ORIGINAL RESEARCH

Divorce and Mental Health: Is Late Divorce Particularly Harmful for Women with Low Earnings?

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Abstract

This paper examines the relationship between divorce and mental health, with a focus on how this association is stratified by sex, age, and individual income. In particular, we test the hypothesis that divorce at advanced ages (50–59) is particularly harmful for women with insufficient personal earnings. Data is drawn from German register data, which includes marital histories of divorcees and diagnosed health outcomes. The analytical sample includes persons aged 30–59 in 2015 ($n = 23,426,639$). The outcome is the annual incidence of mental disease diagnosis which is examined from an intersectional approach by drawing on MAIHDA (Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy). Our findings indicate that women are at a higher risk of receiving a mental health diagnosis than men. Divorce significantly amplifies this risk. Additionally, low income poses a heightened risk for both women and men, particularly when divorce occurs at advanced ages.

Keywords Divorce · Health inequalities · Intersectionality · MAIHDA · Mental health

1 Introduction

Although divorce rates have been high for decades, there has been strong variation in these rates across ages and marital durations. While divorce rates have been declining for shorter marital durations and at younger ages, sharp increases for longer marital durations and at higher ages have been reported. While such patterns were first documented for the U.S.,

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studies for European countries have recently uncovered a similar trend (Brown & Lin, 2012; Cimelli et al., 2021; Solaz, 2021; Zilincikova & Schnor, 2021), including in Germany. For example, in 1999, only 18% of all divorces involved at least one partner aged 50 or older. By 2022, this share had increased to 45% (DESTATIS, 2023).

The academic literature is still split on the question of whether 'gray divorce' (conventionally defined as divorce at age 50 and older) is conceptually different from early divorce. One of the key areas of inquiry is the role of gray divorce and its impact on mental health. On the one hand, typical stressors that characterize divorce at an early age, such as disputes over child custody and child residence, are attenuated because children may have already left the parental home. On the other hand, late divorce may be particularly harmful for mental health, as people have little leeway to readjust their life course at advanced ages (Lin & Brown, 2021). Furthermore, divorce is often a highly stressful event. While stress lowers mental health at all ages, its health-related consequences may be particularly harmful at advanced ages. With demographic changes and an increase in divorce at older ages, there is growing interest in understanding how the association between divorce and mental health varies across age groups. While some studies have examined how late-life divorce relates to economic well-being (e.g., Cimelli et al., 2021; Lin & Brown, 2021), research on its association with mental health remains limited. Existing studies that address health outcomes of gray divorce often focus exclusively on individuals in advanced age (Brown et al., 2019; Hu et al., 2024; Lin et al., 2019; Tosi & van den Broek, 2020); making it difficult to assess whether the observed effects are specific to later life and differ from effects at earlier ages. Furthermore, the interaction between mental health and economic well-being in later life remains poorly understood—particularly whether individuals exposed to fragile economic conditions face heightened health risks when experiencing stressful life events such as divorce at older ages. While scholars have regularly advocated for an intersectional approach in health research (Patalay & Demkowicz, 2023; Riecher-Rössler, 2017; Spencer & Broome, 2023), the majority of studies have concentrated on specific individual stratifying determinants, rather than examining how these factors jointly relate to mental health outcomes.

Our paper contributes to this ongoing debate by investigating how divorce is related to mental health and how patterns differ across age groups. We raise the question of how the relationship between late divorce and mental health is stratified by sex and income. In particular, we examine whether divorce at advanced ages is associated with worse mental health outcomes for women with insufficient personal earnings. In the literature, age 50 is commonly used as a marker for "gray divorce" (e.g., Lin & Brown, 2021). While the age 50 threshold is somewhat arbitrary, it seems meaningful in health-related research, as this age marks the onset of significantly increased morbidity and mortality risks. In line with this logic and the convention of prior studies, we distinguish between individuals aged 30–39, 40–49 and those aged 50–59 in this study. Data for this investigation comes from the registers of the German Pension Fund of the year 2015. The large number of cases ($n = 23,426,639$) enables us to conduct a robust analysis by cross-classifying on various sociodemographic characteristics, overcoming the potential limitations of case numbers in intersectional social strata with less representation. An additional benefit of the data is that it not only includes medical diagnoses, but also complete marital histories of divorcees. In this study, we identify "never divorced" and "newly divorced" individuals. By "newly divorced", we refer to persons who underwent a first divorce three years or less before the reporting year. This

approach enables us to single out individuals who were recently exposed to marital disruption. Concerning methods, we employ Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (MAIHDA). MAIHDA is a method recently introduced in social epidemiology research to examine how health outcomes are stratified across population subgroups (Evans et al., 2018; Merlo, 2018).

We contribute to the literature in two main ways. First, we offer a comprehensive examination of how divorce is associated with mental health across a broad adult age range, comparing patterns at early ages (ages 30–39 and 40–49) to later ages (50–59). While prior studies have largely focused on either early or late divorce, our analysis enables a systematic comparison between age groups, helping to clarify whether associations with mental health are stronger at older ages than at younger ages. Nevertheless, we acknowledge that because our sample only covers individuals up to age 59, our results do not include those aged 60 and over. Thus, our study speaks primarily to divorce among the younger segment of the so-called 'gray divorce' population. Second, we analyze how the relationship between divorce and mental health is stratified by age, sex, and income. In doing so, we go beyond single-dimension subgroup analyses and contribute to a growing body of research advocating for a more nuanced understanding of how multiple sociodemographic factors jointly shape this relationship.

