, and obesity are well-known risk factors for heart attack and stroke (Go et al. 2014; NCHS 2013), yet they are the least studied pathways as they relate to marital history and health (Profant and Dimsdale 1999; Sbarra et al. 2009; Spruill et al. 2009). The general expectation is that marital dissolution is an antecedent of numerous socio-economic, psychosocial, and behavioral risk factors, which in turn, are associated with increased risks for chronic health conditions such high blood pressure, elevated cholesterol, and excess body mass (see Das 2013). Indeed, research shows that married adults generally have greater resources and more social controls to manage conditions such as diabetes and high blood pressure (Bell et al. 2010; August and Sorkin 2010; Kamon et al. 2008; Peyrot et al. 1999; Trivedi et al. 2008), have greater access to health care (Becker 1981; Zuvekas and Tallaferro 2003), and are more equipped to sustain healthy lifestyles (Di Castelnuovo et al. 2009; Meyler et al. 2007).

Hypotheses

The primary objective of the current study is to examine the influence of marital history on black-white differences in stroke in older adults. A life course perspective serves as the overarching framework to understand how current and past exposure to social stressors such as marital instability increases risks for stroke with advancing age. The general expectation is that

marital loss is an added source of cumulative disadvantage that is associated with a constellation of risk factors that are detrimental for preventing (or delaying) stroke in older adults. To this end, several hypotheses are postulated for examination. The first hypothesis draws from the literature on how U.S. whites and blacks differ in rates of stroke at older ages:

> *Hypothesis 1 (H1)*: Black older adults will have greater risks for stroke than white older adults; however, the association will diminish at advanced ages.

The second hypothesis asserts that current marital status and past marital instability will be associated with the onset of stroke. Existing research suggests that older adults who are not continuously married will have risks for stroke that are significantly higher than older adults who are stably married. Although much less documented, it is argued that older adults with a history of marital instability also will have significantly higher risks for stroke than older adults with a life course of continuous marriage. Therefore, I posit:

> *Hypothesis 2 (H2)*: Current and past marital dissolution(s) will increase risks for stoke in older adults.

Next, it is hypothesized that marital instability contributes to the large racial differences in stroke at older ages. Previous studies show that the elevated prevalence of hypertension and diabetes in U.S. blacks does not explain the excess risks of stroke at later ages. From a sociological standpoint, and according to cumulative disadvantage theory, it is argued that the higher incidence of stroke among older blacks than among whites can be explained by the risks associated with current and cumulative exposure to instability in marital relationships over the life course.

> *Hypothesis 3 (H3)*: Current and past marital dissolution(s) will mediate the association between race and stoke in older adults.

Whether the cumulative effect of marital life on stroke differs by race, however, has not been shown. Based on the literature, two alternative hypotheses are tested. First, it is argued that black older adults with a history of marital disruption face additional disadvantages that may significantly increase the incidence of stroke relative to white older adults. According to this argument, marital dissolution will lead to material and economic adversities that are more consequential for black adults who generally face greater socioeconomic disadvantages than white adults. Therefore:

> *Hypothesis 4a (H4a)*: Older blacks with marital instability will have higher risks for stroke than older whites with marital instability.

Conversely, cumulative exposure to marital loss may have less of an impact on blacks than on whites because of a potential resilience that some black adults may have acquired from a life course of disadvantage. Relatedly, it also may reflect that marital disruptions are less common and less socially normative for whites than for blacks. Thus, the following hypothesis is tested:

> *Hypothesis 4b (H4b)*: Older whites with marital instability will have higher risks for stroke than older blacks with marital instability.

The last set of hypotheses focus on the potential mechanisms thought to explain the associations between marital instability and stroke. Although no existing studies have examined the pathways among race, marital life, and subsequent stroke, the expectation is that the mechanisms producing black-white inequalities in stroke will differ by race. For white older adults, it is argued that divorce and widowhood will be most consequential in terms of the

psychological distress and maladaptive behaviors that may result from experiencing marital instability. For black older adults, however, it is predicted that marital instability will operate most directly through the socioeconomic hardships that accompany divorce and widowhood.

> *Hypothesis 5a (H5a)*: Psychosocial and behavioral factors will have the greatest explanatory power for the associations in older whites.
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> *Hypothesis 5b (H5b)*: Socioeconomic factors will have the greatest explanatory power for the associations in older blacks.

DATA AND METHODS

This study uses 10 waves of nationally representative data from the Health and Retirement Study (HRS) for analysis. The HRS is an ongoing prospective cohort study of U.S. adults over the age of 50 sponsored by the National Institute on Aging and the Institute for Social Research at the University of Michigan (HRS 2014). The original study cohort included 9,824 age-eligible respondents born in 1931 to 1941 who have been interviewed biennially since 1992. The initial response rate was 82% in 1992 and re-interview response rates were approximately 94% for 1994-2010, with minimal attrition due to non-response and lost tracking. Since 1998, the HRS has been supplemented with age-selective birth cohorts to replenish the nationally representative sample of older adults. Comprehensive details of the multistage sampling design, survey implementation, and response rates have been documented elsewhere (HRS 2014; Juster and Suzman 1995).

