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Divorce and Death: Forty Years of the Charleston Heart Study

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Abstract

Forty years of follow-up data from the Charleston Heart Study (CHS) were used to examine the risk for early mortality associated with marital separation or divorce in a sample of over 1,300 adults assessed on several occasions between 1960 and 2000. Participants who were separated or divorced at study inception evidenced significantly higher rates of early mortality, and these results held after adjusting for baseline health status and other demographic variables. Being separated or divorced throughout the CHS follow-up window was one of the strongest predictors of early mortality. However, the excess mortality risk associated with remaining separated/divorced was completely eliminated when participants were re-classified as having ever experienced a marital separation or divorce. These findings suggest a key determinant of early death is the amount of time people live as separated or divorced and/or dimensions of personality that predict divorce as well as a decreased likelihood of future remarriage.

Keywords

Divorce; marital separation; mortality; survival analysis; adults; longitudinal analysis

Research in social epidemiology has spurred tremendous advances in understanding the association between interpersonal relationships and physical health. In a seminal paper, House, Landis, and Umberson (1988) reported summary data from several large-scale studies indicating that social integration-- often defined as feeling you have close others you can depend on and who support you-- is highly associated with all-cause morbidity and mortality. In fact, House et al. (1988) concluded that the magnitude of the social integration effect for predicting early death was roughly equivalent in magnitude to the effect size that ultimately led the U.S. Surgeon General to conclude, in 1968, that smoking is unquestionably bad for health. With these basic associations well-established, the last 20 years have witnessed a surge of research aimed at elucidating the mechanisms linking social connectedness and health (e.g., Cacioppo, Hawkley, Crawford et al., 2002; Cohen, 2001; Kiecolt-Glaser & Newton, 2001; Robles & Kiecolt-Glaser, 2003; Seeman, 1996; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). This paper revisits a basic question about the association between marital dissolution and mortality and, in doing so, provides new insights on the long-term health consequences of becoming separated or divorced.

Across several epidemiological studies, being or becoming divorced (or separated) is associated with increased risk for poor physical health outcomes (Ben-Shlomo et al., 1993;

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Ebrahim et al., 1995; Ikeda et al., 2007; Johnson, Backlund, Sorlie, & Loveless, 2000; Lund et al., 2006; Matthews et al., 2002). Relative to married adults, divorced men and women are more likely to die earlier from a range of different diseases, and the magnitude of the all-cause mortality effect appears to be moderated by sex and the timing of the separation experience, with men and older adults more vulnerable to subsequent health problems. The increased mortality risk following marital dissolution is robust, and confidence in these effects is bolstered by the fact that the studies are cross-national (e.g., Ikeda et al., 2007) and often include large, population-based samples (e.g., Hemström, 1996; Johnson et al., 2000).

To study the mechanisms of these effects, two main approaches are taken. First, in sociology and epidemiology, population studies attempt to classify the divorce-health association as a product of social selection or social causation (Joung, van de Mheen, Stronks, van Poppel, & Mackenbach, 1998); that is, does poor health or factors associated with poor health (e.g., hostility, neuroticism, economic disadvantage) lead to both divorce and subsequent physical illness, or are the health problems that follow marital dissolution distinct consequences of this stressful life experience? Evidence exists for both positions, and, without systematic meta-analyses, the most reasonable conclusion is that while selection effects are operating, they are not sufficient to explain the magnitude of the risk for later morbidity or mortality. The second, lower-level approach for interrogating the mechanisms of divorce risk is psychosomatic research, which typically studies how the stress of divorce is associated with more immediate autonomic nervous system, neuroendocrine, or immune responses. Kiecolt-Glaser and colleagues (Kiecolt-Glaser, Fisher, Ogrocki, Stout, & et al., 1987) found that up to two years after the end of their marriage, divorced adults who continue to emotionally struggle with their separation evidenced significantly higher antibody titers to Epstein Barr Virus and a lower percentage of Natural Killer cell activity, both of which indicate compromised immune functioning. Behavioral pathways also are linked to health outcomes following divorce; recently separated or divorced adults drink more, sleep less, and engage in less exercise than married adults (Hetherington & Kelly, 2002).

