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Research Article

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 more than 1,300 adults assessed on several occasions between 1960 and 2000. Participants who were separated or divorced at the start of the study evidenced significantly elevated 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 separation or divorced was completely eliminated when participants who had ever experienced a marital separation or divorce during the study were compared with all other participants. These findings suggest that a key predictor of early death is the amount of time people live as separated or divorced. It is possible that the mortality risk conferred by marital dissolution is due to dimensions of personality that predict divorce as well as a decreased likelihood of future remarriage.

Research in social epidemiology has spurred tremendous advances in understanding the association between interpersonal relationships and physical health. In a seminal article, House, Landis, and Umberson (1988) reported summary data from several large-scale studies indicating that social integration—often defined as feeling that you have close others whom you can depend on and who support you—is highly associated with all-cause morbidity and mortality. In fact, House et al. concluded that the magnitude of the social-integration effect for predicting early death was roughly equivalent to the magnitude of the effect of smoking, which 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 past 20 years have witnessed a surge of research aimed at elucidating the mechanisms linking social connectedness and health (e.g., Cacioppo et al., 2002; Cohen, 2001; Kiecolt-Glaser & Newton, 2001; Robles & Kiecolt-Glaser, 2003; Seeman, 1996; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). This article 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.

Several epidemiological studies have found that being or becoming divorced (or separated) is associated with increased risk for poor physical health outcomes (Ben-Shlomo, Smith, Shipley, & Marmot, 1993; Ebrahim, Wannamethee, McCallum, Walker, & Sharper, 1995; Ikeda et al., 2007; Johnson, Backlund, Sorlie, & Loveless, 2000; Lund, Christensen, Holstein, Due, & Osler, 2006; Matthews & Gump, 2002). Relative to married adults, divorced men and women tend to die earlier from a range of different diseases. 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 than women and younger adults are. The increased mortality risk following marital dissolution is

robust, and confidence in these effects is bolstered by the fact that the studies demonstrating them have been cross-national (e.g., Ikeda et al., 2007) and have often included large, population-based samples (e.g., Hemström, 1996; Johnson et al., 2000).

Two main approaches are taken to study the mechanisms of these effects. First, in sociology and epidemiology, population studies attempt to determine if the divorce-health association is a product of social selection or of 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? There is evidence supporting both positions, and, without systematic meta-analyses, the most reasonable conclusion is that although 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 investigating the mechanisms of the divorce-health link is taken in psychosomatic research, which typically studies how the stress of divorce is associated with more immediate autonomic nervous system, neuroendocrine, or immune responses. Kiecolt-Glaser et al. (1987) found that up to 2 years after marital dissolution, divorced adults who continued to struggle emotionally with their separation evidenced significantly elevated antibody titers to Epstein-Barr virus and a reduced percentage of natural killer cell activity—two indicators of compromised immune functioning. Behavioral pathways also are linked to health outcomes following divorce; recently separated or divorced adults drink more alcohol, sleep less, and engage in less exercise than married adults (Hetherington & Kelly, 2002).

Although the investigation of mechanisms underlying the link between divorce and health outcomes is laudable, a critical shortcoming of many of the population-based studies on

divorce and health is the failure to represent marital status as a 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. Studying marital status as a static variable precludes the possibility of determining whether the risk conferred by a separation experience is attenuated by remarriage or affected by the amount of time someone spends as a separated or divorced adult (relative to time spent married, widowed, or never married). This problem is as much statistical as it is conceptual. The Cox (1972) proportional hazard model , 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, in the present case requiring an evaluation of marital status at every measured mortality interval (see Singer & Willett, 2003). Because mortality is typically assessed monthly or yearly, survival analysis with corresponding marital-status information is prohibitive in population-based studies. A conceptual solution to this problem can help capture the dynamic nature of marital status and elucidate whether variations in divorce status differentially predict long-term mortality.

