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Divorce and health in middle and older ages

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Abstract

The prevalence and incidence of divorce at older ages have doubled since 1990. We use Health and Retirement Study data to describe associations between divorce, remarriage and health in middle and later life, following individuals and couples through divorce and remarriage in models with individual or couple fixed effects. At middle and older ages, divorce is more often associated with adverse physical and mental health changes for women than for men. Remarriage is associated with a restoration of health and depression to pre-divorce levels for men and women. However, men are more likely to remarry. Evidence from couple models suggests that for husbands, but not wives, remarriage may be associated with less depression than the baseline marriage. Differences in self-reported health associated with divorce appear linked to (diagnosed) mental health conditions among wives and physical health conditions among husbands.

Keywords Divorce · Remarriage · Aging · Self-Reported Health · Mental Health · Couples · Fixed effects

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1 Introduction

The prevalence and incidence of divorce have been rising among the middle-aged and elderly, doubling for those aged 50 and older between 1990 and 2010 (Brown and Lin 2012; Kennedy and Ruggles 2014). A substantial literature finds evidence of adverse impacts of divorce on mental and physical health (Waite and Gallagher 2000; Hughes and Waite 2009; Bronselaer et al. 2008). Married persons have health advantages that vary by gender, health outcome, as well as the duration of marriage. Marriage has been linked to lower risks of mortality, cardiovascular disease, and cancer (Lillard and Waite 1995; Goodwin et al. 1987; Reczek et al. 2016).

Despite evidence relating marriage to health, few studies correlate health *transitions* with divorce and remarriage at middle and older ages. Those that do find more evidence of changes in mental than physical health following divorce (Hughes and Waite 2009, p. 344). Even fewer use prospective data to track health transitions of respondents who undergo marital transitions in middle and older ages, the purpose of the present paper.[1]

This study investigates whether divorcing later in life is associated with deteriorating health using the first 10 waves of the Health and Retirement Study (HRS). The HRS has followed middle-aged and elderly individuals since 1992.[2] The HRS follows couples longitudinally even when they are no longer married, providing a unique opportunity to compare changes in spouses' health following divorce. To our knowledge, this is the first study to describe differences between spouses, within couples, in health transitions following divorce or remarriage. Our research questions include: Do people who divorce at middle and older ages experience greater declines in physical and mental health than their married same-sex counterparts? Do changes in health associated with divorce and remarriage differ between men and women? Are divorce and remarriage associated with changes in health trajectories? What mechanisms link divorce and health? Following couples, do wives differ from their husbands in the physical and mental health transitions they experience following divorce and remarriage at middle and older ages?

The next section summarizes theories and evidence linking divorce to health with a focus on longitudinal evidence. Section 3 describes the data and empirical approach. Summary statistics and results from multivariate models are presented in Section 4. Section 5 concludes.

2 Theoretical and empirical relationships between divorce and health

As noted, a vast literature has documented relationships between marital status and health (see Waite and Gallagher 2000; Wilson and Oswald 2005; Wood et al. 2007; Bronselaer et al. 2008 for reviews), including associations between divorce and disability, mental health, self-rated health, and mortality (e.g., Pienta et al. 2000;

[1] Studies that do focus on older populations are e.g., Zhang and Hayward (2006), Hughes and Waite (2009), Dupre et al. (2009), Reczek et al. (2016)

[2] The HRS (Health and Retirement Study 2011) is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan.

Aseltine and Kessler 1993; Simon 2002; Williams and Umberson 2004; Dupre and Meadows 2007; Pudrovska and Carr 2008; Dupre et al. 2009; Goldman et al. 1995).

Several hypotheses could explain the relationship between marital status and health. The first, "marital health selection," suggests that it is easier for healthy people to find marriage partners, and that marriage may not improve health. Although health selection explains part of the association between divorce and health (Goldman 1993; Lillard and Waite 1995; Hughes and Waite 2009; Bronselaer et al. 2008), evidence also supports the second hypothesis, "marital protection," whereby marriage confers health benefits. Spouses encourage healthy behavior and provide emotional support, which improves mental and physical health (e.g., Waite and Gallagher 2000; Wood et al. 2007). Furthermore, due to economies of scale and specialization in home and market production, married couples have increased time and household resources that are inputs into health production (Grossman 1972).[3] More recent literature has suggested that the association between marriage and health might be explained by a link between marriage and a more positive outlook on life (Lucas 2005; Kalmijn 2017). Finally, studies have attributed the health effects of divorce to temporary stress or the uncertainty following divorce (Bronselaer et al. 2008).

A third hypothesis, "Escape," a variant of marital selection, suggests that ending a problematic marriage might improve health and well-being, although empirical evidence for this mechanism is weak (Kalmijn and Monden 2006).

In sum, the marital selection hypothesis suggests that, although divorced people have a lower health stock than married people, divorce does not harm health. The protection hypothesis suggests that a divorce causes a person to lose at a least some of the protective benefits of marriage.

Empirical studies have also found gender differences in other effects of divorce that may produce gender differences in health. Women tend to experience a substantial reduction in family income after divorce (Smock et al. 1999), face a greater marital status gap in wealth than men (Zissimopolous et al. 2015), and are more likely to lose health insurance dependent coverage through the ex-spouse's employer (Lavelle and Smock 2012; Peters et al. 2014). These effects, combined with child-care responsibilities, are likely to increase stress and health problems among women following divorce (Dahl et al. 2015).[4] However, while gender-differences in responsibilities and economic status would predict more adverse health effects of divorce for women, differences in social support and health behaviors following divorce may favor women (Antonucci and Akiyama 1987; Pudrovska and Carr 2008; Reczek et al. 2016). Men may rely more on their wives for social contact and care than the reverse and therefore experience a greater loss of support following divorce (e.g., Berkman and Syme 1979; Sarason et al. 1997; Umberson and Montez 2010). Moreover, men may resort to heavier drinking after divorce (Reczek et al. 2016).

[3] Although market production plays a smaller role in later life, even in later life economies of scale and specialization in specific home production tasks can provide health investment advantages to married couples.

[4] Consistent with the "economic stress" hypothesis, data collected in the first wave of the HRS reveal that 52% of divorced women worry 'a lot' about their retirement income, compared to 31% of married women, 32% of divorced men and 25% of married men (authors' calculations, available upon request).

Economic, social and behavioral transitions associated with divorce could increase stress and give rise to health problems over time (Bronselaer et al. 2008; p. 172).

Mechanisms linking marital status and health may differ between older and younger persons. Health selection may be accentuated in later life due to higher morbidity levels, declining physical functioning, and the concomitant prospect of increased demand for care. While older women may be less able than working-age women to compensate for the economic shock of divorce (Smock et al. 1999; Haider et al. 2003), child care responsibilities should be less of a concern in later life (Dahl et al. 2015), as should the loss of health insurance following divorce given universal coverage under Medicare at age 65. However, loss of a social network due to divorce may be a greater concern for those who have retired than for those who work, and potentially more so for retired men than women (e.g., Berkman and Syme 1979; Antonucci and Akiyama 1987).

A burgeoning literature has considered whether marital quality affects health in mid- and later-life. Low or deteriorating marital quality has been associated with inflammation for middle-aged women but not for men (Donoho et al. 2013) and increased cardiovascular risks for older women, more so than for men (Liu and Waite 2014). If marital quality affects health, then the effects of divorce should vary by marital quality prior to divorce.

The effects of divorce may depend on the prospects for remarriage and its effects on health, which the literature suggests are more favorable for men than women. For women, but not for men, the likelihood of remarriage depends on the age at divorce and on socioeconomic circumstances (Sweeney 1997). Older men may have more opportunities to remarry than older women (Bengtson et al. 1990), and expectations about caregiving responsibilities for a spouse may lead older women to have less favorable attitudes toward remarriage than younger women (Cancian and Oliker 2000; Davidson 2002). All these considerations suggest that there may be differences in associations between health, divorce, and remarriage between younger and older cohorts, and between older men and women.

Many studies have taken a life-course approach, relating the number and timing of marital transitions, and the duration of differing marital states, to health and health behaviors at a later age (Hughes and Waite 2009; Zhang and Hayward 2006; Liu 2012). Findings include that: relative to continuously married counterparts, divorced men and women have worse physical and mental health, and those who remarry recover, but only partly; marriage loss is associated with an increased risk of cardiovascular disease for women; adverse health effects of divorce decrease with age.[5]

Most relevant to the present paper are studies that tracked individuals' physical and mental health, health behaviors, and life satisfaction over time, prior to and following divorce, and considered gender differences in these transitions. Some studies considered how health changes with duration in different marital states.

Dupre and Meadows (2007) related marital trajectories to the onset of serious health conditions (diabetes, cancer, heart attack or stroke) in the HRS. They found that timing, duration, and transitions are important processes linking marital status and health for women, while for men, timing was less important. Additionally, they concluded (p. 647) that negative associations between health and divorce may be

[5] Hughes and Waite (2009) did not find gender differences.

reduced by longer marital duration. A study of data from Norway found that divorce is associated with greater sickness absences, especially among women with children (Dahl et al. 2015).