The central result of this research is that divorce is associated with worse mental health outcomes across all age groups studied, with the effects being particularly pronounced for women with low earnings. Moreover, we show that while the association between divorce and mental health exists at younger ages, it tends to be stronger among those at older ages. While this represents a significant finding, several limitations of this study should be acknowledged at the outset. First, our analysis relies on rehabilitation statistics, which only capture diagnoses that are directly linked to rehabilitation services. As a result, not all health conditions—particularly those related to mental health—are likely to be recorded, potentially leading to an underestimation of the true burden of mental health issues in the population. Second, although we have precise information on the date of divorce, our data are cross-sectional in nature. We do not account for potential selection into divorce based on pre-existing mental health conditions. That is, individuals who experience divorce may differ systematically from those who remain partnered, particularly with respect to prior mental health status (Wade & Pevalin, 2004), which may influence the observed associations. Finally, we compare the mental health outcomes of divorced individuals to those of the total population. A more appropriate comparison group would be the currently married; however, our data do not allow us to identify individuals who are married if they have never experienced a divorce.

2 Prior Research and Hypothesis

Mental health outcomes after union dissolution have been the subject of extensive research. Prior research consistently shows that divorce and separation are associated with declines in mental health, including increased symptoms of depression (Hank & Wagner, 2013; Jang et al., 2009; Kalmijn, 2017). In addition, research has drawn attention to the possibility that individuals who experience union dissolution may differ systematically from those who remain partnered, particularly with respect to mental health. For instance, pre-existing vul-

nerabilities, including lower mental health prior to union dissolution, may increase both the likelihood of divorce and the risk of subsequent lower mental health (Blekesaune, 2008; Johnson & Wu, 2002; Wade & Pevalin, 2004). This suggests that part of the observed association between divorce and mental health may reflect selection processes, rather than the effects of divorce itself.

Several mechanisms may account for the association between union dissolution and mental health. One important mechanism is the impact of divorce on physical health, which in turn may affect mental health. Health research has shown that divorce and separation are associated with elevated risks of cardiovascular disease, cognitive decline, dementia, cancer, and even mortality (Liu et al., 2020; Molloy et al., 2009; Neuman & Werner, 2016; Sbarra et al., 2011; Shor et al., 2012; Wong et al., 2018; Yuan et al., 2021). Physical health challenges can, in turn, be detrimental to mental health, as poor physical health is linked to higher rates of depression (Ohrnberger et al., 2017).

In addition, psychological research has identified some of the social mechanisms underlying the link between family behavior and health outcomes. For example, it has been shown that the mutual social support of partners and dyadic coping may be beneficial for physical and mental health outcomes (Gellert et al., 2011, 2018). The health premium of marriage operates through the monitoring of the partner's behavior, including the partner's eating habits and intake of unhealthy substances, such as alcohol and tobacco (August & Sorkin, 2010; Umberson, 1992; Wilson & Oswald, 2005). It is generally presumed that the impact is greater for men than for women, as traditional gender roles often allocate caregiving responsibilities to women (ibid.). It can also be argued that women who divorce later in life may experience a reduction in their risk of becoming a caregiver of a frail husband or an in-law, potentially benefiting their mental health. Late-life divorce may also be less detrimental for women than for men, as women often have more social and emotional support networks compared to men (Carr & Utz, ew2020; Clark et al., 2008; Klaus, 2021). Taken together, these arguments could suggest that divorce may be more negatively associated with men's health than with women's health, particularly at advanced ages when care and support systems become especially important for both mental and physical well-being.

However, there are also powerful theoretical arguments suggesting that divorce at advanced ages is more strongly correlated with women's than men's health. In particular, the partner market tends to become tighter for women as they age, limiting their options to re-partner (Brown et al., 2019; Wu & Schimmele, 2005). Despite potentially having larger social networks, the absence of a new partner can significantly impact well-being and mental health. As a result, late-life divorce may have more adverse health effects on women than on men. Divorcees' mental health may furthermore be strongly related to their economic well-being, which might, in turn, be shaped by age and sex. The option to switch occupations or career tracks in response to a divorce may be more limited or non-existent if individuals have limited years left until retirement (Lin & Brown, 2021). This limitation applies to both men and women. However, due to traditional gendered care patterns during marriage, late divorce may be more detrimental for women than for men, as women may find it difficult to re-enter the labor market after a late divorce. This argument is particularly relevant for the German context, where many women work only part-time (or less) during marriage and receive a radically lower income than their (ex-)spouses (Brüggmann & Kreyenfeld, 2023).

While earlier research on union dissolution and well-being predominantly relied on survey-based measures of self-reported well-being (e.g., Hank & Wagner, 2013; Jang et al.,

2009; Kalmijn, 2017), a growing body of studies now uses population-wide register data to examine clinical indicators of mental health. This recent literature has drawn on indicators such as antidepressant purchases and medical consultations to assess mental health trajectories before and after divorce. These indicators are less vulnerable to reporting bias than surveys, but they should also be understood as partly reflecting patterns of help-seeking behavior and access to care, rather than underlying mental health problems alone. Studies focusing on psychotropic and antidepressant medication use consistently demonstrate that union dissolution is linked to an increased use of such treatments (Hu et al., 2024; Kühn et al., 2023; Metsä-Simola & Martikainen, 2013; Monden et al., 2015). Moreover, the increases in medication use have been shown to be more pronounced among women who experience union dissolution in later life than for men (Hu et al., 2024). Drawing on Norwegian register data, Kravdal and Wörn (2023) examined mental health trajectories of mothers and fathers around union dissolution. They found that general practitioner consultations for mental health conditions increased markedly shortly before separation but declined thereafter, with negative health effects being more pronounced among mothers than fathers.