Data for the study come from 30,077 participants from the original HRS birth cohort, the Asset and Health Dynamics Among the Oldest Old cohort (AHEAD: $\leq$ 1923), Children of Depression (CODA: 1924-1930), War Baby cohort (WB: 1942-1947), and Early Baby-Boom cohort (EBB: 1948-1953) who were first interviewed in 1992, 1993, 1998, and 2004, respectively, and re-interviewed through 2010. Data for 2012 were not used for this analysis

because information on respondent mortality is not currently available/complete for this period (refer to sensitivity analyses below). Respondents identified by race other than non-Hispanic (NH) white or black (n=3,380; 11%), those aged 50 and younger (n=2,439; 8%), and those with missing data on marital status (n=924; 3%). Adults over the age of 85 at baseline (n=781; 3%) also were excluded to reduce potential bias related to selective health and survival. A person-year file was constructed from the respondents' age-specific cumulative exposure to stroke so that each observation was a record for every additional year beyond their age at entry in the study. The final analytic sample includes 22,553 adults aged 51-85 who contributed, on average, approximately 8 person-years over the 18-year study period. A total of 1,999 strokes (9%) were reported during the 262,433 person-years of observation.

Measurement

More than 50 years of prospective and retrospective data from the HRS were used to reconstruct marital histories for each study member. Marital information was ascertained from detailed responses to questions about the beginning/ending dates (in years and/or months) of all marriages and marital losses reported by HRS participants. The subjects' month/year-specific information was converted to age-specific data using date of birth, date of interview, and date of event. The coding of study measures was facilitated by using HRS data files provided by RAND's Center for the Study of Aging and funded by the National Institute on Aging and the Social Security Administration (HRS 2014).

Race in this study was categorized as NH white (reference group) and NH black (coded 1). Marital status and marital instability were operationalized with two sets of measures. First, four time-varying dichotomous measures (each coded 1) were used to capture changes in marital status for respondents who were never married, continuously married (reference group),

divorced, widowed, or remarried. Second, time-varying dichotomous measures of marital instability were used to indicate respondents with a history of one divorce, two or more divorces, and one or more widowhoods—each coded 1. The small numbers of adults with more than two divorces or more than one widowhood prohibited additional categorizations of marital history for analysis. Continuously married adults are the reference group in the analyses.

The multivariate models adjusted for background characteristics that include age (in years), HRS study cohort (AHEAD, CODA, WB, and EBB each coded 1 and the initial HRS as the reference group), gender (male coded 1), urban-rural residence (urban coded 1), and geographic region (South coded 1). Several categories of previously identified risk factors and resources also are examined as possible mechanisms. *Socioeconomic factors* include the respondents' educational attainment (in years), employment status (coded 1 if not currently working),[2] income from all sources in thousands of dollars (logarithmic scale), and health insurance coverage from any source (coded 1 if no health insurance). *Psychosocial factors* include living arrangement (coded 1 if lives alone), number of depressive symptoms measured by the 8-item abbreviated Center for Epidemiologic Studies Depression Scale (CES-D; range=0-8), and whether the respondent was diagnosed with an anxiety, emotional, or other psychiatric condition (coded 1). *Behavioral factors* include current smoking status (coded 1 if currently smoking), alcohol use (coded 1 if ≥ 3 drinks per day), and frequency of vigorous physical exercise (coded 1 if < 3 times per week). *Physiological factors* include body mass index (calculated as weight in kilograms divided by height in meters squared; <18.5 [underweight; coded 1], 18.5-24.9 [normal weight; reference group], 25.0-29.9 [overweight; coded 1], or ≥30.0 [obese; coded 1]), hypertension (coded 1 if diagnosed), and diabetes mellitus (coded 1 if diagnosed).

Preliminary analyses also included variables to adjust for age at first marriage, number of children, occupational status, abstinence from alcohol, and spouses from the same household; however, results were not significant and the variables were dropped from the final models. Alternative coding strategies were also assessed for the included covariates and did not alter the central findings. With the exception of gender and race, all measures were time varying and time lagged (observed in the previous wave [i.e., within the prior 24 months]—with the exception of age) in the prospective analyses to establish temporal order when estimating the associations between the covariates and subsequent stroke (Allison 1995; Fisher and Lin 1999). Therefore, the time-varying covariates captured changes in many of the socioeconomic, psychosocial, behavioral, and physiological factors thought to account for the elevated risks following marital loss. Alternative lag times (e.g., no lag, 12-months, 48-months, etc.) also were assessed in preliminary analyses and produced largely consistent results.