Dupre et al. (2009) estimated models that related mortality risk to marital status and accumulated durations in different marital states. They found (p. 546) that "accumulation of marital duration was the most robust predictor of survival." Mortality risk decreased with time married, after adjusting for health-related behaviors and SES. Divorce initially raised mortality risks for men, but time spent divorced was unrelated to mortality in fully adjusted models. Divorce was also associated with increased mortality risk for women. SES adjustment greatly reduced the mortality risks associated with divorce for both men and women, though the relative risk remains statistically significantly elevated.

Turning to mental health, in longitudinal analyses of marital transitions in the (US) National Survey of Families and Households, Simon (2002) found that divorce was associated with increases in depression among women but not men. Lucas (2005) found in the German Socio-Economic Panel Study that life satisfaction falls approaching divorce, declines further following divorce, and partly recovers with time in the divorced state. Although evidence suggested that men react more negatively to divorce than women, Lucas was reluctant to reach firm conclusions given mixed evidence of gender differences reported in the literature. On the other hand, Pudrovska and Carr (2008) found little evidence for an effect of divorce on depression in the Wisconsin Longitudinal Survey, examining transitions between 1993 and 2004 among persons in their early 50s in 1993. However, they found divorce was associated with increased alcohol consumption, especially among men, but the association attenuated over time. Reczek et al. (2016) also found that divorce is associated with increased heavy alcohol use among men in the HRS data. Marriage, including remarriage, was associated with reduced drinking among men but increased drinking among women. Qualitative interviews suggested that this pattern was driven by both behavioral convergence (men drink more than women prior to marriage) and social control (men report reducing alcohol consumption to be a good husband).

In a study of Canadian longitudinal data, Averett et al. (2013) included individual fixed effects to control for marital selection, and found that divorce was associated with increased smoking and depression for men, but reduced alcohol consumption for both women and men. On the other hand, a dynamic model of health that included as controls both lagged health indicators and estimates of unobserved health-related heterogeneity revealed no effect of divorce on health in the UK (Kohn and Averett 2014).

Finally, to our knowledge, no study has directly compared husbands' and wives' health trajectories, within couples, through and following divorce. However, Reczek et al. (2016) estimated couple models to study the dynamics of husbands' and wives' alcohol use. They estimated logistic growth curves for alcohol use that allowed for correlation of intercepts and slopes across spouses (within couples). They found few significant cross-effects (i.e. husband's slope or intercept affecting wife's slope or intercept or vice versa). They did not, however, follow couples as they transitioned from marriage to divorce.

Mare and Palloni (1988), studied cross-spouse effects of socioeconomic differences on survival in a model that controlled for shared but unmeasured traits using couple data, and found that most of the variation exists within couples (between husbands and wives) rather than between couples. We, thus, expected (and found) ample within-couple variation in health that could be used to estimate within-couple (husband-wife) differences in associations between marital status and health.

The current study builds on and extends the literature on marital status in mid- and later life (e.g., Hughes and Waite 2009; Zhang and Hayward 2006; Liu 2012; Donoho et al. 2013). It addresses marital selection on unmeasured characteristics by using models with individual fixed effects, in line with Averett et al. (2013). It adds to this literature by also studying within-couple differences in the relationship between marital status and health in models with couple fixed effects, comparing wives to their own husbands. Finally, it extends the work of Dahl et al. (2015), and Reczek et al. (2016) by tracking trajectories of health before and after divorce for an older population.

3 Data and econometric models

We used data from the HRS, a longitudinal dataset that surveys people ages 50 or older every two years about their health, economic status, family structure, and other relevant characteristics. We constructed two analysis samples using the first 10 waves of the publicly-available RAND HRS Data (2011): 1. all individuals married or partnered at the baseline interview; and 2. linked "divorcing" couples who were married or partnered at the baseline interview and interviewed at least once after divorce (or separation for partnered couples, hereafter referred to as divorce).[6] The individual sample includes 10,946 women (607 of whom divorce and 172 remarry) and 10,856 men (533 of whom divorce and 185 remarry); together they contributed 130,734 person-year observations. In all, over the period of 20 years (10 survey waves), 13% of person-year observations were lost from non-response. However, only 6% of persons were eventually dropped from the sample due to non-response. On average, women were observed in the divorced state in 2.6 waves, and men in 1.8 waves.

The couple sample includes 520 divorcing couples with 5,534 person-year observations. From all matched divorcing couples that were married at baseline, 23% of couple-year observations were lost due to non-response of one spouse over the period of 20 years (10 survey waves). Only 8% of couples were lost due to one spouse being dropped from the sample due to non-response.[7] On average, couples were observed in the divorced state for 2.9 survey waves. Of the 520 divorcing couples, 169 wives remarried, while 200 husbands remarried. Some analyses explored the sensitivity of results to a correction for mortality attrition.

[6] Brown and Wright (2017) find that about 4.6% of previously married individuals over age 50 cohabit. We included those partnered/cohabiting as "married". Our conclusions are not sensitive to dropping them from the sample. Results are available upon request.

[7] These attrition rates are in line with the other studies of the HRS (e.g., Reczek et al. 2016; Dupre et al. 2009).

This paper focuses on the associations of health with transitions into divorce and into subsequent remarriage following the baseline marriage. In most models, a divorce (remarriage) begins at the first survey after divorce (remarriage).[8] However, in models that study health transitions over time, divorce was assumed to occur at the midpoint of the interval between the last survey date when marital status was recorded as married or partnered and the first survey date when it was recorded as divorced or separated.

The first outcome of interest is based on self-reported general health status. Self-reported health predicts survival and is a reliable measure of general health (Miilunpalo et al. 1997; McGee et al. 1999) after adjustment for socio-economic status and race (Dowd and Todd 2011). Specifically, the physical health outcome is an indicator of self-reported "bad" health (i.e., fair or poor) versus good, very good or excellent health.

The second outcome of interest is mental health. We used the HRS' abbreviated 8 - item version of the Center for Epidemiologic Studies Depression (CESD) scale, which is considered to be a highly reliable indicator of the likelihood of clinical depression (Radloff 1977). Specifically, the depression outcome is an indicator for whether clinical depression is likely, as measured by a score of four or above on the abbreviated CESD scale.[9]

Covariates include years of education, dummy variables for black and Hispanic identification, census division, HRS cohort, and age (as a quadratic) which is also interacted with gender to allow for gender-specific age profiles of health. Adjusted household income was explored as a mediator in the relationship between marital status and self-reported health, and defined as the sum of the head and spouse's income, divided by the square-root of the household size (OECD 2009).[10] It is top-coded at $300,000 (inflation adjusted to 2010) to reduce the influence of HRS imputation errors (Alwin et al. 2014). Mental and physical health conditions were also explored as mediators in the association between marital status and self-reported health. Besides the depression indicator, psychological condition, which is an indicator for whether a person was ever diagnosed with an emotional, nervous, or psychiatric condition, was explored as a potential mental health mediator. Additionally, indicators for whether a person was ever diagnosed with physical health conditions (high blood pressure, diabetes, cancer, lung disease, heart condition, stroke, and arthritis) were explored as potential physical health pathways through which divorce could be associated with general self-reported health.

[8] The remarried include respondents who either changed marital status from divorced or separated to partnered or married, or who changed partners.

[9] This corresponds to clinical depression indicated by a score of 16 or more on the full scale (Steffick 2000). The Online Appendix provides additional information on imputation of missing information and other details of measure construction. Models also included a dummy variable to indicate the use of imputed depression data.

[10] The HRS collects income information of the household head and spouse only.

To estimate the relationship between marital status and health among individuals, we estimated the following linear probability model (LP):

$$Y_{it} = \beta_0 + \beta_1 DIV_{it} + \beta_2 Male_i \cdot DIV_{it} + \beta_3 Rem_{it} + \beta_4 Male_i \cdot Rem_{it} + \beta_5 Male_i + X_{it}'\delta + \eta_i + \varepsilon_{it} \quad (1)$$

where the dependent variable, Y_{it}, is, alternatively, a dichotomous health outcome indicating whether the respondent reports fair or poor health, or an indicator for depression (CESD ≥ 4). DIV_{it}, is a binary indicator for whether respondent i is divorced or separated at time t. Rem_{it} is an indicator for whether respondent i is remarried at time t. Throughout the paper, remarriage is defined as the marriage following divorce from the baseline marriage.[11] Finally, a vector X_{it} includes other demographic characteristics as described above.[12], [13]

As indicated by equation (1), the main results are from models that include individual fixed effects (FEs) to control for marital health selection on time-invariant unobservables; the estimates from these FE models are identified from within-person variation in marital status and health. OLS models that do not include individual (or couple) fixed effects cannot control for potential confounders of the health-marital status relationship. (For results without fixed effects, see Online Appendix Tables A9 and A10). Standard errors were clustered at the individual level to correct for potential heteroskedasticity and correlation of the error terms within observations for an individual across survey waves.

Linear probability models facilitate comparisons between models with and without FEs since marginal effects are undefined in logit models with FEs, and odds ratios are difficult to compare across models (Mood 2010; Norton 2012). Additionally, interactions between gender and marital status were of particular interest, but interaction effects in non-linear models with FEs are easily misinterpreted (Ai and Norton 2003). In sum, coefficients from LP models are easy to interpret and are the parameters of interest (probability derivatives).[14]

[11] While it is possible to model a baseline marriage as remarriage if it is not the respondent's first marriage, we were primarily interested in the health-changes associated with changes in marital status in later life.