While previous studies have greatly advanced our understanding of the short- and long-term effects of divorce on mental health, they have often been limited in other respects. First, they either do not distinguish between early and late divorce or focus exclusively on one of the two. Second, few take an intersectional perspective that considers how multiple sociodemographic characteristics—such as sex, age, and income—interact to shape mental health outcomes after union dissolution. Building on these insights and aiming to address the gaps, we hypothesize that divorce is associated with poorer mental health outcomes for women compared to men, particularly at advanced ages. Furthermore, we propose that income moderates this association, with older, divorced women in low-income groups representing a particularly high-risk subgroup for developing mental health disorders.

3 Data and Method

3.1 Method: MAIHDA

Stratification research has a long tradition of examining systematic inequalities across categorical groups such as gender, class, and race (e.g., Tilly, 1998; Grusky 2014). Nevertheless, most quantitative studies to date have not taken an intersectional approach to examining the social stratification of the relationship between divorce and mental health. Instead, they have often focused on the separate effects of each social determinant in isolation, repeatedly overlooking how sex, age, and other fundamental social categories interact. A major reason for this shortcoming is that sample sizes of standard surveys were often insufficient for researchers to conduct complex interactions (Bell et al., 2019). The standard regression approach is limited, as interactions with more than two covariates become increasingly complex and difficult to interpret. In this context, Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (MAIHDA) has been proposed as a potential way forward (Evans et al., 2018). In social epidemiology research, MAIHDA is now even considered to be "the new gold standard for investigating health disparities" (Merlo, 2018, p.79). The MAIHDA methodology consists of fitting multilevel logistic regression models, with individual respondents at the first level being nested within intersectional social strata

at the second level (defined by the stratum ID variable) (Evans et al., 2018). The model seeks to untangle the differences in the outcomes by identifying them as between-strata variation (i.e., between intersections of different identities) or within-strata variation (i.e., within intersections of the identities). Therefore, it helps to assess how much belonging to a particular social stratum can affect the outcome variable. MAIHDA has several advantages over the single-level regression approaches. The model automatically adjusts the weight for social strata when there are fewer individuals due to the residuals' shrinkage, so that all estimates have proportionate effects (Balloo et al., 2022). Hence, MAIHDA is a more parsimonious alternative that is especially suitable when sample sizes are small and many interactions need to be considered (Mahendran et al., 2022). Compared to other methods, such as three-, four or five-way interactions of social determinants, MAIHDA is a more efficient strategy for identifying high-risk subgroups in health research (Evans et al., 2024). It has also been shown to generate more accurate predictions than conventional regression models relying on fixed main effects with interaction terms (Van Dusen et al., 2024). As such, it is a method that effectively responds to calls for "precision public health," which seek to address health disparities through tailored interventions targeting well-defined population subgroups. For further details on the MAIHDA methodology, see Evans et al. (2018), the tutorial by Evans et al. (2024) and Axelsson Fisk et al. (2018).

3.2 Data and Sample

We use large-scale registry data from the German Federal Pension Insurance (Deutsche Rentenversicherung). The registers of the German Pension Fund include records of more than 90% of the resident population in Germany. However, members of certain professions, such as farmers, lawyers, and civil servants, are not covered in the data. Through the Research Data Centre (FDZ-RV), we requested access to three datasets that have been linked by a unique identifier. First, we used the AKVS statistics (Aktiv-Versicherten-Statistik), which include the base population of the year 2015. This data was merged to the VA statistics (Versorgungsausgleichsstatistik), which contain biographical information on the dates of divorce of the divorced population (Keck et al., 2020). Finally, the REHA statistics (Rehabilitation-Statistik) were linked, which contain information on all diagnoses for the year 2015 based on the ICD-10 classification. It should be noted that the REHA statistics include diagnoses related to rehabilitation measures. In the German system, a person becomes eligible for rehabilitation (REHA) when certain medical or occupational conditions are met — for example, after a serious disease, surgery, or injury. Eligibility generally requires that a physician confirms the medical necessity of the measure and that there is a reasonable expectation that the rehabilitation will lead to an improvement or stabilization of the person's health. Since the German Pension Insurance (*Deutsche Rentenversicherung*) is the primary institution responsible for approving and financing rehabilitation, we are able to make use of the data it collects. However, it is important to emphasize that diagnosis incidences calculated based on rehabilitation statistics (REHA) only reflect diagnoses approved for rehabilitation measures. Not all individuals who suffer from serious mental illness seek medical help or apply for rehabilitation measures (Krause et al., 2024). Furthermore, patterns of REHA participation vary by age: younger individuals, particularly those who have recently entered the workforce, may be more reluctant to register for rehabilitation com-

pared to older individuals who have been employed for a longer period. These limitations must be taken into account when interpreting the data.

The data is limited to persons aged 30 to 59 in 2015. Younger individuals are excluded as divorce below age 30 is rare in the case of Germany. Persons aged 60 and above are excluded because the REHA-statistics do not include complete diagnoses of the retired population. While this exclusion could be considered a limitation, it is worth noting that divorces at age 60 and above included only 5% of all divorces in 2015 (DESTATIS, 2023). We focus on first divorce and furthermore exclude those whose first divorce occurred more than three ago. We exclude those individuals who have been divorced for an extended period because the negative effects of divorce on mental health tend to lessen over time (Leopold, 2018). Therefore, we focus on the immediate and short-term effects of divorce. We split the sample into never divorced and newly divorced (persons divorced for the first time three years or less prior to the observation). Note that a small number of these individuals may have re-partnered or remarried within the two years following their separation. The sample size for each subgroup is 22,884,321 and 542,318, respectively (see Fig. 1). It has to be acknowl-edged that the never-divorced is a fairly heterogeneous control group consisting of people who are (still) married as well as those who never married.