The incidence of stroke was the main outcome for analysis. At each survey interview, study participants were asked whether "a doctor ever told you that you had a stroke" and in what year (and month after 1994) if it occurred. Although subjects' reports of stroke are less precise than clinical data, studies show considerable consistency between diagnostic reports of serious health events from survey respondents and those from medical evaluations (Bush et al. 1989; Okura et al. 2004). For persons who experienced a stroke, the outcome corresponds to the age of the event (calculated from the dates of birth and the event). For persons who did not have a stroke, the outcome corresponds to the age when respondents were last observed in the absence of an event. Three thousand eighty one subjects (approx. 15%) died during the study period and were censored at their age of death.

Statistical Analysis

Baseline characteristics of the HRS sample were computed for all participants and for NH whites and NH blacks. Comparisons by race were calculated with 2-tailed *t* tests for continuous and count variables and χ^2 tests for categorical variables. *P*-values were based on 2-tailed tests and considered statistically significant at $p < .05$. Discrete-time hazard models were then used to estimate the odds ratios (ORs) for the incidence of stroke associated with race, marital factors, and other covariates. The hazard rate is defined as the conditional probability that an individual will have a stroke at time *t,* given that the individual was disease-free at the beginning of time *t.* The ratio of these conditional probabilities is calculated as the *odds* of a stroke, or $\ln[P_t / 1 - P_t]$ in logit form. Various functional forms (e.g., piecewise exponential, log-linear, curvilinear) were evaluated using graphical plots and standard Bayesian information criterion (BIC) statistics to determine the parametric specification that best captured the distribution of strokes across age (Raftery, 1995). A linear function of the log odds was the best fitting and most parsimonious of those evaluated. In notation, the log odds of stroke is specified as a linear function of increasing age and a set of time-invariant (e.g., race) and time-varying (e.g., marital status and history) variables, expressed as:

$$\ln[P_{it} /(1 - P_{it})] = \alpha_t + \boldsymbol{\beta}'\mathbf{X}_{it},$$

so that

$$\alpha_t = \alpha_0 + \alpha_1 t,$$

where the log odds of a stroke in a sample of *n* independent observations ($i = 1,2,3\ldots n$) at time *t* is a function of time, α_t, and a vector of independent variables **X**, where **β** is a vector of parameters to be estimated. Time (α_t) is specified as a linear function of age, so that time begins at baseline age (α_0) and increases ($\alpha_1 t$) until the age at which a stroke occurs or becomes a

censored observation. All models included a significant interaction term for race x age to account for the known changes in racial differences in stroke across age (Chong and Sacco 2005; Giles et al. 1995; Go et al. 2014).

Age-adjusted odds were first estimated and plotted to describe differences in incident rates of stroke for the time-varying measures of marital status and marital history in NH whites and NH blacks. Next, a set of multivariate models examined the associations among race, marital factors, and stroke. Model 1 included race and adjusted for age, study cohort, gender, urban-rural residence, and geographic region (H1); Model 2 further included variables for marital status and marital history to assess the degree to which marital factors mediate the relationship between race and stroke (H2); and Model 3 tested interactions between race and the marital variables to assess whether racial differences in stroke are moderated by marital status and marital history (H3). A second set of multivariate analyses were stratified by race to examine the potential socioeconomic, psychosocial, behavioral, and/or physiological mechanisms associated with marital differences in the incidence of stroke for NH whites and NH blacks (H4a-H5b).

Three sets of sensitivity analyses were also conducted. First, although mortality was relatively low during the study period (< 15%), competing-risk hazard models were estimated to account for potential bias due to selective mortality. Results were nearly identical to those presented here, with only negligible changes in the point estimates and CIs (± .01-.001). Second, although the analyses adjust for a large number and range of covariates, it is possible that additional unmeasured confounding (i.e., residual confounding) may have contributed to the findings. Therefore, a series of discrete-time random effect frailty models were estimated to assess potential bias from unobserved measures. The analyses revealed no significant bias and suggest that unobserved heterogeneity is not altering the central findings. Finally, separate

models were run for the marital status and marital history measures because preliminary analyses indicated a moderate degree of bivariate correlation and multicollinearity in the models—condition values were > 60, with the largest variance decomposition proportions and variance inflation factors among the marital variables.

All models were weighted for the complex sampling design to produce unbiased variance estimates and robust standard errors were calculated using sandwich estimators of variance to account for the intra-individual correlation in the repeated observational data. Analyses were conducted using Stata 12.0 (StataCorp 2011).

RESULTS

Characteristics of the study participants are presented for the entire sample and by race in Table 1. Non-Hispanic blacks were more likely to be younger, female, live in rural areas, and reside in the South compared with non-Hispanic whites. Non-Hispanic blacks also had less education, lower levels of income, were less likely to have any health insurance, exercised less, lived alone, and had more depressive symptoms than NH whites. Rates of smoking, obesity, diagnoses of hypertension or diabetes mellitus, and the occurrence of stroke were also significantly higher in NH blacks than NH whites. In terms of marital status, NH whites were more likely to be continuously married or remarried at baseline than NH blacks; whereas NH blacks had significantly higher rates of being currently divorced or widowed compared with NH whites. With regard to past marital instability, NH blacks were significantly more likely to have a history of divorce and/or widowhood than NH whites. There were no statistically significant race differences for those with a history of two or more divorces.