[12] Health behaviors were considered as either marital-health selection factors or mechanisms. Alternative models additionally included controls for BMI (based on self-reported height and weight) smoking currently, household income, more than three alcoholic beverages per day, and a dummy variable for lacking health insurance, relevant for those younger than 65 years of age. Although inclusion of these controls reduced the size of the significant divorce associations by 0–1.4 percentage points, statistical significance was unchanged for 6 out of the 8 significant divorce and remarriage associations reported in Table 2 (and Online Appendix Table A1). Evidence for an important mediating role of health behaviors was absent for men and mixed for women. See Online Appendix Table A11 for results.

[13] Models also control for widowhood, fully interacted with gender. Controls for race, ethnicity, and Census region were included to account for the HRS oversamples of blacks and Hispanics and Florida residents (Winship and Radbill 1994; Solon, Haider, and Wooldridge 2015).

[14] Results from logistic regression models are reported in Online Appendix Table A5. Inference was not affected by the choice of model. Specifically, the coefficients of the variables of interest in Logit models (Online Appendix Table A5) have the same sign and significance levels as LP models (Table 2, and Online Appendix Table A1).

To study the association between marital status and health in the sample of linked couples, we estimate the following LP model on a sample of matched ex-spouses:

$$\begin{aligned} Y_{ijt} = \gamma_0 + \gamma_1 Couple\_Divorced_{jt} + \gamma_2 Husband_{ij} + \\ \gamma_3 Couple\_Divorced_{jt} \cdot Husband_{ij} + \\ \gamma_4 Couple\_Divorced_{jt} \cdot Remarried_{ijt} + \\ + \gamma_5 Couple\_Divorced_{jt} \cdot Remarried_{ijt} \cdot Husband_{ij} + X_{ijt}\sigma + \xi_j + \upsilon_{ijt}, \end{aligned} \tag{2}$$

where dependent variable, Y_{ijt}, is one of the binary health outcomes described above. The key independent variable is an interaction of a binary variable $Husband_{ij}$, indicating whether respondent i in couple j is the husband, and $Couple\_Divorced_{jt}$, indicates whether couple j has divorced or separated by time t.[15] Also of interest is the triple interaction of $Couple\_Divorced_{jt}$, $Husband_{ij}$, and $Remarried_{ijt}$, where the latter is a binary indicator for whether person i in couple j has remarried by time t.[16] The models control for unmeasured time-invariant couple characteristics by including a vector ξ_j of couple FEs. Standard errors are clustered at the individual level.

Our goal is to describe within-couple gender differences in the effect of divorce and remarriage. In other words, couple models allow for the study of how a wife's health transitions compare to her husband's health transitions, following changes in marital status. Couple FEs adjust for couple-specific characteristics, which could be important confounders of the association between divorce and health; for example, the key determinants of divorce in the HRS identified by Lin et al. (2018) are couple-specific (e.g., marital duration and marital quality). In contrast, the gender interaction in the individual model compares the divorce effect between men and women on average, rather than directly comparing the experiences of "matched" husband-wife pairs.

The study also describes the health trajectory for both spouses, leading up to and following divorce and remarriage. For this purpose, interactions between marital status and time are included in some couple models:

$$\begin{aligned} Y_{ijt} = \delta_0 + \delta_1 Couple\_Divorced_{jt} + \delta_2 Husband_{ij} + \\ \delta_3 Couple\_Divorced_{jt} \cdot Husband_{ij} + \\ \delta_4 Couple\_Divorced_{jt} \cdot Remarried_{ijt} \\ + \delta_5 Couple\_Divorced_{jt} \cdot Remarried_{ijt} \cdot Husband_{ij} + \\ \delta_6 time + \delta_7 time \cdot Couple\_Divorced_{jt} \\ + \delta_8 time \cdot Husband_{ij} + \delta_9 time \cdot Couple\_Divorced_{jt} \cdot \\ Husband_{ij} + \delta_{10} time \cdot Couple\_Divorced_{jt} \cdot Remarried_{ijt} \\ + \delta_{11} time \cdot Couple\_Divorced_{jt} \cdot Remarried_{ijt} \cdot Husband_{ij} \\ + X_{ijt}\sigma + \xi_j + \eta_{ijt} \end{aligned} \tag{3}$$

[15] It is possible that remarriage/repartnering is selected on health status. We tested the sensitivity of the results, by treating divorce as an absorbing state (until death or loss to follow up). In those models, we focus on the couple's divorce, essentially constraining husbands and wives to have the same marital status following divorce. Online Appendix Table A2 shows the results from these models.

[16] Note that $Couple\_Divorced_{jt}$ remains 1 after the couple has divorced. $Remarried_{ijt}$ indicates a marriage after the couple divorces. Therefore, $Couple\_Divorced_{jt}$, is always 1 if $Remarried_{ijt}$ is 1, and a triple interaction does not technically change the specification, but is added for expositional clarity.

where time measures the number of years since divorce (negative for years prior to divorce), and all other variables are as described above. We estimated models with and without remarriage. The procedure used is in the spirit of the distributed-fixed-effects models of Killewald and Lundberg (2014), who describe wage changes before and after marriage for men, of Dahl et al. (2015), who study marital dissolution and sickness absence, and of Reczek et al. (2016), who study divorce and alcohol consumption in the HRS. Due to modest sample sizes, model specifications constrained health trajectories to change linearly in the period before and after divorce and remarriage, with possibly a different slope in each period, and allowed for discrete changes at the time of divorce and remarriage. These models allow health trajectories of husbands and wives to differ both before and after divorce and remarriage.

4 Results

Table 1a reports weighted summary statistics by marital status, separately for men and women, for the sample of individuals.[17] For simplicity, we refer to the baseline married state as "married" throughout this paper. Among women (the first three columns), a larger share of divorced and remarried women, compared to married women, report their health as "bad", and have a higher likelihood of clinical depression (CESD ≥4). Divorced men are more likely than married men to report "bad" health and depression, while remarried men are not. Compared to married women, divorced women are also more likely to have been diagnosed with a psychological condition, lung disease or high blood pressure, while remarried women are more likely to have been diagnosed with a psychological condition, cancer, stroke, or arthritis. Compared to married men, divorced men are more likely to have been diagnosed with a psychological condition, stroke or arthritis, while remarried men are more likely to have been diagnosed with a psychological or heart condition. For men and women, age differs little between married, divorced, and remarried persons, but income, race, and education (for men) do; for example, 10% of divorced and remarried women are racially identified as black compared to 6% of married women, 14% of divorced men, 9% of remarried men, and 6% of married men. Divorced persons have lower adjusted household income than their married and remarried counterparts.

Table 1b reports weighted summary statistics by marital status, separately for matched husbands and wives. While proportions in "bad" health and depressed appear to differ across marital states for both wives and husbands, most differences are not statistically significant. However, remarried husbands are statistically significantly less likely to be depressed than married husbands. In terms of diagnosed conditions, remarried wives are more likely to have had a diagnosis of cancer, psychological, or lung conditions than married wives. Among husbands, those in the divorced state are more likely to have been diagnosed with a psychological

[17] Summary statistics for the widowed in the individual sample are not shown, but available upon request.

Table 1a Weighted summary statistics, individual sample

Sample means (SD) - proportions (unless indicated)						
	Individuals					
	Women			Men		
	Married	Divorced	Remarried	Married	Divorced	Remarried
"Bad" health, %	0.21	0.30**	0.29*	0.23	0.32**	0.25
Clinical depression likely, %	0.13	0.25**	0.18**	0.09	0.20**	0.10
CESD score (1–8)	1.3	2.2**	1.8**	1.0	1.8**	1.1
	(1.9)	(2.5)	(2.1)	(1.6)	(2.2)	(1.6)
Adjusted household income, in $100k	0.5	0.3**	0.5	0.5	0.4**	0.5
	(0.5)	(0.3)	(0.5)	(0.5)	(0.4)	(0.5)
Psychological condition, %	0.14	0.26**	0.35**	0.08	0.20**	0.19 **
Heart condition, %	0.14	0.16	0.19	0.24	0.27	0.32**
Lung condition, %	0.07	0.11**	0.09	0.07	0.09	0.10
Diabetes, %	0.12	0.13	0.12	0.17	0.20	0.21
Cancer, %	0.11	0.09	0.17*	0.11	0.09	0.10
Stroke, %	0.05	0.06	0.13**	0.07	0.10*	0.09
Arthritis, %	0.53	0.55	0.63*	0.43	0.49*	0.49
High blood pressure, %	0.45	0.49*	0.47	0.47	0.51	0.52
Age, years	63.5	61.6**	62.2**	64.7	63.7**	65.0
	(8.9)	(7.1)	(6.3)	(9.5)	(7.9)	(8.0)
Education, years	12.7	12.9	12.6	12.9	12.7	12.8
	(2.8)	(2.6)	(2.6)	(3.3)	(3.3)	(3.1)
Black, %	0.06	0.10**	0.09	0.06	0.14**	0.09
Hispanic, %	0.06	0.07	0.06	0.06	0.08	0.06
Person-years	56,146	1,846	744	56,723	1,337	975
Persons	10,953			10,555		

Numbers in parentheses are standard deviations. Married and Remarried include those partnered/cohabiting. Remarriage refers to the marriage after the first divorce observed in the data. Divorced include those separated. Descriptive statistics of widowed men and women are not shown here, but available upon request. Gender, education and the indicators for black and Hispanic identification are time-invariant. Stars mark means significantly different from married in two-tailed tests

*$p < 0.1$; **$p < 0.05$

condition, cancer, and high blood pressure, while remarried husbands are more likely to have had a cancer diagnosis, compared to those married.[18]

The couple sample is much smaller than the individual sample, and the two samples differ in characteristics because, although all are married at baseline, all members of the couple sample divorce, while some in the individual sample remain married or become widowed.[19]

[18] Summary statistics for couples are shown for the husbands and wives in their married, divorced, and remarried states. While all divorce, not all remarry, thus differences in means for time-constant variables result from an unbalanced panel.