Although the investigation of divorce-health mechanisms is laudable, a critical shortcoming of much of the population-based studies on divorce and health is the failure to represent marital status as dynamic, time-varying variable. Up to 75% of adults who divorce ultimately remarry (National Center for Health Statistics, 2001), yet the social epidemiology literature often casts marital status as a stable person-variable. The study of marital status as a static variable precludes the possibility that the risk conferred by a separation experience is attenuated by remarriage or mitigated by the amount of time someone spends as separated/divorced adult (relative to time spent married, widowed, or single/never married). This problem is as much statistical as it is conceptual. The Cox proportional hazard model (Cox, 1972), the most commonly used method for predicting event onsets can accommodate time-varying variables; however, this approach requires that the predictors of interest be updated at each outcome assessment, requiring an evaluation of marital status at every measured mortality interval (see Singer & Willett, 2003), which is typically monthly or yearly. For obvious reasons, this kind of analysis is prohibitive in population-based studies. A conceptual solution to this problem can help capture the dynamic nature of marital status and help elucidate whether variations in divorce status differentially predict long-term mortality.

The Present Study

This report uses data from the Charleston Heart Study (CHS), which is a community-based cohort study designed to assess the natural course of health and aging using a representative sample of adults over age 35 residing in Charleston County, South Carolina. The study began in 1960, and marital status data were collected during several follow-up phases, in 1962–64, 1974–75, 1984–85, 1987–89, and 1990–91; mortality data were updated

throughout the study, with the final update spanning the 41-year period from 1960 through 2000. The length of this follow-up window is unique and allows us to predict mortality for over 75% of the sample while also adjusting for important predictors of health outcomes that were collected during the baseline intake session. To represent marital status as a more dynamic variable, adults were classified in three primary ways. First, marital status (married, separated/divorce, widowed, or never married) at the first assessment in 1962–64 was examined as a predictor of long-term mortality. Second, the hazard ratio of early death for adults who were separated or divorced at each assessment (to which they contributed data) was compared to all other participants who contributed at least one marital status entry; this comparison has direct implications for understanding the health consequences of divorce for the 25% of adults who do not remarry after their first marriage ends.[1] Finally, to determine if the effect of *remaining* separated/divorced differed from the effect of *ever* experiencing a separation or divorce, the sample was re-classified to compare the hazard ratio of adults who simply experienced a marital separation/divorce (at some point during the CHS follow-up period) to all other participants. The comparison of hazard ratios between these two groups of adults-- those who simply experienced marital separation/divorce and those who remained separated/divorced at each CHS follow-up assessment-- can help elucidate if the duration of time someone lives as a divorced adult is an important predictor of early mortality.

Method

Participants

The CHS began in 1960 with an initial sample of 2,181 adults; to increase the representativeness of the sample, 102 peer-nominated black men of high socioeconomic status (SES) were added to the sample during the 1962–64 phase. At the first assessment, the total sample included 1,195 women and was 61.1% white; the remainder of the participants were black. Participants were an average 48 years and 9 months (*SD* =11 years and 6 months) at the start of the study. Information on marital status was collected via self-report, and participants were classified as married, widowed, separated, divorced, or never married at each assessment; for the present analyses, the separated and divorced categories were collapsed to create a single category defined by the experience of marital separation. At the 1962–64 assessment, the first time marital status data were available, 83.2% of the sample describe themselves as married, 10% as widowed, 5.5% as separated or divorced, and 3.3% as never married. More than half of the initial sample entered the study along with their spouses and data recorded for both members of the couple. To account for non-independence of spousal data, each singleton was selected for analyses (n = 993), then one member of each couple was selected at random to contribute to the analyses. For each of the three main analyses reported below, this selection process was repeated 500 times; thus, the reported parameter estimates are derived from bootstrapped resamples with the intention of using all the available data. Resampling the couples in this way and eliminating participants with no marital status data (at any assessment) yielded a final sample of 1,376 adults for each analysis with roughly the same sex and ethnicity distribution as the full 1960 sample. Further details about the baseline assessment and sample demographics can be obtained from previous CHS reports (Keil et al., 1993; Nietert, Sutherland, Keil, & Bachman, 2006).