The age-adjusted plots shown in Figure 1 demonstrate significant racial differences (NH black p-value < .001) in rates of stroke across most ages. The figure also demonstrates the

previously established change in racial differences in stroke at older ages (NH black x age *p*-value < .001) as hypothesized (H1). Table 2 presents the sociodemographically-adjusted ORs for the association between race and stroke and the mediating and moderating effects of marital status and marital history. Model 1 shows that risks for stroke are significantly higher in NH blacks than in NH whites (OR=1.82; $p < .001$) as predicted by Hypothesis 1. Model 2 shows that risks for stroke are elevated in all older adults who are not continuously married (H2). In terms of marital status, risks are significantly higher among those who were never married (OR=1.42), divorced (OR=1.27), remarried (OR=1.30), and widowed (OR=1.66). In terms of cumulative marital instability, the incidence of stroke significantly increases for adults with a history of one divorce (OR=1.32), two or more divorces (OR=1.46), and one or more times being widowed (OR=1.66) compared with adults without a history of marital loss. However, the addition of measures for marital status and marital history in Model 2 provides only limited evidence of their mediating role on the association between race and stroke (H3).

Model 3 includes interaction terms and indicates that the association between race and risks for stroke are significantly moderated by marital status and marital history. Overall, the findings for Hypothesis 4 are mixed—although more consistent with H4b than with H4a. Results suggest that NH blacks who are never married have significantly greater risks of developing stoke at older ages than NH whites who never married ($p < .05$). Conversely, the excess risks associated with a history of one divorce ($p < .01$) and two or more divorces ($p < .05$) are significantly greater among NH whites than among NH blacks. For illustrative purposes, these results are plotted as predicted odds in Figure 2 to demonstrate the differential patterns of risk for NH whites and NH blacks across age. The results for widowhood history are not plotted for purposes of space and because the patterns largely resemble widowed status.

Table 3 presents the results from a series of models examining the potential mechanisms contributing to marital differences in stroke for NH whites and NH blacks. Overall, it can be seen that marital status and marital history have a significantly greater impact on the incidence of stroke among NH whites than among NH blacks (H4b). However, the inclusion of more than a dozen socioeconomic, psychosocial, behavioral, and physiological explanatory variables only partially attenuated these associations. For NH whites, behavioral factors (Model 4) are attributable to the largest reductions in ORs for those who are currently divorced or widowed, or have a history of divorce or widowhood. Psychosocial factors (Model 3) reduced the ORs and significance level most for NH whites who are currently remarried. For NH blacks, the excess risks for stroke associated with being never married—and to some extent being currently widowed—are attenuated most due to socioeconomic factors (Model 2). Together, these findings lend partial support for Hypotheses H5a and H5b. In addition, according to estimated BIC statistics (not presented), marital history is more predictive of stroke than marital status for NH whites; however, there are no discernible differences for NH blacks. And as expected, the models with physiological factors (Model 5) have the greatest overall model fit for the incidence of stroke—although these factors appear to be operating largely independent of race and marital factors.

Finally, supplementary analyses were conducted to examine whether the associations varied for men and women and/or across age. Of the nearly two dozen interactions that were tested, there was no evidence that the key findings differed across age and there was only one significant interaction ($p < .05$) to suggest that NH white women had higher risks of developing a stroke than NH white men.

DISCUSSION

The current study is the first to examine racial differences in the longitudinal association between past and present marital experiences and the incidence of stroke at older ages. The results demonstrate that marital status and marital history operate differently according to race and extend our understanding of how cumulative exposure to social relationships produces inequalities in cardiovascular health. Overall, NH blacks have significantly higher rates of marital instability, greater numbers of health-risk factors, and substantially higher rates of stroke at most ages compared with NH whites. Somewhat contrary to expectations, however, the effects of marital history are more pronounced for NH whites than for NH blacks. The odds of having a stroke are significantly higher in NH whites who are currently divorced, remarried, and widowed, as well as those with a history of divorce or widowhood, compared with NH whites who are continuously married. In NH blacks, however, risks for stroke are only elevated in those who never married or had been widowed—with no significant risks attributable to divorce.