3.3 Outcome Variable: Mental Disease Diagnosis

The health diagnoses come from rehabilitation statistics, where the outcome variable is the diagnosis of a mental disease in 2015. We use the primary diagnosis recorded when a patient entered the REHA database to construct a binary variable that is equal to one if the person was diagnosed with a mental disease in 2015 (Chapter V of the ICD-10 classification), and is equal to zero otherwise. Chapter V of the ICD-10 classification contains 11 blocks subdi-viding the category of mental disease.[1] The most common diagnoses recorded in our sample are recurrent depressive disorder (29%), the experience of a depressive episode (24%), and reaction to severe stress (16%) (see Table S1 in the Supplementary Material). Within Chap-ter V of the ICD-10, we excluded the diagnosis of mental disease due to psychoactive sub-stance use (2). Substance-related disorders are excluded from the outcome variable because there is evidence indicating that the relationship between divorce and substance use differs from the relationship between divorce and other mental diseases (Leopold, 2018).

Our outcome variable is based on the standardized assessments of medical doctors. Using a medical diagnosis to measure mental health reduces short-term bias, and measures mental health more accurately than self-rated indicators could (Salk et al., 2017). Still, not all mental diseases are covered in the rehabilitation statistics, and we cannot rule out the possibility that there is a sex or age bias in how doctors diagnose mental disease (see also the discussion in the concluding section of this paper).

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[1] The 11 blocks of mental diseases are: (1) organic, including symptomatic, mental diseases; (2) mental and behavioral disorders due to psychoactive substance use; (3) schizophrenia, schizotypal, and delusional dis-orders; (4) mood disorders; (5) neurotic stress-related and somatoform disorders; (6) behavioral syndromes associated with physiological disturbances and physical factors; (7) disorders of adult personality and behav-ior; (8) mental retardation; (9) disorders of psychological development; (10) behavioral and emotional disor-ders with onset usually occurring in childhood and adolescence; and 11) unspecified mental disorders. Note that we only consider the primary diagnosis.
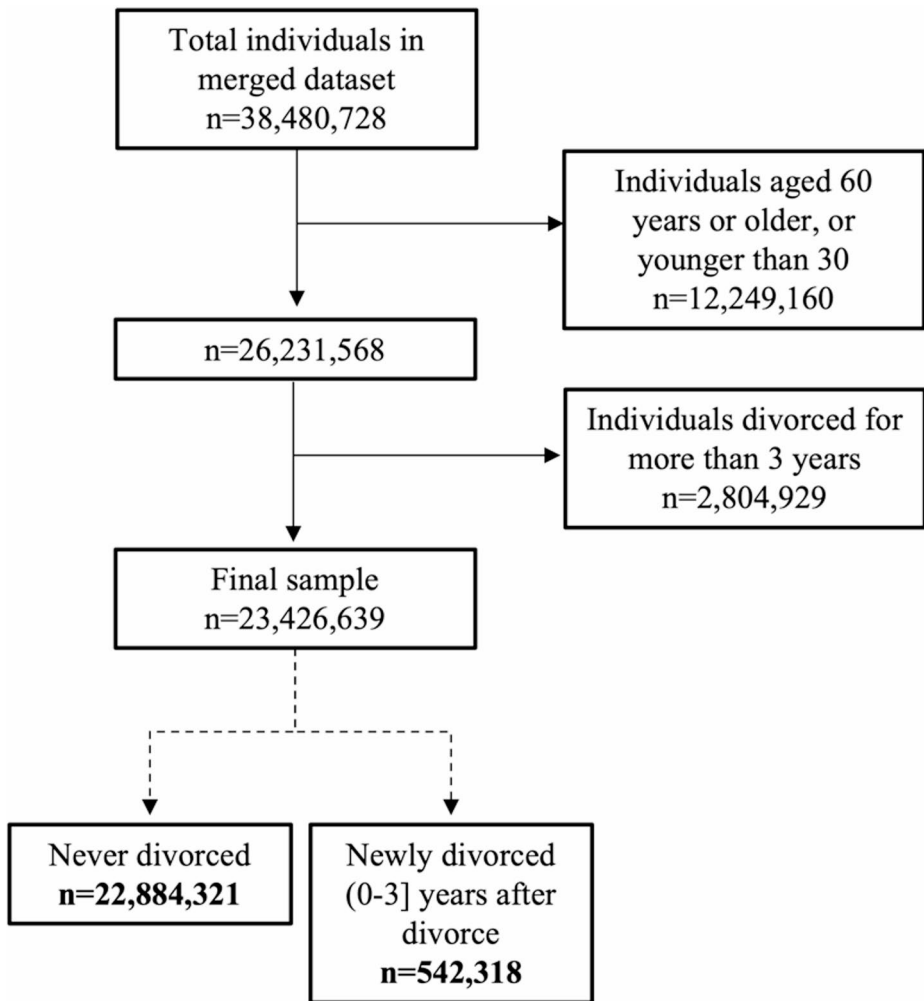
Fig. 1 Sample construction

3.4 Variables

We created 24 unique strata by combining each possible category of the following sociode-mographic variables: sex, age, and individual income. Although race is a fundamental marker for stratification research in countries like the United States, it is not measured in most European countries, particularly in administrative data. Our data is no exception. It includes information on citizenship (German or foreign citizenship) and region (East or West Germany). These variables are additional fundamental markers of inequality which we treat as control variables, as our focus is on the interaction of age, sex, and income which allows us to test the hypothesis that divorce at advanced ages is particularly harmful for women with insufficient personal earnings.