THE PRESENT STUDY

For the study reported here, we used data from the Charleston Heart Study (CHS), 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 1962–1964, 1974–1975, 1984–1985, 1987–1989, and 1990–1991; 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 allowed us to predict mortality for more than

75% of the sample while also adjusting for important predictors of health outcomes that were assessed during the baseline intake session.

To represent marital status as dynamically as possible, we classified adults in three separate ways. First, marital status (married, separated-divorce, widowed, or never married) at the first assessment, in 1962–1964, was examined as a predictor of long-term mortality. Second, we calculated the hazard ratio (HR) of early death for adults who were separated or divorced at each assessment (to which they contributed data) relative 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 or divorced differed from the effect of having ever experienced a separation or divorce, we reclassified the sample to calculate the HR of adults who simply experienced a marital separation or divorce at some point during the CHS follow-up period relative to all other participants. Comparing HRs of adults who simply experienced marital separation or divorce and adults who remained separated or divorced at each CHS follow-up assessment can help elucidate whether 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, the researchers added 102 peer-nominated Black men of high socioeconomic status (SES) to the sample during the 1962–1964 phase. At the first assessment, the total sample included 1,195 women and 986 men; the sample was 61.1% White, and the remainder of the participants were Black. Participants were on average 48 years 9 months old

(SD = 11 years 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 1962–1964 assessment, the first time marital-status data were available, 81.2% of the sample was married, 10% was widowed, 5.5% was separated or divorced, and 3.3% was never married.

More than half of the initial sample consisted of people who entered the study along with their spouses, and data were recorded for both members of each couple. To account for nonindependence of spousal data, we selected for analyses all the singletons (n = 993) and then one member of each couple at random. For each of the three main analyses reported here, this selection process was repeated 500 times; thus, the reported parameter estimates are derived from bootstrapped resamples selected 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; this sample had roughly the same sex and ethnicity distribution as the full 1960 sample. Further details about the baseline assessment and demographics of the sample can be obtained from previous CHS reports (Keil et al., 1993; Nietert, Sutherland, Keil, & Bachman, 2006).

Procedures and Measures

In-person medical interviews were conducted at the 1960 assessment (and in 1962–1964 for the high-SES Black men), and some of the measures collected at intake were used as covariates in the longitudinal survival models. These variables included participants' age at intake, race (Black vs. White), sex (men vs. women), self-reported number of years of education, total serum cholesterol level (mg/dL), smoking status (assessed by two dichotomous variables:

current smokers vs. all others and former smokers vs. all others), elevated blood pressure (a dichotomous variable scored as present if the baseline systolic average was at least 140 mm Hg or if the baseline diastolic average was at least 90 mm Hg; 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 present or absent), and body mass index (weight in kilograms divided by the square of the height in meters). Mortality data were updated several times over the course of the study, 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 from 1960 through 2000.

Data Analysis

To predict mortality over the 41-year study period, we used Cox (1972) proportional hazards models, a regression approach commonly referred to as survival analysis. We created a time-to-death (TTD) variable, calculated as the number of months a person lived after his or her intake interview; for participants who were still alive in 2000, the TTD entry was censored due to non-event occurrence. Cox's 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 earlier 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 HRs and confidence intervals (CIs) were computed for each predictor variable to determine the increase or decrease in risk for early death based on a 1-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; participants who were still alive in 2000 were censored for the subsequent survival analyses because of 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 in Procedures and Measures) and demographic variables (sex and race). The HR indicates that separated and divorced adults had a 55% greater likelihood of death within the 41-year follow-up period than participants in any of the other three marital-status groups. Figures 1a presents the covariate-adjusted survival curve. No two- or three-way interactions were observed among sex, race, and marital status, but it is worth noting that TTD was significantly shorter for men than for women (HR = 1.44, 95% CI = 1.36–1.54, $p < .001$); this result is consistent with other evidence indicating that separated and divorced men evidence greater morbidity and mortality than separated and divorced women.