[19] For most of our analyses, we no longer include a couple in our sample after the death of one spouse.

Table 1b Weighted summary statistics, couple sample

Sample means (SD) - proportions (unless indicated)						
	Couples					
	Women			Men		
	Married	Divorced	Remarried	Married	Divorced	Remarried
"Bad" health, %	0.26	0.31	0.33	0.28	0.33	0.25
Clinical depression likely, %	0.22	0.26	0.21	0.20	0.20	0.11*
CESD score (1–8)	1.9	2.3	1.9	1.7	1.8	1.1**
	(2.3)	(2.5)	(2.3)	(2.3)	(2.2)	(1.7)
Adjusted household income, in $100k	0.5	0.3*	0.5	0.4	0.4	0.5
	(0.5)	(0.3)	(0.5)	(0.4)	(0.4)	(0.5)
Psychological condition, %	0.17	0.24	0.36*	0.14	0.22**	0.17
Heart condition, %	0.12	0.15	0.20	0.18	0.27	0.34
Lung condition, %	0.07	0.14	0.08*	0.07	0.09	0.11
Diabetes, %	0.12	0.13	0.13	0.15	0.20	0.18
Cancer, %	0.08	0.08	0.15**	0.05	0.10*	0.13**
Stroke, %	0.05	0.07	0.13	0.05	0.10	0.09
Arthritis, %	0.42	0.55	0.59	0.36	0.48	0.45
High blood pressure, %	0.35	0.46	0.44	0.42	0.53*	0.52
Age, years	57.5	61.2*	61.8	59.1	63.6*	63.9**
	(6.5)	(7.0)	(6.0)	(7.6)	(7.6)	(7.1)
Education, years	13.0	13.1	12.5	12.5	12.7	12.8
	(2.8)	(2.5)	(2.6)	(3.5)	(3.2)	(3.1)
Black, %	0.10	0.08	0.08	0.12	0.12	0.08
Hispanic, %	0.09	0.06	0.07	0.10	0.08	0.06
Person-years	1,365	1,035	369	1,365	920	484
Persons	521			519		

Numbers in parentheses are standard deviations. Married and Remarried include those partnered/cohabiting. Remarriage refers to the marriage after the first divorce observed in the data. Divorced include those separated. Gender, education, and the indicators for black and Hispanic identification are time-invariant. Stars mark means significantly different from married in two-tailed tests

*$p < 0.1$; **$p < 0.05$

Column (1) of Table 2 shows the key estimated associations from the model of individuals' self-reported health and depression, with controls for education, age, black and Hispanic identification and individual fixed effects. For women but not men, being divorced is associated with a 4.1 percentage point greater likelihood of

Table 2 Divorce, remarriage and physical and mental health, individuals and couples estimated associations from linear probability models with individual or couple fixed effects

Dependent variable =	Individuals		Couples	
	"Bad" health	Depression	"Bad" health	Depression
	(1)	(2)	(3)	(4)
Marital status (ref: married)				
Divorce women	0.041**	0.038**	0.048**	0.047*
	(0.014)	(0.016)	(0.021)	(0.024)
Divorce men	0.002	0.037**	0.054**	0.022
	(0.017)	(0.017)	(0.023)	(0.023)
Gender-difference divorce (women - men)	0.040*	0.001	−0.006	0.026
	(0.022)	(0.023)	(0.030)	(0.030)
Remarriage women	0.028	−0.021	0.051	−0.006
	(0.023)	(0.025)	(0.034)	(0.034)
Remarriage men	0.013	−0.016	−0.007	−0.050*
	(0.019)	(0.018)	(0.030)	(0.028)
Gender-difference remarriage (women - men)	0.016	−0.005	0.058	0.044
	(0.029)	(0.031)	(0.042)	(0.039)
Individual fixed effects	Yes	Yes	No	No
Couple fixed effects	No	No	Yes	Yes
Person-years	130,734	110,394	5,534	4,538
Persons	21,802	20,334	1,040	964

This table shows estimated associations from Linear Probability Models. The dependent variable "Bad" Health is an indicator for fair or poor self-reported health and Depression is an indicator for whether clinical depression is likely according to the CESD scale (CESD ≥ 4). CESD information was imputed for 64 person-years in the sample of individuals and 2 person-years in the sample of couples. The models for depression include a variable to indicate whether depression status was imputed from partial information. All models control for age and age (as a quadratic) fully interacted with gender, education, dummies for black, Hispanic, Census region (9) and HRS cohort (2). Models for individuals also include an indicator for widowhood fully interacted with the gender indicator. Couple sample only includes observations when both spouses are alive. The associations shown are relative to the married state (which includes those partnered/cohabiting). The standard errors (in parentheses) are adjusted for heteroskedasticity and for clustering within individual. Full results are shown in Online Appendix Table A1

For women in the individual model, the divorce association is the coefficient of the *Divorced* variable (which includes those separated), and the remarriage association is the coefficient of the *Remarried* variable in Online Appendix Table A1. For men in the individual model, the divorce-association is the sum of the coefficient of the *Divorced* variable, and the coefficient of the *Divorced-Male* interaction term, while the remarriage-association is sum of the coefficient of the remarriage variable and the coefficient of the *Remarried-Male* interaction term. For wives in the couple model, the divorce association is the coefficient of the *Couple Divorced* variable, and the remarriage association is the sum of the coefficients of the *Couple Divorced* and the *Remarried* variables in Online Appendix Table A1. For husbands in the couple model, the divorce-association is the sum of the coefficient of the *Couple Divorced* variable, and the coefficient of the *Couple Divorced-Male* interaction, while the remarriage association is the sum of the coefficient of *Couple Divorced*, *Couple Divorced-Male*, *Remarried*, and *Remarried-Male* (Online Appendix Table A1)

$^{*}p < 0.1$; $^{**}p < 0.05$

"bad" health than is being married ($p < 0.05$).[20,21] The gender-difference in the association between divorce and "bad" health is statistically significant at the 10% level. Among women, divorce is associated with "bad" health but the difference between health in the remarried and married state is not significant.[22] Other model covariates have expected signs (see the Online Appendix Table A1 for the full results.)[23]

Column (3) of Table 2 shows the self-reported health results for divorcing couples, controlling for couple FEs. For both husbands and wives, divorce is associated with a similar (five percentage point) increase in the likelihood of "bad" health.[24] For husbands, there is little evidence of a difference in "bad" health between the remarried and married states.[25] For wives, differences between "bad health" in either the divorced or remarried state compared to the baseline marriage are of similar size (around five percentage points), although only the divorced differential is statistically significant.[26] Note that while the results suggest that the remarried state is healthier than the divorced state for both husbands and wives, the lower likelihood that wives will remarry makes the overall-post-divorce experience more adversely associated

[20] In (OLS) models without individual fixed effects, divorce is associated with worse health and more depression for both men and women, and remarriage is associated with worse health and depression for women (relative to baseline marriage), but only with depression for men. Most of the gender-differences are not statistically significant. All point estimates tend to be larger in absolute size compared to models that control for individual fixed effects. While OLS coefficients are larger, the fixed-effects results still show an effect of divorce for women, suggesting that our main conclusion is not driven by health selection into divorce. This is in line with Lin et al. (2018) who find little evidence of health selection into divorce in a similar sample. See Online Appendix Table A9 for results.

[21] For women, the regression-adjusted difference in "bad" health between women in the divorced and married states is the coefficient of the divorce variable. For men, it is the sum of the coefficient of divorce, and the coefficient of the divorce-male interaction term.

[22] For women, the regression-adjusted difference between the married and remarried states is the coefficient of the remarriage variable. For men, it is the sum of the coefficient of the remarriage variable and the coefficient of the remarriage-male interaction term.

[23] We also estimated alternative models that additionally included controls for BMI (based on self-reported height and weight) smoking currently, household income, more than three alcoholic beverages per day, and a dummy variable for lacking health insurance, relevant for those younger than 65 years of age. Although inclusion of these controls reduced the size of the significant divorce associations by 0–1.4 percentage points, statistical significance was unchanged for 6 out of the 8 significant divorce and remarriage associations reported in Table 2 (and Online Appendix Table A1). Evidence for an important mediating role of health behaviors is absent for men and mixed for women. See Online Appendix Table A11 for results.