For the past several decades, life course research has made innumerable contributions to our understanding of how social factors and health interrelate over personal and historic time. The current study contributes to this body of work in several important ways. First, this study uses longitudinal data from the largest representative panel of U.S. white and black adults over the age of 50. The HRS provided detailed retrospective histories and prospective data spanning almost 20 years to estimate the age-related incidence of stroke using time-varying covariates and multivariate hazard models. Second, and relatedly, this study considered the widest array of explanatory factors for racial differences in stroke related to marital instability. Nevertheless, the distinct marital effects for NH whites and NH blacks remained largely robust statistically significant despite accounting for more than a dozen possible mechanisms. Moreover, the time-

varying covariates captured changes in many of the socioeconomic, psychosocial, behavioral, and physiological factors thought to explain the elevated rates of stroke following a divorce or widowhood. Third, the results of this study also contribute to mounting evidence that the cardiovascular risks associated with social stressors are comparable in magnitude to established risk factors such as smoking, diabetes, and hypertension (Dupre et al. 2012; Gallo et al. 2004). In NH whites, for example, the adjusted risks associated with hypertension (OR=1.77) and diabetes (OR=1.68) are similar in size to the risks observed in NH whites with a history of two or more divorces (OR=1.65). The adjusted risks in NH blacks who never marry are even larger (OR=1.80). In much the same way, the findings for marital status and marital history largely mirror the protracted and cumulative associations recently documented between lifetime exposure to job loss and risks for a heart attack (Dupre et al. 2012).

The general finding that marital status and marital history are more consequential for NH whites than for NH blacks is not unexpected (H4b). According to cumulative disadvantage theory, older adults with a history of marital instability are hypothesized to confront disadvantages that exert a cumulative effect on age-related rates of stroke onset. The analyses suggest that it is the absence of any marital involvement (i.e., never married) that poses the greatest risk for stroke in older NH blacks; and alternatively, any experience of marital loss elevates rates of stroke in older NH whites. Several explanations for these findings are postulated.

The first possible explanation is related to the concept of resilience (see Suedfeld 1997). Resilience is viewed as a clustering of psychological resources that promote social competence, effective problem-solving, and a proactive stance toward the environment (Affleck and Tennen 1996; Smith 2006). Relatedly, resilience also refers to the ability of some individuals to obtain

and mobilize resources that would typically be unavailable to them. Resilient individuals are able to find stability and order for themselves in unstable circumstances (such as marital loss), and they are able to procure knowledge, resources, and influence that are not assessable from family or their immediate environments (Mullings 2006). In this regard, some NH blacks may have benefited from an unmeasured form of resilience or hardiness that permits them to sustain health despite deprivation. Unfortunately, direct measures of resilience and related traits, such as self-efficacy, a sense of control, and optimism are not available for analysis.

Second, it also is plausible that divorce is a less normative and consequently more socially stressful transition in NH whites than in NH blacks. The HRS data provide some support to this argument. Table 1 shows large distributional differences in rates of divorce by race. Most notably, NH blacks are more than twice as likely as NH whites to be divorced at baseline. Furthermore, supplemental analyses demonstrate stronger correlations between marital loss and increases in most risk factors (particularly psychosocial distress) in NH whites. Accordingly, the multivariate findings suggested that psychosocial factors and maladaptive health behaviors exerted the largest (albeit modest) attenuation of marital effects (H5a). A third and final possible explanation is that marital instability increases risks for stroke more for NH whites than for NH blacks because of the low underlying rates of stroke in whites and already elevated rates in blacks. In other words, there may be a "ceiling effect" that contributes to greater attributable increases in stroke in NH whites than in NH blacks. However, these interpretations remain guarded until more research is conducted to validate and further explain these findings.

This study also showed that NH whites who are remarried have risks for stroke that are nearly equivalent in magnitude to NH whites who are divorced (ORs=1.23 vs. 1.26, respectively) relative to continuously married NH whites. This pattern suggests that the increased likelihood

of stroke among those who were divorced or widowed is not ameliorated with remarriage later in the life course. Indeed, there is evidence for this finding in related research. For example, research shows that remarried adults have significantly greater levels of physical and psychological illness than adults who are continuously married—especially among women (Barrett 2000; Dupre et al. 2012; Hughes and Waite 2009). The present findings further corroborate this pattern in NH whites to suggest that remarriage after divorce or widowhood may not confer the same health benefits for those who remarried stably married.

An important area for future research will be to further investigate the mechanisms underlying these findings. The prevailing argument is that marital dissolution has a negative impact on the economic, behavioral, and emotional well-being of individuals that reduces their ability to prevent, detect, and treat illness (LaPierre 2012; Lavelle and Smock 2012; O'Rand and Hamil-Luker 2005; Smock, Manning, and Gupta 1999; Umberson 1992). Somewhat contrary to expectations and existing literature, results show that losses of income and health insurance (Hughes and Waite 2009; Smock et al. 1999) and increases in depressive symptoms, alcohol use, and smoking (Dupre et al. 2009; LaPierre 2012; Umberson 1992), did not account for the excess risks attributable to a history of divorce or widowhood. It is suspected that the acute and chronic stress associated with marital loss may have played an important role in the findings (Eaker et al. 2007; Steptoe and Kivimäki 2012). Indeed, studies have recently identified possible biological mechanisms—for instance, blood pressure reactivity, elevated cortisol, and hemoglobin A_{1c}—related to the stress of divorce that warrant additional exploration as they relate to the incidence of stroke (Molloy et al. 2009; Sbarra et al. 2009). Relatedly, it also is possible that a history of marital loss may have negative consequences for medication adherence, healthcare utilization, and disease management that may precipitate or worsen vascular health (Koskenvuo et al. 1981;

Molloy et al. 2008; Wu et al. 2009). Therefore, I encourage future studies to explore these and other mechanisms to explain how current and repeated exposure to marital loss incurs increasing risks for stroke at older ages.