Forty-one of the 62 participants who were separated or divorced at the first marital-status assessment remained separated or divorced throughout the study. To explore the possibility that remaining separated or divorced over the entire CHS follow-up conferred the greatest risk, we created a new grouping variable that identified participants who were separated or divorced at every follow-up period for which they provided data ($n = 61$). Table 1 displays the bootstrapped parameter estimates from the survival models comparing these participants with the remainder of the sample after adjusting for the early health and demographic covariates. Remaining separated

or divorced was a strong predictor of early mortality after adjusting for the covariates, and the risk for early mortality conferred by being separated or divorced throughout the CHS follow-up was stronger than the risk conferred by being a current or former smoker in 1960.[2] Figure 1b presents the adjusted survival curves for adults who were separated or divorced at every assessment and for all other participants. As the figure shows, at 300 months (25 years) after intake, roughly 50% of the separated-divorced sample remained alive, whereas close to 65% of the other CHS participants remained alive. As in the prior analysis, TTD was significantly shorter for men than for women. Two additional comparisons both indicated that the increased risk for early mortality was specific to remaining separated or divorced throughout the CHS follow-up period. Participants who were separated or divorced at every assessment evidenced greater risk for early mortality compared with participants who were widowed at every assessment ($n = 220$; HR = 1.64, 95% CI = 1.58–1.71, $p < .001$) and compared with 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 classified as separated or divorced if they reported being separated or divorced at any marital-status assessment during the 41-year study period; this resulted in 151 adults (slightly more than 10% of the restricted sample) being classified as having ever experienced a separation or divorce. Table 1 displays the results of the full survival model comparing participants who were ever separated or divorced with all other participants. Men once again evidenced a significantly faster TTD than women. 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 divorce status.

Four findings from this study are notable. First, as regards the effects of early marital status on later mortality, adults who reported they were separated or divorced in 1962–1964 evidenced significant risk for early death, even after we accounted for demographic and health variables at entry into the study. Second, in all the survival models, the effect of sex persisted regardless of the marital-status effect; thus, when separated and divorced adults exhibited significant risk for early death, the separated and divorced men were at greatest risk because of the cumulative nature of two independent main effects, not an interaction between marital status and participant's sex. Third, participants who were separated or 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 who were separated or divorced at every assessment evidenced greater mortality risk than participants who were widowed or single at every assessment. Finally, the effect of separation or divorce was completely eliminated when the divorced-separated category was expanded to include all participants who had ever experienced a separation or divorce during the follow-up. 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 or 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 age 18 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, among all separated or divorced adults, it is these individuals who are 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 rather some combination of intrapersonal and situational determinants associated with not remarrying after a separation experience.

The clearest difference between CHS participants who experienced a marital separation and those who were separated throughout the study period is that the latter group lived longer as separated-divorced adults than did any other participants in the sample. Because the findings also demonstrate there is specific risk for early mortality associated with remaining separated or divorced relative to remaining widowed or single, it is unlikely that the absence of a supportive marital relationship explains the mortality risk of participants who were divorced or separated at all follow-ups. One potential explanation is that there is something uniquely difficult about remaining separated or 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 postdivorce 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 increase the likelihood of divorce and 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 because of 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 people struggle to come to terms with a marital separation, personality may play a role in predicting health outcomes via increased cardiovascular reactivity or compromised health behaviors.

In interpreting the results of any longitudinal study—especially one that spans nearly half a century—once must confront the fact that the variables measured at the study's inception have taken on different meanings with the passage of time. 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 4.5% of the sample remained separated or divorced throughout the follow-up. Given that divorce was so rare at the start of the study, being classified

as something other than married or widowed may have served as a proxy for psychological states that also predicted early death. Unfortunately, the CHS data afford little opportunity to describe the psychological profile of the study cohort. Although changes in the societal acceptance of marital separation and divorce pose an interpretive dilemma for understanding why marital dissolution was a long-term predictor of death, it is critical to recognize that the observed mortality effects, and the differences between participants who remained separated or divorced and those who were ever separated or divorced, would not have been apparent without the extended follow-up window permitted by the CHS. The observed findings generalize to adults who divorced sometime between 1932 and 1990, a period when the rate of marital dissolution skyrocketed almost 240% (from 1960 to 1982) before slowly declining (as it has continued to do since).