[24] For wives, the regression-adjusted difference in "bad" health between the married and divorced states is the coefficient of the "couple divorced" variable. For husbands, it is the sum of the coefficient of the "couple divorced" variable and the coefficient of the "couple divorced"-husband interaction term.

[25] For wives, the regression-adjusted difference in health between the remarried and married state, is the sum of the coefficient of the "couple divorced" variable and the coefficient of the remarriage variable. For husbands, it is the sum of four coefficients: the coefficient of the "couple divorced" variable, the coefficient of the "couple divorced" and husband interaction, the coefficient of the remarriage variable, and the coefficient of the triple interaction between "couple divorced", remarriage and husband.

[26] In (OLS) models without couple fixed effects, divorce was associated with worse health for wives, but not husbands, while remarriage was associated with less depression for husbands. None of the gender-differences were statistically significant. All point estimates tended to be larger in absolute size compared to the models that control for couple fixed effects. See Online Appendix Table A9 for results.

with self-reported health for wives than their husbands. This was also confirmed in models that included a control for divorce only (not remarriage) (Column (1) and (3) in Online Appendix Table A2). The results from these models showed that, all-in-all, life after divorce is associated with a higher likelihood of "bad" self-reported health for wives but not for husbands.

Columns (2) and (4) in Table 2 show results from models of clinical depression. According to the results summarized in column (2), divorce is associated with an increased likelihood of depression for men and women, but no differences in depression exist between the remarried and married state for either. Looking at couples, in column (4), divorce is associated with an increase in depression for wives but not husbands. For wives, there is no (adjusted) difference in depression between the remarried and married states, while for husbands, remarriage is actually associated with a statistically significantly lower likelihood of depression compared to the baseline marriage.

In sum, divorce is more often associated with deteriorations in self-reported health and depression for women than for men, and for wives than for their husbands. There is little difference in health between the remarried and married states, except for a lower likelihood of depression for husbands in the remarried state.

5 The role of health diagnoses and time

5.1 Diagnoses

Since divorce appears to be associated with worse self-reported general health, we briefly considered the mediating role of income and of diagnoses of mental, and physical health conditions. Table 3 summarizes the results of fixed-effects models of self-reported general health, where we sequentially added controls for adjusted household income, mental health conditions, and physical health conditions.

The mental health conditions include: the likelihood of depression and a diagnosed psychological condition. The physical health conditions include: high blood pressure, lung condition, heart condition, diabetes, cancer, stroke and arthritis. (Full results are reported in Online Appendix Table A3.) Column (1) and (5) in Table 3 correspond to columns (1) and (3) in Table 2, with controls for demographic characteristics and individual or couple FEs. Controls for adjusted income were added in columns (2) and (6), income and mental health conditions in columns (3) and (7); and income, mental and physical health conditions in columns (4) and (8).

For women, mental health accounts for about 27% of the association between divorce and women's health, while income and physical health conditions account for about 5%, and 7% respectively.[27] In the fully-adjusted model (column 4), the difference between the divorced and married states is 2.5 percentage points for women and (essentially) zero for men. For wives, mental health conditions also play

[27] For example, adding income controls reduced the association between divorce and health by 0.2 percentage points, or 5% (0.2/4.1) of the association between divorce and health in column (1). Adding mental health controls reduced the association between divorce and health by another 1.1 percentage point, or 27% (1.1/4.1) of the association between divorce and health in column (1).

Table 3 Mediating effects in the relationship between divorce, remarriage and self-reported health, individuals and couples estimated associations from linear probability models with individual or couple fixed effects

	Individuals				Couples			
Dependent variable = "Bad" health	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Marital status (ref: married)								
Divorce women	0.041**	0.039**	0.028**	0.025*	0.048**	0.033	0.014	0.011
	(0.014)	(0.014)	(0.014)	(0.014)	(0.021)	(0.021)	(0.020)	(0.019)
Divorce men	0.002	0.001	−0.006	−0.006	0.054**	0.053**	0.043*	0.023
	(0.017)	(0.017)	(0.017)	(0.016)	(0.023)	(0.023)	(0.023)	(0.022)
Gender-difference divorce (women - men)	0.040*	0.038*	0.034	0.030	−0.006	−0.020	−0.029	−0.012
	(0.022)	(0.022)	(0.021)	(0.021)	(0.030)	(0.029)	(0.027)	(0.026)
Remarriage women	0.028	0.029	0.020	0.009	0.051	0.056*	0.031	0.020
	(0.023)	(0.023)	(0.022)	(0.022)	(0.034)	(0.034)	(0.032)	(0.029)
Remarriage men	0.013	0.013	0.011	0.008	−0.007	−0.002	0.008	−0.027
	(0.019)	(0.019)	(0.019)	(0.018)	(0.030)	(0.030)	(0.029)	(0.029)
Gender-difference remarriage (women - men)	0.016	0.016	0.010	0.001	0.058	0.058	0.023	0.048
	(0.029)	(0.029)	(0.029)	(0.028)	(0.042)	(0.041)	(0.040)	(0.038)
Individual fixed effects	Yes	Yes	Yes	Yes	No	No	No	No
Couple fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Adj. HH. income control	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Mental health conditions	No	No	Yes	Yes	No	No	Yes	Yes
Physical health conditions	No	No	No	Yes	No	No	No	Yes
Person-years	130,734	130,734	130,734	130,734	5,534	5,534	5,534	5,534
Persons	21,802	21,802	21,802	21,802	1,040	1,040	1,040	1,040

This table shows estimated associations from Linear Probability Models. The dependent variable is an indicator for fair or poor self-reported health. All models control for age and age (as a quadratic) fully interacted with gender, education, dummies for black, Hispanic, Census region (9), and HRS cohort (2). Adjusted household income represents income of the respondent and the spouse adjusted for whether in a couple household. Mental Health Conditions include controls for psychological condition, an indicator for a diagnosis of emotional, nervous, or psychiatric condition and for depression, an indicator for depression according to the CESD scale (CESD ≥ 4), an indicator if depression status was imputed from partial information, and indicators for missing psychological information and CESD information. CESD information was imputed for 64 person-years in the sample of individuals and 2 person-years in the sample of couples. Physical Health Conditions include controls for seven physical health conditions (heart condition, lung condition, diabetes, cancer, stroke, arthritis, and high blood pressure). Models for individuals also include an indicator for widowhood fully interacted with the gender indicator. The couple sample only includes observations when both spouses are alive. The associations shown are relative to the baseline married state (which includes those partnered/cohabiting). The standard errors (in parentheses) are adjusted for heteroskedasticity and for clustering within individual. Full results are shown in Online Appendix Table A3. For women in the individual model, the divorce association is the coefficient of the *Divorced* variable (which includes those separated), and the remarriage association is the coefficient of the *Remarried* variable in Online Appendix Table A3. For men in the individual model, the divorce-association is the sum of the coefficient of the *Divorced* variable, and the coefficient of the *Divorced-Male* interaction term, while the remarriage-association is sum of the coefficient of the remarriage variable and the coefficient of the *Remarried-Male* interaction term. For wives in the couple model, the divorce association is the coefficient of the *Couple Divorced* variable, and the remarriage association is the sum of the coefficients of the *Couple Divorced* and the *Remarried* variables in Online Appendix Table A3. For husbands in the couple model, the divorce-association is the sum of the coefficient of the *Couple Divorced* variable, and the coefficient of the *Couple Divorced-Male* interaction, while the remarriage association is the sum of the coefficient of *Couple Divorced*, *Couple Divorced-Male*, *Remarried*, and *Remarried-Male* (Online Appendix Table A3)

*$p < 0.1$; **$p < 0.05$

a substantial role in the relationship between divorce and "bad" health; the difference between divorce and "bad" health falls by 1.9 percentage points when mental health conditions are controlled (column 7), 40% of the association between divorce and wives' health in column (1). For husbands, physical health conditions play a larger role in the association between divorce and health, explaining 37% of the association between divorce and health.[28]

To summarize, the evidence, although mixed, suggests that mental rather than physical health accounts for much of the association between divorce and self-reported general health for women, while physical health is more important for men.

5.2 Time

The next set of models for couples describe how associations between divorce and health evolve over time. Figures 1a, b and 2a, b plot the results as a schematic of health trajectories for a typical couple. (See Online Appendix Table A4 for the full regression results.) Specifically, the trajectories without remarriage use the coefficients on the variables *Couple Divorced*, fully interacted with *Husband* and *Time*, where time is zero at divorce (from columns (1), and (3) in Online Appendix Table A4).[29] The trajectories with *Remarriage* additionally use the remarriage interactions, fully interacted with *Husband* and *Time* (from columns (2) and (4) in Online Appendix Table A4).[30]

Figure 1a shows results from the model of "bad" health without controls for remarriage, and results from the model with controls for remarriage are shown in Fig. 1b. The figure plots the evolution of "bad" health for husbands and wives, relative to the wives' health at the time of divorce. Wives and husbands have similar health trajectories, though husbands appear slightly worse off than wives just prior to divorce (have a higher likelihood of "bad" health). Divorce is associated with a slight discrete increase in "bad" health for wives, but not for husbands, although their health changes similarly in divorce. However, Fig. 1b suggests that the transition to remarriage is associated with a substantial improvement in husbands' health trajectories. Generally, the slopes do not differ much by marital state, although the figures suggest that wives' health might deteriorate faster over time in divorce than husbands'. This is in line with Dupre et al. (2009), who find stronger evidence of increasing mortality risk during the first years of divorce for women than for men, after controlling for SES.