Sex is defined as male or female. Age is grouped into three categories: 30–39, 40–49, and 50–59. It is important to note that our divorced population includes individuals who separated three years or less prior to the time of observation. This means, for example, that someone classified as age "50–59 & divorced" may have separated just before reaching age 50. We considered narrowing the analysis to individuals who separated in the reporting year (2015), so that age at divorce and current age would overlap more precisely. However, even in register data, the sample size for such a restriction would have been too small for such an investigation.

As a proxy for a person's economic standing, we use the individual income the person earned in the reporting year. Income is stored in the registers as earning points (EP). Earning points (EP) are a relative measure of annual gross income compared to the national average in a given year. In 2015, the average annual income in Germany was 35,363.00 euros.[2] Thus, an individual earning half the average income (17,681.50 euros in 2015) would be granted 0.5 EP, while someone earning exactly the average income would be granted 1 EP. We distinguish four categories of individuals according to their earning points: (1) low income: no income or less than 60% of the average income; (2) lower middle income: between 60% of average income to less than average income; (3) upper middle income: average income to up to 50% above average income; and (4) high income: 50% or more above average income. Note that we only account for individual labor market earnings. Other incomes or assets are not considered, as they are not available in the registers. Social strata are derived from all the possible combinations of the three strata variables – sex, age, and income – leading to 24 groups ($2 \times 3 \times 4 = 24$) (for the descriptive statistics on the prevalence of each stratum, see Tables S2 and S3 in the Supplementary Material). The strata are then coded as a categorical variable with each stratum ID.

We also control for citizenship and region. Citizenship is a binary variable that distinguishes between persons with German citizenship and persons with another citizenship. Citizenship is a relevant stratifying variable that partially captures a person's migration background. The region variable indicates whether the person was living in East or West Germany in 2015. We adjust for this covariate due to differences in the divorce, employment, and earnings patterns of the two regions.

Table 1 displays the descriptive analysis for the entire sample, and the split samples for never divorced and newly divorced persons. In 2015, we observe an annual diagnosis rate of 0.41, meaning that 0.41% of individuals in the sample received at least one mental disease diagnosis during that year. The table also shows that the annual incidence of mental disease diagnosis is 0.40 for the never divorced and 0.83 for the newly divorced, which means that being recently divorced roughly doubles the risk of being diagnosed with a mental disease.

3.5 Analytical Strategy

In a first step, we conduct a descriptive analysis of the annual incidence of mental disease diagnosis in 2015. The analysis is stratified by sex, age, and by whether the person has recently experienced a divorce. We distinguish here between persons who are newly divorced (first divorce occurred three years or less prior to the observation), and persons who had never divorced up to the reporting year.

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[2] https://www.sozialgesetzbuch-sgb.de/sgbvi/anlage-1.html.

Table 1 Sample statistics, column percent

	Entire sample	Never divorced (%)	Newly divorced (%)
Sex			
Male	52	52	48
Female	48	48	52
Age			
30–39	33	33	27
40–49	34	33	44
50–59	33	34	29
Citizenship			
German	86	86	90
Other	14	14	10
Region			
West	79	79	84
East	21	21	16
Income			
High income	15	15	12
Upper middle income	20	20	19
Lower middle income	24	24	25
Low income	41	41	44
Annual incidence of mental disease diagnosis	0.41	0.40	0.83
N	23,426,639	22,884,321	542,318

AKVS statistics, REHA statistics and VA statistics 2015, own estimates

Low income: 0-59% of the average income; lower middle income: 60%-99% of the average income; upper middle income: 100%-149% of the average income; high income: 150% or more than the average income

In a second step, we conduct the MAIHDA analysis. Here, we conduct two separate analyses of the never divorced and the newly divorced. The analysis of the never divorced provides evidence on the overall sex, age, and income gradient of mental health in society, and, thus serves as a reference. The other part of the analysis focuses on the newly divorced persons. We employ Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (MAIHDA) for each sample to study the inequalities in the incidence of mental disease diagnosis between social strata. Following the MAIHDA methodology, multilevel logistic regression models are estimated with mental disease diagnosis as the outcome variable. Individuals located at level 1 are nested within social strata at level 2. For each of the two successive analyses, we first fit a null model (model 1) with no covariates and a random intercept for the strata. This serves to calculate the Variance Partition Coefficient (VPC), which is a measure of discriminatory accuracy that captures the level of outcome variance at the strata level. Furthermore, we fit the main effects model adjusted for covariates (model 2) that includes all the strata-defining variables as fixed effects (i.e., sex, age, and income). With this second model, we calculate the VPC and the Proportional Change in Variance (PCV), which indicates how much of the variance at the strata level remains after the fixed effects are added. A PCV below 100% indicates that the remaining variance

cannot be explained by the main (additive) effects but is instead explained by interaction (multiplicative) effects. Additionally, the predicted strata-level residuals of model 2 are analogous to the interaction effects for each stratum, as they isolate the interaction from the already accounted main effects. Thus, the analysis of the strata-level residuals allows us to determine for which specific population subgroups a mental health diagnosis has interaction effects, either protective (less than expected by the main effects only) or hazardous (more than expected by the main effects only).