[1]CHS participants who were separated or divorced at every assessment for which they contributed data are described as having, “remained separated/divorced throughout the study.” It is possible that, between assessments, some of these adults remarried, then divorced again. For simplicity, this group is referred to as remaining separated/divorced, but it is most accurate to describe them as adults who were separated/divorced at each CHS assessment.

Procedures and Measures

In-person medical interviews were conducted at the 1960 assessment (and in 1962–64 for the high SES black men), and a select set of the variables collected at intake were used as covariates the longitudinal survival models. These variables included: participants' age at intake, self-reported number of education years, total serum cholesterol level (mg/DL), smoking status (dichotomized as two separate variables: being a current smoker vs. all others and being a former smoker vs. all others), elevated blood pressure status (a dichotomous variable scored as present if their baseline systolic average was at least 140 mmHg or if their diastolic average was at least 90 mmHg; baseline blood pressure was collected across two resting periods at the start and end of the intake interview), self-reported history of diabetes (dichotomized as yes or no), and body mass index (weight in kilograms divided by the square of theheight in meters). Mortality data were updated several times over the course of the study, obtained using the National Center for Health Statistics National Death Index and the Social Security Death Index (Nietert et al., 2006). This approach permitted vital status classification (and hence mortality classification) of 98% of the cohort for the period 1960–2000.

Data Analysis

The data were analyzed using Cox proportional hazards models (Cox, 1972), a regression approach commonly referred to as survival analysis, to predict mortality over the forty-year study period. A time to death (TTD) variable was created as the number of months a person lived after their intake interview; for participants who were still alive in 2000, their TTD entry was censored due to non-event occurrence. Cox's (1972) regression model is widely used to study event onset in the biomedical and social sciences. For each analysis, the data were resampled according to the procedures described above to generate 500 data sets; the survival models were then run on each data set, and the resulting parameter estimates were output to a separate file. From this file, mean hazard ratios (HR) and confidence intervals were then computed for each predictor variable to determine the increase or decrease in risk for early death based on a one unit increase in the independent variable of interest.

Results

Of the 1,376 adults in the restricted sample assessed at baseline, 74% had died by 2000; the remaining adults were censored for the subsequent survival analyses due to non-event occurrence. Among the deceased adults, the average TTD from the 1960 assessment was 325 months (*SD* = 142 months, range = 0 to 491 months). The first survival model assessed differences in mortality based on marital status at entry into the study. Relative to married, widowed, and never married participants, adults who were separated or divorced at the first marital status assessment evidenced a significantly reduced TTD (HR: 1.55, 95% CI: 1.47, 1.63, $p < .001$); after accounting for the early health indicators (described above) and demographic variables (sex and race), the HR indicates that separated/divorced adults have a 57% greater likelihood of death within the forty-year follow-up period than participants in any of the other three marital status groups. The covariate adjusted survival plot is displayed in Figure 1a. No 2-or 3-way interactions were observed between sex, race, and marital status on mortality, but it is worth noting that men evidenced a significantly faster TTD than women (HR: 1.44, 95% CI: 1.36, 1.54, $p < .001$), which helps explain why separated/divorced men evidence greater morbidity and mortality than separated/divorced women.