Despite the strengths of this study, several limitations are acknowledged. Although the data are rich in the number and scope of measured covariates, certain clinical parameters and potentially important qualitative measures are lacking. First, the analyses of stroke are based on self-reported data—and not medical evaluations—which may bias the true rates of stroke incidence. However, the HRS provides the only known source of data that includes measures of stroke (and its timing) along with rich time-varying measures of marital life and numerous socioeconomic, psychosocial, behavioral, and physiological covariates. Future studies are warranted to validate these findings with medical assessments. Second, data were not available for the treatment and control of hypertension, diabetes, and/or high cholesterol prior to stroke; or other prophylactic measures to reduce the likelihood of a cerebrovascular event (e.g., prior cardiac revascularization). I also could not identify the characteristics or quality of past marriages or the circumstances of divorce. Although detailed measures of past marital relationships were not available, the multivariate analyses showed that depressive symptoms and maladaptive behaviors—presumed correlates of marital quality—did not account for the associations. Relatedly, the study lacked direct measures of stress levels, anxiety, and the loss of social support that may have contributed to the associations between marital status and marital history and subsequent stroke.

In sum, this study showed how cumulative exposure to marital instability is associated with the onset of a major health event that is responsible for significant racial inequalities in premature disability and death. Marital instability is more consequential to the incidence of

stroke for NH whites than for NH blacks and should be recognized with other traditional risk factors to better understand existing disparities in stroke. More studies are needed to further investigate the mechanisms contributing to the associations and to build on this evidence to inform health policy and practice to ultimately lessen the burden of CVD in vulnerable segments of the population.

ENDNOTES:

1. According the American Heart Association Statistics Committee and Stroke Statistics Subcommittee, cardiovascular diseases (ICD-9 codes 390-495) include hypertension, peripheral artery disease, heart disease, stroke, and other diseases of the circulatory system (Go et al., 2014).

2. A measure for retirement also was assessed but ultimately dropped due to the lack of variance in older cohorts, particularly the AHEAD cohort with almost all participants reporting being retired.

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Table 1. Characteristics of Study Participants from the Health and Retirement Study at Baseline

	Total (n = 22,553)	Non-Hispanic White (n = 18,838)	Non-Hispanic Black (n = 3,715)
Sociodemographic Background			
Age in years	62.70 (10.23)	62.98 (10.25)	61.32 (9.98)***
Study cohort, ≤ 1923	29.88	30.66	25.92***
Study cohort, 1924-1930	8.82	9.56	5.11***
Study cohort, ≥1931	61.30	59.79	68.96***
Male	45.77	46.75	40.78***
Urban	20.38	22.09	11.68***
Lives in the South	39.49	36.58	54.24***
Marital Status			
Never married	3.50	2.90	6.57***
Continuously married	36.25	38.24	26.14***
Divorced	12.81	10.58	24.06***
Remarried	32.24	34.10	22.80***
Widowed	15.20	14.17	20.43***
Marital History			
0 Divorces	76.21	77.05	71.92***
1 Divorce	18.28	17.27	23.39***
≥ 2 Divorces	5.52	5.68	5.01*
0 Widowhoods	82.11	83.17	76.77***
≥ 1 Widowhood	17.89	16.83	23.23***
Socioeconomic Factors			
Years of education	12.24 (3.07)	12.53 (2.85)	10.77 (3.67)***
Not currently working	51.72	51.56	52.57
Household income in thousands of dollars	16.40 (41.22)	17.13 (44.07)	12.69 (21.25)***
No health insurance	8.47	7.33	14.27***
Psychosocial Factors			
Lives alone	18.98	18.22	22.83***
CES-D depressive symptoms	1.73 (1.94)	1.63 (1.88)	2.22 (2.13)***
Anxiety or emotional condition	7.42	7.48	7.11
Behavioral Factors			
Current smoker	20.60	19.65	25.44***
Excess alcohol consumption	14.50	15.18	11.25***
No vigorous exercise	80.31	79.89	82.45***
Physiological Factors			
Underweight, BMI < 18.5	1.92	1.97	1.64
Overweight, BMI 25.0-29.9	40.34	40.44	39.87
Obese, BMI ≥ 30.0	15.21	14.08	20.94***
Diagnosed hypertension	38.51	35.44	54.08***
Diagnosed diabetes	10.53	9.03	18.12***
Stroke during study period	8.88	8.50	10.79***

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; BMI, body mass index.
Significance tests for race differences were calculated by analysis of variance or x^2 tests.
* p ≤ .05; ** p ≤ .01; *** p ≤ .001 (two-tailed test).