4 Results

4.1 Descriptive Results

Figure 2 illustrates the incidence of mental disease diagnosis by sex, age, and divorce status (see Figure S1 in the Supplementary Material for descriptive analysis of other health outcomes). The figure displays large differences between the newly divorced and the never divorced groups. Newly divorced individuals have a much higher incidence of mental disease than people who were never divorced. In particular, divorced women at advanced ages have a strongly elevated risk of receiving a mental disease diagnosis. Overall, this descriptive analysis supports the view that the elevated risk of receiving a mental disease diagnosis in the divorced population warrants special attention, especially for women at advanced ages.
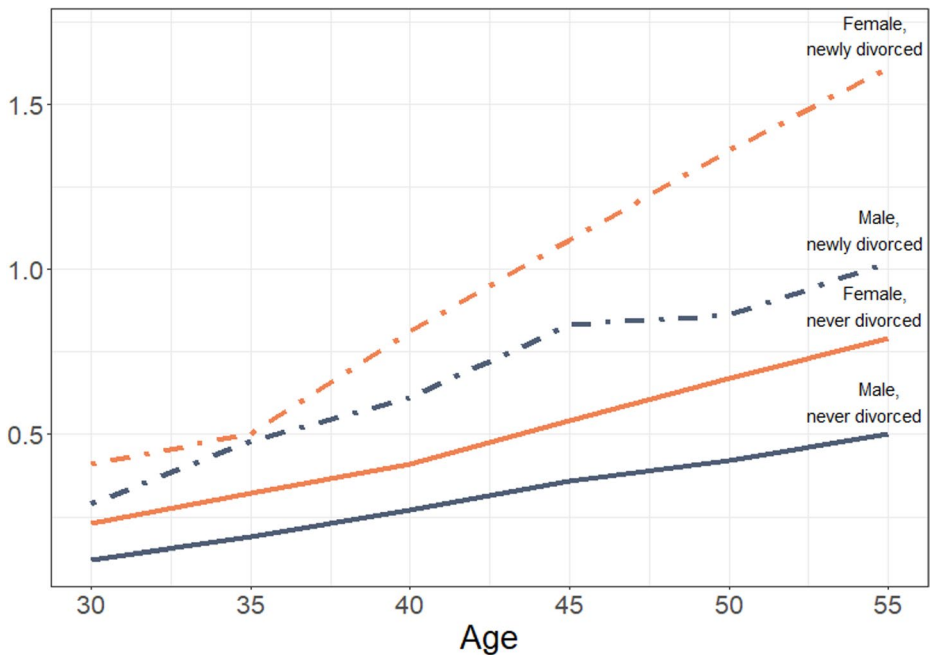
Source: AKVS statistics, REHA statistics, and VA statistics 2015; own estimates.

Fig. 2 Incidence of mental disease diagnosis in 2015

4.2 Regression Results

The results of the MAIHDA models are presented in Table 2. Columns (1) and (2) include the results for the never divorced population. The VPC value for the null model (13.66%) indicates a good level of clustering (Axelsson Fisk et al., 2018), revealing that the individuals within each of the strata have a similar incidence of mental disease diagnosis. The main effects model shows that the odds of receiving a mental disease diagnosis are 44% higher for women than for men. It also indicates that the odds of being diagnosed with a mental disease are more than 100% higher for individuals in their forties and fifties than for individuals in their thirties. Additionally, having a high income significantly lowers the odds of receiving a diagnosis compared to having an upper middle, lower middle, or low income. Indeed, the odds of being diagnosed with a mental disease are more than three times higher

**Table 2** MAIHDA models predicting the likelihood of a mental disease diagnosis, OR [95% CI]

	Never divorced		Newly divorced	
	(1) Null effects model (Model 1)	(2) Main effects model adjusted for covariates (Model 2)	(3) Null effects model (Model 1)	(4) Main effects model adjusted for covariates (Model 2)
Fixed effects				
Intercept	0.003 [0.002–0.004]	0.001 [0.001–0.002]	0.006 [0.004–0.008]	0.002 [0.001–0.002]
Sex				
Male		Ref.		Ref.
Female		1.44 [1.24–1.68]		1.14 [0.96–1.35]
Age				
30–39		Ref.		Ref.
40–49		2.38 [1.96–2.89]		2.11 [1.69–2.64]
50–59		3.38 [2.79–4.10]		2.99 [2.39–3.73]
Income				
High income		Ref.		Ref.
Upper middle income		1.49[1.18–1.88]		1.43[1.09–1.89]
Lower middle income		1.57[1.25–1.97]		1.46[1.11–1.92]
Low income		3.43[2.74–4.29]		3.74[2.87–4.87]
Measures of variance				
Between-strata variance	0.52 [0.33–1.08]	0.01 [0.01–0.02]	0.43 [0.24–0.79]	0.03 [0.02–0.07]
VPC (%)	13.66	0.82	11.63	0.97
PCV (%)		92.61		91.68
BIC	75,024.52	74,767.93	50,606.09	50,508.76

OR = odds ratio. Both the Variance Partition Coefficient (VPC) and the Proportional Change in Variance (PCV) values have been multiplied by 100 and presented as percentages. The Bayesian information criterion (BIC) is used as a goodness-of-fit measure. Model 2 controls for citizenship and region. The VPC is a measure of discriminatory accuracy that captures the level of outcome variance at the strata level. A PCV below 100% indicates that the remaining variance cannot be explained by the main effects but is instead explained by multiplicative effects

for individuals with a low income than for individuals with a high income. The VPC in the main effects model is 0.82%, which implies a considerable reduction, but some level of clustering remains. The PCV value of 92.61% indicates that the main effects included in this second model account for most of the differences in the incidence of diagnosis between strata. However, more than 7% of these differences are not captured by the main effects, which indicates the existence of some multiplicative effects in the between-strata variance.