Forty-one of the 62 participants who were separated/divorced at the first marital status assessment remained separated/divorced throughout the study; to explore the possibility that remaining separated/divorced over entire the CHS follow-up confers the greatest risk, a new grouping variable was computed that identified participants who were separated/divorced at

every follow-up period for which they provided data (n = 61). The left panel of Table 1 displays the bootstrapped parameter estimates from the survival models comparing these participants to the remainder of the sample after adjusting for the early health and demographic covariates. The HR of remaining separated/divorced was a strong predictor of later mortality after adjusting for the covariates, and the risk for early mortality conferred by being separated/divorced throughout the CHS follow-up was stronger than the HR of being a current or former smoker in 1960.[2] The adjusted survival curve comparing these adults to all other participants in Figure 1b. As shown, at 300 months (25 years) after intake, roughly 40% of the separated/divorced sample remained alive, whereas close to 60% of the other CHS participants remained alive at the same period. Two additional marital status comparisons were conducted, both of which indicated that the increased risk for early mortality is specific to remaining separated/divorced throughout the CHS follow-up period. Participants who were separated/divorced at every assessment evidenced greater risk for early mortality compared to participants who were widowed at every assessment (n = 220, HR: 1.64, 95% CI: 1.58, 1.71, $p < .001$), and those who were single at every assessment (n = 59, HR: 1.26, 95% CI: 1.18, 1.34, $p < .001$).

In the final analysis, participants were re-classified as separated/divorced if they reported being separated/divorced at any marital status assessment during the forty-year study period; this resulted in 151 adults being classified as having ever experienced a separation/divorce, which is slightly less than 10% of the restricted sample. The right panel of Table 1 displays the results of the full survival model using the ever separated/divorced category as the marital status variable. Participants who experienced a marital separation or divorce at some point during the study period were at no greater risk for early mortality than those participants who never experienced a separation or divorce. The covariate-adjusted survival curves for these two groups, shown in Figure 1c, overlap entirely.

Discussion

A distinct strength of the CHS is the nearly half-century follow-up period. Using the mortality data observed in this window, the analyses revealed that separated or divorced adults can be at considerable risk for early death, but the magnitude of this effect depends on the definition used to determine one's divorce status. Four findings from this work are notable. First, when examining the effects of early marital status on later mortality, adults who reported they were separated or divorced in 1962–64 evidenced significant risk for early death, even after accounting for demographic and health variables at entry into the study. Second, in all of the survival models, the effect of participant sex persisted regardless of the marital status effect; thus, when separated/divorced adults exhibited significant risk for early death, it was the separated/divorced men at greatest risk due to the cumulative nature of two independent main effects, not an interaction between marital status and participant sex. Third, participants who were separated/divorced at every marital status assessment (to which they contributed data) evidenced the highest risk of early death during the follow-up period, and the magnitude of this effect was greater than the size of the mortality risk conferred by being a current smoker in 1960. Moreover, participants separated/divorced at every assessment evidenced greater mortality risk than participants who were widowed or single at every assessment. Finally, the effect of remaining separated/

[2]Given that the ratio of always separated/divorced participants to all other participants is highly skewed (roughly one separated/divorced participant for every 21 other participants), the analyses were re-run in a smaller sample to determine if the hazard ratio would change if divorce adults were more evenly matched with all other participants. The data was resampled to yield a sub-sample of 250 adults, of which 61 were always separated/divorced adults and the remainder were chosen at random from larger sample (with the stipulation that only one member of each couple was chosen). This process was repeated 10 times and the Cox regression model was run on each resample. The resulting mean HR estimates for the sub-sample analysis were virtually identical to those reported in the left panel of Table 1.

divorced throughout the CHS was *completely eliminated* when the marital status category was expanded to include all participants who experienced a separation or divorce. Thus, simply experiencing a marital breakup during the CHS follow-up was not enough to alter one's mortality risk, and the results demonstrate that how separation/divorce status is defined makes a critical difference in the long-term prediction of death.