Figure 2a suggests that depression increases for husbands and wives as they approach divorce. For wives, depression appears to increase at the time of divorce,

[28] The change from .043 to .023, is a 2 percentage point reduction, or 37% of .054, the coefficient in column (1).

[29] The schematic without remarriage uses the coefficients of Husband, Couple Divorced, Couple Divorced-Husband, Time, Time-Husband, Time-Couple Divorced, and Time-Couple Divorced-Husband.

[30] The schematic with remarriage additionally uses the coefficients Couple Divorced-Remarried, Couple Divorced-Remarried-Husband, Time-Couple Divorced-Remarried, and Time-Couple Divorced-Remarried-Husband.

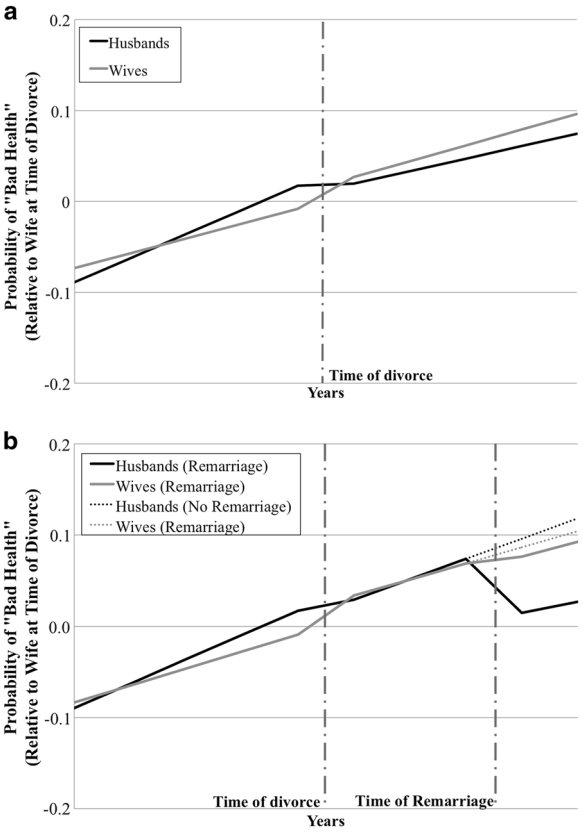

Fig. 1 **a** Schematic of Typical Health Trajectory. **b** Schematic of Typical Health Trajectory with Remarriage. Note: These figures graphically display the sum of the coefficients on time, husband, divorce, (remarriage) and the full interactions of these variables from models that include couple fixed effects, shown in column (1) and (2) in Online Appendix Table A4. Time is measured as years in divorce, where divorce occurs at the midpoint between the interview date divorce is first reported and the date of the prior interview wave. In **b**, remarriage is assumed to occur at a fictitious time several years following divorce

while it appears to be associated with a decrease in depression for their husbands, though neither change is statistically significant. Duration in divorce is (statistically significantly) associated with a decline of depression for husbands and wives. Apart from the suggested differences in the transition to divorce, the trajectories within the married and divorced states are similar for wives and husbands. The finding of increasing depression as divorce nears, followed by an improvement in depression over time post-divorce, is in line with Lucas (2005), who finds that life satisfaction drops during the approach to divorce and then gradually rebounds. However, Fig. 2b suggests that the post-divorce decline documented in Fig. 2a may be driven by a reduction associated with the transition into remarriage, while duration in remarriage is associated with increasing depression.

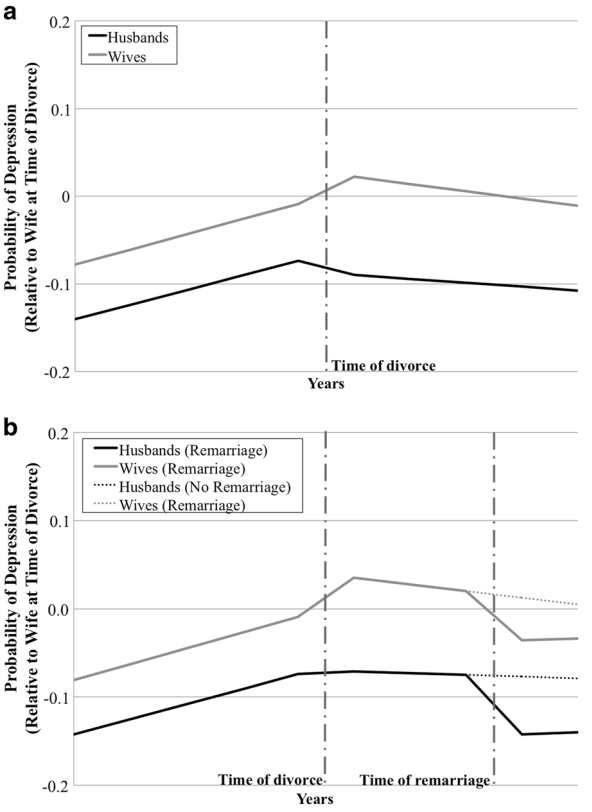

Fig. 2 **a** Schematic of Typical Depression Trajectory. **b** Schematic of Typical Depression Trajectory with Remarriage. *Note*. These figures graphically display the sum of the coefficients on time, husband, divorce, (remarriage) and the full interactions of these variables from models that include couple fixed effects, shown in column (3) and (4) in Online Appendix Table A4. Time is measured as years in divorce, where divorce occurs at the midpoint between the interview date divorce is first reported and the date of the prior interview wave. In figure 3b, remarriage is assumed to occur at a fictitious time several years following divorce

6 Robustness checks and supplemental analyses

Several analyses tested the sensitivity of results to: 1. functional form (linear versus logistic regression models); 2. measuring self-reported health as the complete 5-category Likert scale rather than as a binary outcome (bad/good); 3. measuring mental health on an 8-item CESD scale rather than as a binary outcome (depressed/not depressed); and 4. mortality attrition. None of our main conclusions were

sensitive to these choices (see Tables A5, A6, and A7 in the Online Appendix).[31] We also assessed how the associations between divorce, remarriage and health differed by duration of baseline marriage. We discuss the mortality attrition, and duration analyses in further detail below.

The "bad" health results presented above used data for survivors only. Therefore, the finding of a negative association between divorce and self-reported health for women and not for men could be driven by higher male mortality rates at middle and older ages, especially among divorced men. To test the sensitivity of results to selective mortality attrition, the deceased are restored to the sample for the first survey wave following death by classifying their health status at this wave as "bad." This procedure restored 2,364 person-year observations for women and 3,769 person-year observations for men to the sample of individuals, and 30 couple-year observations for deceased wives and 93 for deceased husbands to the couple sample. Two time-varying covariates, age and region of residence, are updated by using age at death recorded by the HRS, and assigning region of residence to the region at the last interview. Other covariates in the basic model are time-invariant. Results were not sensitive to this correction for mortality attrition (see Online Appendix Table A7, column (2) and (4)).

Models with time interactions presented above allowed for the study of the association of duration of divorce and remarriage with health. However, they did not allow for the study of whether the health-associations of divorce and remarriage differ by duration of the baseline marriage. While it has been hypothesized that the negative effects of divorce are worse after a longer marriage, due to a difficulty of rebuilding an identity post-divorce, the empirical evidence has been mixed (e.g., Bronselaer et al. 2008). Online Appendix Table A8 shows the results from models of "bad" health and depression (as in Table 2) stratified by short versus long duration of baseline marriage at the time of divorce. We found that divorce was associated with declines in "bad" health for women, and for husbands and wives, in short-duration marriages (shorter than the sample median), but not in long duration marriages. This finding is similar to Wauterickx and Bracke (2004) who also find negative associations between divorce and well-being for women only following shorter marriages, and with Dupre and Meadows (2007) who find that those in longer-duration marriages might experience fewer of the negative effects associated with divorce. The results from models of depression were mixed, and suggest a negative association of divorce for women in longer marriages, but not in shorter ones, while divorce is associated with more depression for husbands in shorter marriage, and not in longer ones.

[31] Specifically, the coefficients of the variables of interest in Logit models (Online Appendix Table A5) have the same sign and significance levels as LP models (Table 2, and Online Appendix Table A1). The coefficients of the key variables in models of the complete 5-category Likert Scale (Column (1) and (3) Online Appendix Table A6) have the same sign and significance levels as in LP models of "bad" health (Table 2, and Online Appendix Table A1). The coefficients on the key variables in models of the 8-item CESD scale (Column (2) and (4) Online Appendix Table A6) have the same sign and significance levels as the LP models of depression (Table 2, and Online Appendix Table A1).