Columns (3) and (4) of Table 2 present the results of the MAIHDA models for the newly divorced sample. The good level of clustering indicated by the VPC value for the null model (11.63%) implies that the individuals within each of the strata have a similar incidence of mental disease diagnosis. Like the analysis for the never divorced sample, the main effects model reveals that in the newly divorced population, women are more likely to receive a diagnosis than men, although the difference is not statistically significant. In addition, older individuals are more likely to have a diagnosis than younger individuals, especially those aged 50–59 compared to those aged 30–39. Individual income is also associated with the incidence of mental disease diagnosis. The newly divorced with a low, lower middle, or upper middle income are at greater risk of having a mental disease diagnosis than those with a high income. The odds of low-income individuals are more than three times higher than those of high-income individuals to receive a mental disease diagnosis. The VPC in the main effects model is substantially smaller than in the null model, indicating lower levels of clustering. The PCV value of 91.68% implies that more than 8% of the differences between the strata are not captured by the main effects, which suggests a multiplicative effect between strata.

Figure 3 displays the predicted incidence of mental disease diagnosis for each social strata from model 1. The left panel shows the results for the never divorced. The figure suggests that the classification into social strata can explain some differences in the incidence of mental disease diagnosis. Those individuals with a higher predicted incidence of mental
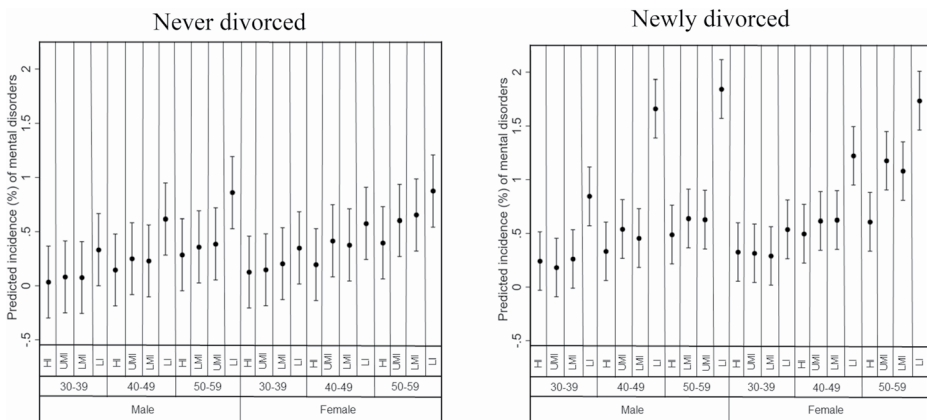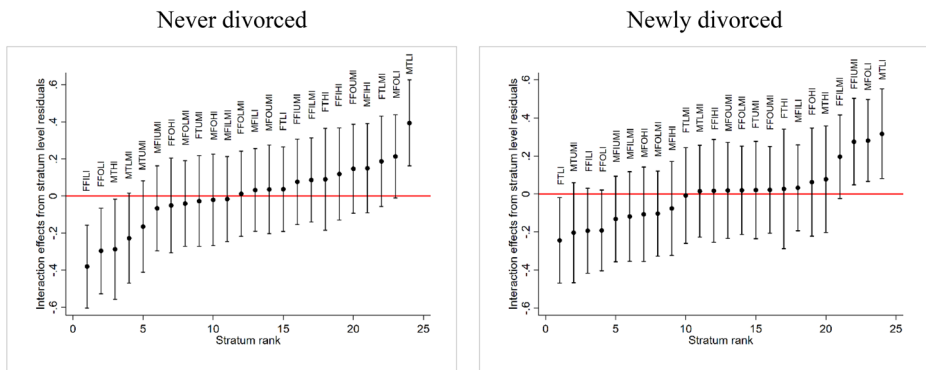

Note: Predictions are made based on the null effects models (model 1) and their 95% confidence intervals. HI = high income; UMI = upper middle income; LMI = lower middle income; LI= low income. Vertical bars show 95% confidence intervals.

Fig. 3 Predicted incidence of mental disease by social strata

disorders tend to have a lower income and are older – and are especially likely to be in their fifties. For example, low-income women in their fifties have the highest predicted incidence (incidence = 0.84), followed by low-income men in their fifties (incidence = 0.83). In contrast, high-income men in their thirties have the lowest predicted incidence (incidence = 0.04).

The differences in the incidence of diagnosis by strata are significantly more pronounced among the newly divorced than among the never divorced (right panel of Fig. 3). Age seems to be more relevant in driving the differences in the likelihood of receiving a mental disease diagnosis among women, while income is more relevant among men. Divorced low-income individuals have a particularly elevated incidence of mental disease diagnosis. At ages 50–59 the annual incidence is 1.86 for men and 1.75 for women. Figure 3 also highlights the groups that are at relatively low risk of receiving a mental disease diagnosis. Notably, women aged 50–59 display strongly elevated risks of mental disease diagnosis, except those divorced women earning a high income (50% or more above average earnings).