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 minimized the potential of selection bias, it is possible that third variables operated to both increase risk for divorce and increase risk for early death. Second, the CHS data do not provide for a fine-grained distinction among different divorce groups. It would be informative to have more frequent assessments of marital status and rates of remarriage. 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 & Gump, 2002). The CHS data are not well suited to capturing any differences in mortality risk between people who are separated and those who are divorced. Finally, although the CHS is a large, community-based sample, the number of participants who remained separated or divorced throughout the follow-up period was relatively small. In some of

the analyses, the HRs for the group comparisons were based on subgroups that contained fewer than 100 participants. Therefore, these parameter estimates should be interpreted with caution and viewed as preliminary rather than definitive.

CONCLUSIONS

The findings from this study suggest that living a large portion of your life as a separated or divorced adult confers considerable risk for all-cause mortality. Notably, the risk of early death associated with remaining separated or divorced was greater than the long-term risk conferred by being a cigarette smoker 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 divorced-separated groups, and future research investigating personality variables, health behaviors, stress reactivity, and the receipt of social support among separated or divorced adults will help reveal the situational- or individual-level factors that underpin the risk for early death.

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[1]For the sake of simplicity, we refer to participants who were separated or divorced at every assessment (for which they contributed data) as "remaining" separated or divorced. It is possible that some of them remarried and then divorced again between assessments.

[2]Given that the ratio of participants who were always separated or divorced to all other participants was highly skewed (roughly 1 separated or divorced participant for every 21 other participants), we reran the analyses in a smaller sample to determine if the HRs would change if divorced adults were more evenly matched with all other participants. The data were resampled to yield a subsample of 250 adults; 61 people in this subsample were always separated or divorced, and the remainder were chosen at random from the 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 in this subsample analysis were virtually identical to those reported in Table 1.

Fig. 1. Survival curves depicting the cumulative proportion of the sample remaining alive as a function of time since the baseline assessment and marital status. Results for three different classifications of marital status are shown. In the first (a), categories refer to marital status at the

baseline assessment. In the second (b), participants who remained separated or divorced throughout the follow-up period were placed in one category, and all other participants were placed in another. In the third (c), participants who reported being separated or divorced at any assessment were placed in one category, and all other participants were placed in another.

Table 1

Bootstrapped Hazard Ratios (HRs) and 95% Confidence Intervals (CIs) Obtained From Cox Proportional Hazards Models Predicting Time to Death

Predictor	HR	95% CI
Always separated or divorced		
Age	1.09	1.08–1.10
Elevated blood pressure	1.40	1.32–1.48
Nonsmoker	0.60	0.52–0.67
Former smoker	0.75	0.62–0.89
Diabetes	0.94	0.81–1.07
Cholesterol (mg/dL)	1.00	0.99–1.00
BMI (kg/m^2)	1.01	1.00–1.02
Education (years)	0.96	0.95–0.97
Sex	1.47	1.39–1.56
Race	1.03	0.95–1.11
Marital status	1.66	1.60–1.70
Ever separated or divorced		
Age	1.09	1.08–1.10
Elevated blood pressure	1.41	1.33–1.49
Nonsmoker	0.59	0.52–0.66
Former smoker	0.77	0.63–0.91
Diabetes	0.97	0.84–1.09

Cholesterol (mg/dL)	1.00	1.00–1.00
BMI (kg/m^2)	1.01	1.00–1.02
Education (years)	0.96	0.87–1.05
Sex	1.47	1.39–1.55
Race	1.03	0.87–1.21
Marital status	0.98	0.91–1.06

Note. The HR for each parameter is the effect of that variable on time to death after accounting for all other variables in the model. In the "always separated or divorced" analysis, participants who were separated or divorced at every assessment period for which they provided data were compared with all other participants in the sample; in the "ever separated or divorced" analysis, participants who experienced a marital separation or divorce at any point during the follow-up period were compared with all other participants in the sample. For information on how the variables were coded, see the text.