7 Summary and conclusions

Hughes and Waite (2009) noted that few longitudinal studies have related changes in marital status to changes in mental and physical well-being at older ages. Partly in response, we sought to understand better the associations between divorce and physical and mental health, as well as differences between men and women at these ages. To our knowledge, this study is the first to estimate these associations in middle and later life in longitudinal data in the United States, comparing divorced and remarried individuals to their continuously married counterparts, and comparing health-differences between spouses who were followed before and after divorce and remarriage.

Results from models that control for individual FEs show that divorce is associated with worse self-reported health for women, but not for men. Among couples, models that control for couple FEs suggest that divorce is associated with worse self-reported health among both wives and husbands. Among individuals and couples, the results suggest little difference between the remarried and baseline-married states.

However, for both individuals and couples, results from models that do not separate the remarried from the divorced state reveal that post-divorce life is associated with an increased likelihood of reporting "bad" health for women and wives, but not for men and husbands. Thus, taken together, the results show that divorce is associated with worsening self-reported health for both wives and husbands; that remarriage is associated with improving self-reported health for both; but that wives face health disadvantages (relative to their ex-husbands) from divorce because they are less likely to remarry at these ages.

Models that study depression (CESD score of 4 or more) among individuals show that divorce is associated with similar increases in depression for men and women, and that remarriage is associated with an improvement for both. However, among couples, divorce is associated with an increase in depressive symptoms only among wives. Furthermore, remarriage is associated with a reversal of the depressive symptoms for both husbands and wives. In fact, remarriage is associated with lower depression for husbands than in their baseline marriage.

A concern regarding these findings is that mortality rates are generally higher for men than women at older ages, and that differential mortality could bias estimates. However, our results were not sensitive to incorporating death in the "bad" health category.

Models that allow the association between divorce and health to vary over time suggest that divorce is associated with a small abrupt deterioration in (self-reported) physical health at the time of divorce for wives, but not for husbands. Furthermore, remarriage is associated with an improvement in husbands' health trajectories (controlling for other covariates), but less-so for their wives. Additionally, divorce is associated with a worsening of depression at the time of divorce among wives, but not husbands. However, remarriage is associated with an improvement in depression for both spouses.

Finally, our models described how mental health conditions (depression and psychological diagnoses) may account for a substantial portion of the association between divorce and self-reported "bad" general health for women, implying that mental health conditions may underlie much of the association between divorce and

their self-reported health. While evidence is mixed, the results suggest that physical health conditions may play a larger role for husbands (only in couple models).

Late-life divorce was more often associated with poor health for women than men. This evidence differs from other findings in the literature that divorce is associated with greater declines in health for men than women (e.g., Williams and Umberson 2004). However, the mechanisms that underlie the association between marital status and health may differ in later life, and therefore both the associations of health with divorce and gender differences in those associations could vary with age. Further research is needed to explore potential mechanisms. For example, due to increasing morbidity, the force of health selection into divorce and remarriage may be greater at older ages. Younger persons may be better able to offset the economic shocks of divorce than older persons by working additional jobs or hours, retraining, or moving to where labor market conditions are more favorable. However, those under age 65 may be at greater risk of losing health insurance following divorce due to their ineligibility for Medicare.

The majority of longitudinal studies of divorce and health have been based on younger samples or samples that pool all ages, perhaps because, until recently, few persons divorced in later life. The present study used more recent data focused on older age groups. Its findings are consistent with other recent studies focused on middle aged and elderly individuals, which either found no gender differences (Hughes and Waite 2009), or found that marital loss and poor marital quality are more strongly related to illnesses (cardiovascular disease or inflammation) among older women than older men (Zhang and Hayward 2006; Donoho et al. 2013; Liu and Waite 2014). However, after covariate adjustment, Dupre et al. (2009) find more evidence for divorce-related mortality risk for men than women.

Our approach has been descriptive and was not intended to establish causal impacts of divorce and remarriage. The chief threat to causal inference is that fixed-effects models control only for time-invariant unmeasured characteristics; they do not correct for bias induced by reverse causality or selection on time-varying unobserved characteristics. For instance, a traumatic experience (such as the death of a child) could both destabilize a marriage and adversely affect health, leading to a spurious correlation between changes in health and changes in marital status.

Theoretically, instrumental variables techniques could be used to support causal inferences, if valid instruments were available. For example, changes in divorce laws have been used as instruments for studies of the effects of divorce on socioeconomic status (e.g., Gruber 2004). The state-divorce-laws instruments could be implemented with the restricted HRS data. However, state divorce laws may or may not be valid instruments. States with strict divorce laws may also differ from other states in many respects, such as in the generosity of their Medicaid programs, which should be directly related to health, so state policy instruments may not convincingly establish a causal relationship between marital status and health (e.g., Moffitt 2005).

Measurement of divorce may also affect estimates of the relationship between divorce and health. Divorces may drag on before they are finalized, for example, though we classified separated persons as divorced. In part, this is a philosophical question about the meaning of "divorce" that is beyond the scope of this study (though see Tumin et al. 2015).

Although the study sample has reasonable power to detect associations between divorce, remarriage, and health for men and women separately, power to detect gender differences in the associations was limited by the sample size (number of divorces and remarriages of men and women), particularly in the sample of couples. Future research on gender difference in outcomes associated with divorce and remarriage would benefit from larger samples of men and women, and especially matched husbands and wives. Additionally, more research is needed to understand the mechanisms through which divorce and remarriage in mid- and later life become associated with health, and to understand gender differences. For example, a long-standing literature explores the importance of social networks and social support for explaining associations between health and marital status, especially widowhood (Berkman and Syme 1979; Berkman 1984; House et al. 1982; Umberson et al. 1992). Future work could use data in the restricted-use HRS on the location of adult children (and other information) to explore social support as a mechanism.

This study found that divorce at middle and older ages is often associated with deteriorations in self-reported health and depression for women and men. While remarriage may be associated with improvements in health, women may be less likely to remarry. Finally, this paper documented that mental health accounts for a large portion of the association between divorce and self-reported general health (especially for women). Therefore, the results provide further evidence of the potential importance of social, psychological or medical interventions that could address divorce as a risk factor for mental health in later life, especially among women (Brown and Lin 2012; Kennedy and Ruggles 2014).

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

Ai, C., & Norton, E. C. (2003). Interaction terms in logit and probit models. *Economics Letters*, *80*(1), 123–29.

Alwin, D. F., Zeiser, K., & Gensimore, D. (2014). Reliability of self-reports of financial data in surveys, results from the Health and Retirement Study. *Sociological Methods Research*, *43*(1), 98–136.

Antonucci, T. C., & Akiyama, H. (1987). An examination of sex differences in social support among older men and women. *Sex Roles*, *17*(11–12), 737–49.

Aseltine, R., & Kessler, R. (1993). Marital disruption and depression in a community sample. *Journal of Health and Social Behavior*, *34*(3), 237–51.

Averett, S. L., Argys, L. M., & Sorkin, J. (2013). In sickness and in health: an examination of relationship status and health using data from the Canadian national Public Health Survey. *Review of Economics of the Household*, *11*(4), 599–633.

Bengtson, V., Rosenthal, C., & Burton, L. (1990). Families and aging: diversity and heterogeneity. In R. Binstock & L. George (Eds.), *Handbook of aging and the social sciences*. 3rd ed. (pp. 263–281). San Diego, CA: Academic Press.

Berkman, L. F. (1984). Assessing the physical health effects of social networks and social support. *Annual Review of Public Health*, *5*, 413–32.

Berkman, L. F., & Syme, S. L. (1979). Social networks, host resistance, and mortality: a nine-year follow-up of Alameda county residents. *American Journal of Epidemiology*, *109*(2), 186–204.

Bronselaer, J. L. J., De Koker, B. S. M., & Van Peer, C. M. A. (2008). The impact of divorce on the health status of ex-partners. *Archives of Public Health*, *66*, 168–186.

Brown, S. L., & Lin, I. F. (2012). The gray divorce revolution: rising divorce among middle-aged and older adults, 1990-2009. National Center for Family and Marriage Research, Bowling Green State University, Working Paper Series, WP-12-04.

Brown, S. L., & Wright, M. R. (2017). Marriage, cohabitation, and divorce in later life.*Innovation in Aging*, *00*(00), 1–11.

Cancian, F. M., & Oliker, S. J. (2000). *Caring and gender*. Walnut Creek, CA: AltaMira Press.

Dahl, S. A., Hansen, H. T., & Vinges, B. (2015). His, her, or their divorce? Marital dissolution and sickness absence in Norway. *Journal of Marriage and Family*, *77*(2), 461–479.

Davidson, K. (2002). Gender differences in new partnership choices and constraints for older widows and widowers. *Ageing International*, *27*(4), 43–60.

Donoho, C. J., Crimmins, E. M., & Seeman, T. E. (2013). Marital quality, gender, and markers of inflammation in the MIDUS cohort. *Journal of Marriage and Family*, *75*(1), 127–41.

Dowd, J. B., & Todd, M. A. (2011). Does self-reported health bias the measurement of health inequalities in U.S. adults? Evidence using anchoring vignettes from the Health and Retirement Study. *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, *66*(4), 478–89.