The increased risk conferred by remaining separated/divorced throughout the CHS has important public health implications that are largely unrecognized. Current national statistics indicate that approximately 75% of adults who divorce subsequently remarry (National Center for Health Statistics, 2001). In recent census data, 9% of the adult population over 18 years reported experiencing a divorce (U.S. Census Bureau, 1998); this lifetime prevalence rate indicates that close to 2.30% of the adult population (or, 4,365,000 adults) will experience a marital breakup without remarrying. Approximately 175,000 adults per year become divorced and will not remarry (National Center for Health Statistics, 2006), and it is these individuals who at the greatest risk for early death. The findings reported here suggest a nuanced picture of the association between marital status and mortality; it is not the experience of separation or divorce per se that confers risk, but some combination of intrapersonal and situational determinants associated with not remarrying after a one's separation experience.

The clearest difference between CHS participants who experienced a marital separation versus those who were separated throughout the study period is that the latter group lived longer as separated/divorced adults than any other participants in the sample. Because the findings also demonstrate there is *specific risk* for early mortality associated with remaining separated/divorced relative to being widowed or single at every assessment, it is unlikely that the absence of a supportive marital relationship explains the mortality risk. One potential explanation is that there is something uniquely difficult about remaining separated/divorced that accelerates time to death. There are many candidate stressors associated with divorce that, if maintained over time, can be associated with poor health. The financial strain of long-term single parenthood, for instance, may limit resources that provide health protection, especially for women (Wickrama et al., 2006). Similarly, if persistent or active conflict with an ex-partner disrupts the likelihood of remarriage, heightened stress reactivity can compromise immune functioning and increase risk for subsequent physical illness (see Kiecolt-Glaser et al., 1987).

Although elements of the post-divorce social environment (e.g., financial strain) or how people respond to this experience (e.g., persistent grief, changes in health behaviors) may increase risk for early mortality, a more parsimonious explanation is that personality factors such as neuroticism and hostility, which can operate to select adults out of marriage (Rogge, Bradbury, Hahlweg, Engl, & Thurmaier, 2006), underpin the observed effects. Jockin, McGue, and Lykken (1996) found that negative emotionality predicts divorce risk, and that this dimension of personality and divorce risk correlate largely due to common genetic factors. Adults with diagnosed antisocial personality disorder are 2.5 times more likely to become divorced than adults without a personality disorder diagnosis (Whisman, Tolejko, & Chatav, 2007), and hostility and neuroticism are both associated with risk for physical illness (Adler & Matthews, 1994). As adults come to terms with a marital separation, personality may play a role in predicting health outcomes via increased cardiovascular reactivity or by compromising health behaviors.

The context of the CHS suggests that there is something unique about adults who remain separated/divorced throughout the follow-up period. Any longitudinal study-- especially one that spans nearly half a century-- must confront the fact that the variables measured at study inception have a different meaning when viewed from the vantage point of the present.

There is no better example of this point than the case of divorce. What is a relatively common life event today was experienced by only about 10% of the CHS sample, and only 5% of the sample remained separated/divorced throughout the follow-up. Being classified as something other than married or widowed may thus serve as a proxy for psychological states that also predict early death. Unfortunately, the CHS data affords little opportunity to describe the psychological profile of the study cohort. While changes in the societal acceptance of marital separation and divorce pose an interpretive dilemma for understanding the long-term prediction of death, it is critical to recognize that these mortality effects, and the associated differences between the always and ever separated/divorced groups, would not be apparent without the extended follow-up window permitted by the CHS. The observed findings generalize to adults who divorced, on average, sometime between 1932 and 1990, a period of time in this century when the rate of marital dissolution skyrocketed almost 240% from 1960 to 1982 before slowly declining over the last 25 years.