TABLE 2. Discrete-Time Odds Ratios for Stroke Associated with Race, Marital Status, and Marital History in U.S. Older Adults, HRS (n=22,553)

	Odds Ratio		
	Model 1	**Model 2**	**Model 3**
Non-Hispanic black (vs. NH white)	1.82***	1.71***	1.72***
Marital Status (vs. continuously married)			
Never married		1.42**	1.17
Divorced		1.27**	1.29*
Remarried		1.30***	1.31**
Widowed		1.66***	1.67**
Never married*NH black			1.79*
Divorced* NH black			0.96
Remarried*NH black			0.90
Widowed*NH black			0.97
Non-Hispanic black (vs. NH white)	1.82***	1.74***	2.05***
Marital History (vs. continuously married)			
1 Divorce		1.32***	1.46***
≥ 2 Divorces		1.46***	1.64***
≥ 1 Widowhood		1.40***	1.40***
1 Divorce*NH black			0.66**
≥ 2 Divorces*NH black			0.56*
≥ 1 Widowhood*NH black			0.98

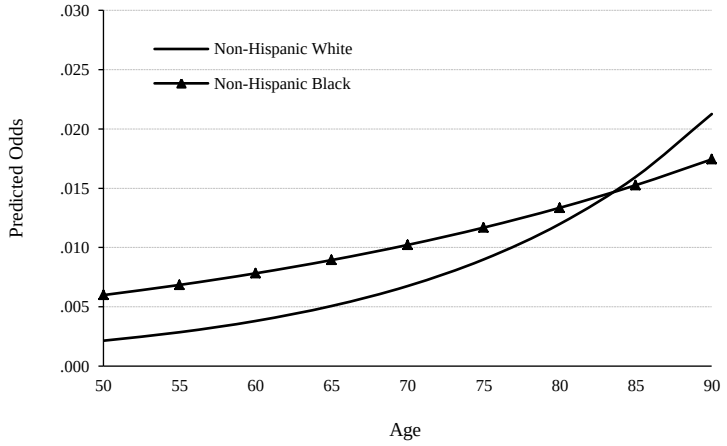
Models adjust for age (centered at 65), race x age, gender, study cohort, urban-rural residence, and geographic region.
Note: Models are estimated separately for marital status and marital history.
* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$ (two-tailed test).

TABLE 3. Adjusted Discrete-Time Odds Ratios for Stroke Associated with Marital Status and Marital History in Non-Hispanic White and Black U.S. Older Adults, HRS (n=22,553)

	Odds Ratio					
	Model 1: Demographic Factors	**Model 2: Socioeconomic Factors**	**Model 3: Psychosocial Factors**	**Model 4: Behavioral Factors**	**Model 5: Physiological Factors**	**Model 6: Full Model**
Non-Hispanic White						
Continuously married	[Reference]	[Reference]	[Reference]	[Reference]	[Reference]	[Reference]
Marital Status						
Never married	1.18	1.15	1.26	1.14	1.16	1.20
Divorced	1.30**	1.27*	1.32*	1.24*	1.31**	1.26*
Remarried	1.32***	1.29***	1.27**	1.29***	1.31***	1.23**
Widowed	1.70***	1.64***	1.78***	1.61***	1.67***	1.65***
Marital History						
1 Divorce	1.47***	1.46***	1.47***	1.44***	1.48***	1.47***
≥ 2 Divorces	1.65***	1.61***	1.57***	1.57***	1.62***	1.50***
≥ 1 Widowhood	1.41***	1.38***	1.49***	1.36***	1.39***	1.42***
Non-Hispanic Black						
Continuously married	[Reference]	[Reference]	[Reference]	[Reference]	[Reference]	[Reference]
Marital Status						
Never married	1.80**	1.67*	1.78*	1.78**	1.90**	1.75*
Divorced	1.19	1.17	1.12	1.17	1.18	1.11
Remarried	1.18	1.15	1.14	1.16	1.17	1.13
Widowed	1.49*	1.42*	1.43*	1.45*	1.44*	1.35
Marital History						
1 Divorce	0.97	0.99	0.95	0.96	0.95	0.95
≥ 2 Divorces	0.92	1.01	0.89	0.93	1.03	1.04
≥ 1 Widowhood	1.33*	1.30*	1.29*	1.32*	1.30*	1.25