Dupre, M. E., & Meadows, S. O. (2007). Disaggregating the effects of marital trajectories on health. *Journal of Family Issues*, *28*(5), 623–652.

Dupre, M. E., Beck, A. N., & Meadows, S. O. (2009). Marital trajectories and mortality among US adults. *American Journal of Epidemiology*, *170*(5), 546–555.

Goldman, N. (1993). Marriage selection and mortality patterns: Inferences and fallacies. *Demography*, *30*(2), 189–208.

Goldman, N., Korenman, S., & Weinstein, R. (1995). Marital status and health among the elderly. *Social Science and Medicine*, *40*(12), 1717–30.

Goodwin, J. S., Hunt, W. C., Key, C. R., & Smaet, J. M. (1987). The effect of marital status on stage, treatment, and survival of cancer patients. *Journal of the American Medical Association*, *258*(21), 3125–30.

Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy*, *80*(2), 223–255.

Gruber, J. (2004). Is making divorce easier bad for children? The long-run implications of unilateral divorce. *Journal of Labor Economics*, *22*(4), 799–833.

Haider, S. J., Jacknowitz, A., & Schoeni, R. F. (2003). The economic status of elderly divorced women. Michigan Retirement Research Center, Working paper WP 2003–046.

Health and Retirement Study, (HRS Public Data and RAND Contributions) public use dataset (2011). Produced and distributed by the University of Michigan with funding from the National Institute on Aging (grant number NIA U01AG009740). Ann Arbor, MI, http://hrsonline.isr.umich.edu/index.php?p=regcou.

House, J. S., Robbins, C., & Metzner, H. L. (1982). The association of social relationships and activities with mortality: prospective evidence from the Tecumseh Community Health Study. *American Journal of Epidemiology*, *116*(1), 123–140.

Hughes, M. E., & Waite, L. J. (2009). Marital biography and health at mid-life. *Journal of Health and Social Behavior*, *50*(3), 344–358.

Kalmijn, M., & Monden, C. W. S. (2006). Are the negative effects of divorce on well-being dependent on marital quality? *Journal of Marriage and Family*, *68*(5), 1197–1213.

Kalmijn, M. (2017). The ambiguous link between marriage and health: a dynamic reanalysis of loss and gain effects. *Social Forces*, *95*(4), 1607–1636.

Kennedy, S., & Ruggles, S. (2014). Breaking up is hard to count: the rise of divorce in the United States, 1980-2010. *Demography*, *51*(2), 587–598.

Kohn, J., & Averett, S. L. (2014). The effect of relationship status on health with dynamic health and persistent relationships. *Journal of Health Economics*, *36*, 69–83.
Killewald, A., & Lundberg, I. (2014). Men's labor market outcomes: is there a case for marriage? Department of Sociology, Harvard University. Revised version of paper presented to the 2014 meetings of the Population Association of America.
Lavelle, B., & Smock, P. J. (2012). Divorce and women's risk of health insurance loss. *Journal of Health and Social Behavior*, *54*(4), 413–431.
Lillard, L. A., & Waite, L. J. (1995). 'Til death do us part: Marital disruption and mortality. *American Journal of Sociology*, *100*(5), 131–56.
Lin, I.-Fen, Brown, Susan, L., Wright, M. R., & Hammersmith, A. M. (2018). Antecedents of gray divorce: a life course perspective. *The Journals of Gerontology: Series B*, *73*(6), 1022–1031.
Liu, H. (2012). Marital dissolution and self-rated health: age trajectories and birth cohort variations. *Social Science and Medicine*, *74*(7), 1107–16.
Liu, H., & Waite, L. J. (2014). Bad marriage, broken heart? Age and gender differences in the link between marital quality and cardiovascular risks among older adults. *Journal of Health and Social Behavior*, *55*(4), 403–423.
Lucas, R. E. (2005). Time does not heal all wounds: a longitudinal study of reaction and adaption to divorce. *Psychological Science*, *16*(12), 945–950.
Mare, R. D., & Palloni, A. (1988). *Couple models for socioeconomic effects on the mortality of older persons. CDE Working Paper*. Madison, WI: Center for Demography and Ecology, University of Wisconsin-Madison. No. 88-7.
McGee, D. L., Liao, Y., Cao, G., & Cooper, R. S. (1999). Self-reported health status and mortality in a multiethnic US cohort. *American Journal of Epidemiology*, *149*(1), 41–46.
Miilunpalo, S., Vuori, I., Oja, P., Pasanen, M., & Urponen, H. (1997). Self-rated health status as a health measure: the predictive value of self-reported health status on the use of physician services and on mortality in the working-age population. *Journal of Clinical Epidemiology*, *50*(5), 517–528.
Moffitt, R. (2005). Remarks on the analysis of causal relationships in population research. *Demography*, *42* (1), 91–108.
Mood, C. (2010). Logistic regression: why we cannot do what we think we can do, and what we can do about it. *European Sociological Review*, *26*(1), 67–82.
Norton, E. C., (2012). Log odds and ends. NBER Working Paper 18252 (July)
OECD (2009) What are equivalence scales? www.oecd.org/dataoecd/61/52/35411111.pdf
Peters, H. E., Simon, K., & Taber, J. R. (2014). Marital disruption and health insurance. *Demography*, *51* (4), 1397–1421.
Pienta, A. M., Hayward, M. D., & Jenkins, K. R. (2000). Health consequences of marriage for the retirement years. *Journal of Family Issues*, *21*(5), 559–86.
Pudrovska, T., & Carr, D. (2008). Psychological adjustment to divorce and widowhood in mid- and later life: do coping strategies and personality protect against psychological distress? *Advances in Life Course Research*, *13*, 283–317.
Radloff, L. S. (1977). The CES-D scale: a self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*(3), 385–401.
RAND HRS Data, Version L. (2011). *Produced by the RAND Center for the Study of Aging*. Santa Monica, CA: with funding from the National Institute on Aging and the Social Security Administration. December.
Reczek, C., Pudrovska, T., Carr, D., Thomeer, M. B., & Umberson, D. (2016). Marital histories and heavy alcohol use among older adults. *Journal of Health and Social Behavior*, *57*(1), 77–96.
Sarason, B. R., Sarason, I. G., & Gurung, R. A. R. (1997). Close personal relationships and health outcomes: a key to the role of social support. In Duck S, (Ed.), *Handbook of personal relationships*. West Sussex, England: Wiley.
Smock, P. J., Manning, W. D., & Gupta, S. (1999). The effect of marriage and divorce on women's economic well-being. *American Sociological Review*, *64*(6), 794–812.
Steffick, D. E. (2000). *Documentation of affective functioning measures in the Health and Retirement Study. 2000, Survey Research Center*. AnnArbor, MI: University of Michigan.
Simon, R. W. (2002). Revisiting the relationships among gender, marital status, and mental health. *American Journal of Sociology*, *107*(4), 1065–1096.
Solon, G., Haider, S. J., & Wooldridge, J. M. (2015). What are we weighting for? *Journal of Human Resources*, *50*(2), 301–316.
Sweeney, M. M. (1997). Remarriage of women and men after divorce. *Journal of Family Issues*, *18*(5), 479–502.

Tumin, D., Han, S., & Qian, Z. (2015). Meanings and measures of marital separation. *Journal of Marriage and Family*, *77*, 312–322.

Umberson, D., & Montez, J. K. (2010). Social relationships and health: a flashpoint for health policy. *Journal of Health and Social Behavior*, *51*(Suppl), S54–S66.

Umberson, D., Wortman, C. B., & Kessler, R. C. (1992). Widowhood and depression: explaining long-term gender differences in vulnerability. *Journal of Health and Social Behavior*, *33*(1), 10–24.

Waite, L. J., & Gallagher, M. (2000). *The case for marriage: why married people are happier, healthier, and better off financially.* New York, NY: Doubleday.

Wauterickx, N., & Bracke, P. (2004). Echtscheiding, attitudes en welbevinden. Een longitudinale studie. In: In D. Mortelmans, M. Casman, R. Doutrelepont, (eds.) *Elf jaar uit het leven in België: Socio-economische analyses op het Gezinsdemografisch Panel PSBH*. (2004. 576–603). Gent: Academia Press.

Williams, K., & Umberson, D. (2004). Marital status, marital transitions, and health: a gendered life course perspective. *Journal of Health and Social Behavior*, *45*(1), 81–98.

Wilson, C. M., & Oswald, A. J. (2005). How does marriage affect physical and psychological health? A survey of the longitudinal evidence. Working Paper. Coventry: University of Warwick, Department of Economics. (Warwick economic research papers).

Winship, C., & Radbill, L. (1994). Sampling weights and regression analysis. *Sociological Methods & Research*, *23*(2), 230–257.

Wood, R.G., Goesling, B., & Avellar, S., (2007). The effects of marriage on health: a synthesis of recent research evidence. Report. Mathematica Policy Research.

Zhang, Z., & Hayward, M. D. (2006). Gender, the marital life course, and cardiovascular disease in late midlife. *Journal of Marriage and Family*, *68*(3), 639–657.

Zissimopolous, J. M., Karney, B. R., & Rauer, A. J. (2015). Marriage and economic well being at older ages. *Review of Economics of the Household*, *13*(1), 1–35.