The results of this study should be considered in the light of several limitations. First, the associations uncovered in this analysis cannot be deemed causal. Although adjusting for early health status minimizes the potential of selection bias, it is possible that third variable explanations are still operating to both select adults out of marriage and increase risk for early death. Second, the CHS data do not provide for a fine-grain distinction between the different divorce groups. It would be informative to have more frequent assessments of marital status and rates of remarriage rates. Despite these limitations, time spent as a separated or divorced adult emerged as a strong predictor of later mortality. Third, research in this area typically distinguishes between marital separation and divorce (e.g., Matthews et al., 2002). To the extent that being separated or divorced differentially predicts long-term mortality, the CHS data are not well-suited to capturing these differences. Finally, although the CHS is a large, community-based sample, the number of participants who remained separated/divorced throughout the follow-up period was relatively small.

Conclusions

The findings from this study suggest that living a large portion of your adult life as a separated or divorced adult confers considerable risk for all-cause mortality. Notably, the risk of early death associated with remaining separated/divorced was greater than the long-term risk conferred by regular cigarette smoking in 1960. In contrast, the mere experience of a marital breakup produced no elevation in mortality risk. There are several candidate mechanisms to explain the differences between these groups, and future research investigating personality variables, health behaviors, stress reactivity, and the receipt of social support among separated or divorced adults will help explain the situational- or individual-level factors that underpin the risk for early death.

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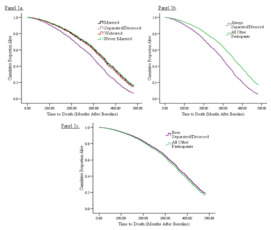

Figure 1.
Survival curves depicting the cumulative proportion of the sample remaining alive after the baseline assessment as a function of marital status. Panel 1a displays the survival curves for all participants according to their marital status at the baseline assessment; Panel 1b displays the survival curves for participants who remained separated/divorced throughout the CHS follow-up period relative to all other participants; and, Panel 1c displays the survival curves for participants classified as *ever* experiencing a separated/divorced relative to all other participants. Relative to adults who experienced a marital separation or divorce at some point over the study, those participants who were always separated/divorced evidenced significantly greater risk for early death.

Table 1

Bootstrapped Hazard ratios (HR) and 95% Confidence Intervals (CI) Obtained from Cox Proportional Hazards Models Predicting Time to Death Based on Marital Status

	HR	95% CI		HR	95% CI
Always Separated/Divorced[a]			***Ever Separated/Divorced***[b]		
Age	1.09	1.08,1.10	Age	1.09	1.08,1.10
Elevated BP	1.40	1.32,1.48	Elevated BP	1.41	1.33,1.49
Non-Smoker	.60	.52,.67	Non-Smoker	.59	.52,.66
Former Smoker	.75	.62,.89	Former Smoker	.77	.63,.91
Diabetes Hx	.94	.81,1.07	Diabetes Hx	.97	.84,1.09
Cholesterol	1.00	.99,1.00	Cholesterol	1.00	1.00,1.00
BMI (kg/m^2)	1.01	1.00,1.02	BMI (kg/m^2)	1.01	1.00,1.02
Education (years)	.96	.95,.97	Education (years)	.96	0.87,1.05
Sex	1.47	1.39,1.56	Sex	1.47	1.39,1.55
Race	1.03	.95,1.11	Race	1.03	0.87,1.21
Marital Status	1.66	1.60,1.70	Marital Status	.98	0.91,1.06

Note.

[a]Under this marital status classification, participants who were separated/divorced at every assessment period for which they provided data were compared to all other participants in the sample;

[b]Under this marital status classification, participants who experienced a marital separation or divorce at any point during the follow-up period were compared to all other participants in the sample. Cholesterol = total serum cholesterol level (mg/DL) at baseline; Non-smoker compares non-smokers at baseline to all other participants; Former Smoker compares former smokers at baseline to all other participants; Elevated blood pressure was present if participants' baseline systolic average was at least 140 mmHg or if their diastolic average was at least 90 mmHg; Diabetes Hx = self-reported history of diabetes diagnosis; BMI = body mass index (weight in kilograms divided by the square of theheight in meters); Race compares white participants to black participants; and Sex compares men to women.

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