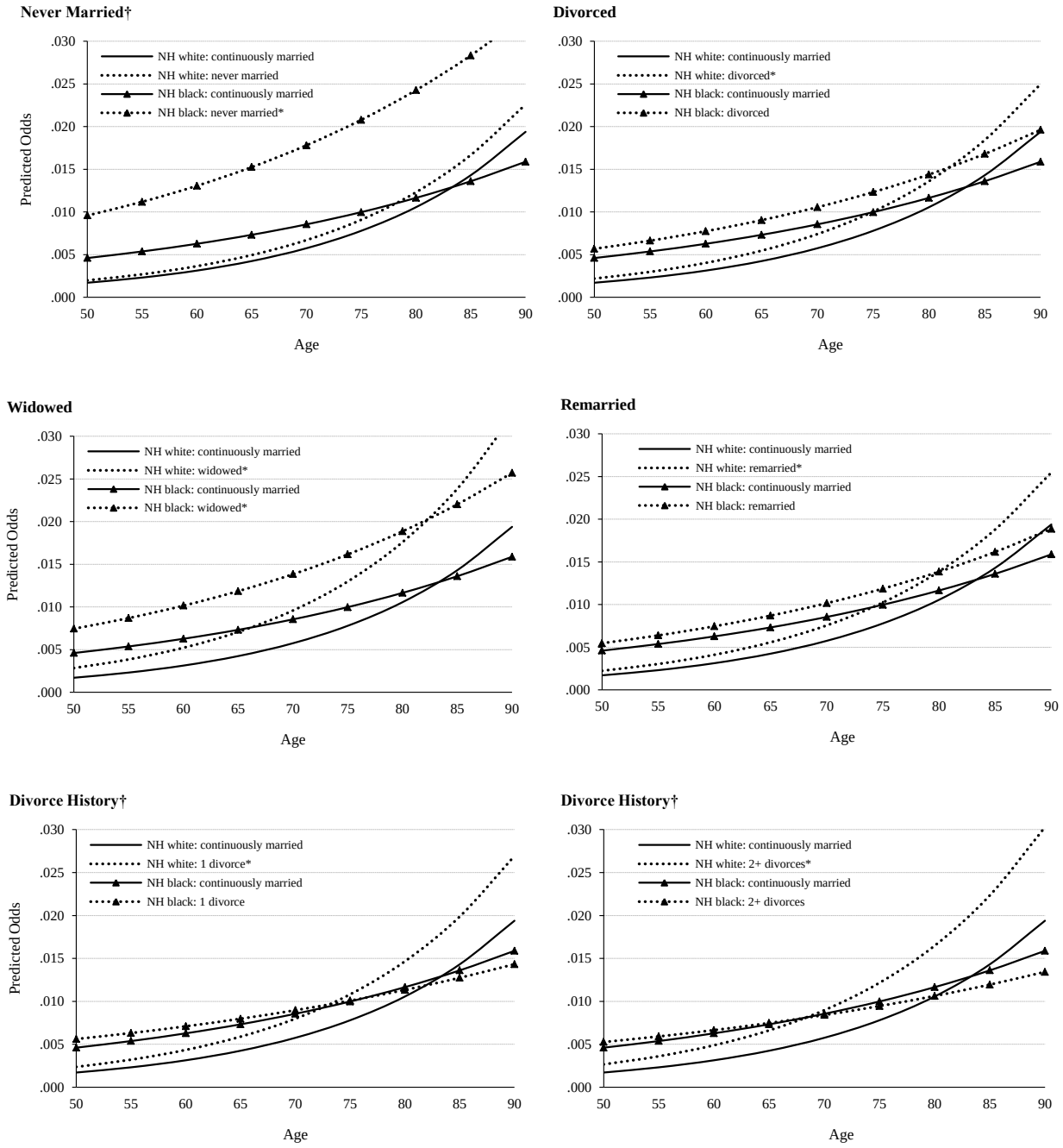
Model 1 adjusts for age, race x age, gender, study cohort, urban-rural residence, and geographic region.
Model 2 includes model 1 covariates and adds education, employment status, income, and health insurance.
Model 3 includes model 1 covariates and adds living arrangement, CES-D depressive symptoms, and anxiety or emotional conditions.
Model 4 includes model 1 covariates and adds smoking, alcohol use, and exercise.
Model 5 includes model 1 covariates and adds BMI, hypertension, and diabetes.
Model 6 includes all covariates.
Note: Models estimated separately for marital status and marital history.
* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$ (two-tailed test).

Figure 1. Age-adjusted Risks for Stroke in Non-Hispanic White and Black Older Adults, HRS 1992-2010 (n=22,553)



Note: Differences are statistically significant for race ($p < .001$) and race x age ($p < .001$).

Figure 2. Adjusted Risks for Stroke by Marital Status and Marital History in Non-Hispanic White and Black Older Adults, HRS 1992-2010 (n=22,553)



Note: Models also include age, race, race x age, gender, study cohort, urban-rural residence, and geographic region.

* Indicates statistically significant marital differences at < .05.

† Indicates statistically significant race differences at < .05.