Figure 4 displays the strata-level residuals of the model adjusted for covariates (model 2), which show the extent to which each social stratum differed from what was explained by the main effects alone for each of the outcomes (see also Tables S4 and S5 in the Supplementary Material for the values). The left panel shows the effects for the never divorced. As indicated by the large PCV value, most of the 95% confidence intervals for the residuals cross zero. Still, the figure shows that four out of 24 strata have residuals significantly different from zero, indicating a multiplicative effect. Among the never divorced, a hazardous effect is observed among low-income men in their thirties. The right panel presents the results for the newly divorced, showing that four out of 24 strata have residuals significantly different from zero. A protective effect is observed among low-income women in their thir-

Never divorced   Newly divorced

Note: Strata-level residual predictions (i.e., interaction effects) are made based on the main effects model adjusted for citizenship and region (model 2), and their 95% confidence intervals. Social strata are ordered by rank, with the lowest rank on the left. M = male; F = female; T = 30-39 years old; FO = 40-49 years old; FI = 50-59 years old; HI = high income; UMI = upper middle income; LMI = lower middle income; LI= low income. Vertical bars show 95% confidence intervals. Effects above the red line are considered hazardous, while those below are considered protective.

Fig. 4 Differences in mental disease incidence due to multiplicative effects

ties. Conversely, there is a hazardous effect among low-income men in their thirties and forties, and upper middle-income women in their fifties.

5 Discussion and Conclusion

This study aimed to assess the relationship between divorce and the likelihood of receiving a mental disease diagnosis in Germany, and whether this relationship varies across social strata. The guiding hypothesis was that divorce at advanced ages (50–59) is associated with a higher likelihood of mental health diagnosis among women with no or low earnings compared to other groups. Our findings show that individuals aged 30–59 have a higher incidence of mental disease diagnosis if they are recently divorced compared to the total population. The observed incidence of mental disease diagnosis in newly divorced individuals is 0.83, which differs substantially from the average of 0.40 among those who were never divorced. This substantial difference echoes earlier findings that divorce is closely linked to lower mental well-being (Johnson & Wu, 2002). For illustrative purposes, we also examined the association between divorce and the incidence of diagnosis with other diseases (see Figure S1 in the Supplementary Material). While divorce is also associated with being diagnosed with other diseases, the difference between the divorced and the never divorced is modest compared to the stark differences that we find for mental disease.

Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (MAI-HDA) was used to examine the moderating effects of age, sex, and individual income. Our study finds that women are more likely than men to be diagnosed with a mental disease. Low-income groups are at higher risk than high-income groups, and older individuals are more likely to be diagnosed with a mental disease than younger individuals. When looking at different strata combinations, we find that low-income persons at advanced ages are the most likely to receive a mental disease diagnosis. While we observe a similar pattern in the divorced and the never-divorced population, there are some striking findings for the "newly divorced":

First, the age gradient is stronger in the divorced population than in the comparison group. Thus, our results are consistent with the observation that mental well-being is lower among individuals who experience divorce at later ages compared to those who divorce earlier in life. This result is in line with findings from the previous literature (Brown & Lin, 2012; Lin et al., 2019), which highlighted the negative effects of later-life union dissolution on mental health. Our study expands this literature by systematically comparing across multiple age groups, rather than focusing solely on older or younger individuals. This finding has some relevant implications. With the increase in divorce at later ages and the postponement of major life events, it is important to examine how these trends may relate to mental health outcomes over time. If some of this effect is causal—which we cannot determine without further evidence—it may suggest that the prevalence of mental disease could increase as the population continues to age.

Second, the age effect is stronger for women than for men, suggesting that late divorce is more strongly associated with poorer mental well-being among women than among men. While age seems to be a risk factor for women, the small group of women with a high income (50% or more above the average income) has a relatively low risk of receiving a mental disease diagnosis at advanced ages. Among men, it is not age, but low income

which seems to be the strongest risk factor for being diagnosed with a mental disease. This applies to all men, but newly divorced men in particular. Overall, our findings support the hypothesis that old age, divorce, and low income are significant risk factors in women's life trajectories, which are related to mental well-being. This aligns with evidence from Hu et al. (2024), who show that the increases in antidepressant use after union dissolution are larger for women than men. While our analysis focuses on mental health, related studies have also documented similarly sex-based disadvantages in the aftermath of late divorce, with women experiencing substantially greater declines in standard of living than men (Lin & Brown, 2021). Together, these findings underscore the compounded vulnerabilities faced by older women following divorce, particularly those with limited financial resources. Our analysis provides robust estimates regarding the association between divorce and the incidence of mental disease diagnosis across strata based on sociodemographic variables. However, there are also important limitations that must be noted. The data is dependent on individuals seeking rehabilitation and contact with the German public health system, which may vary across different social strata. For this reason, we might underestimate the incidence of diagnosis, since those individuals who are outside of the system are not included in the analysis. As help-seeking behavior and access to the health system differ by sex, age, and income, some of the group differences we observe may partly reflect disparities in treatment utilization rather than true differences in underlying mental health. In addition, differences in doctors' diagnoses based on a patient's age and sex may influence the results. Being perceived as a man or a woman may elicit different responses from medical doctors, who might diagnose and recommend interventions differently based on sex (Mauvais-Jarvis et al., 2020: 566). Moreover, older adults are more likely to undergo regular medical screenings, which may result in a higher prevalence of mental health diagnoses compared to younger adults (Krause et al., 2024). Therefore, some of the age gradients that we find may be related to an increase in diagnosis that is independent of health status. We can neither rule out the possibility that doctors may respond differently in their diagnoses depending on the patient's life course situation. For example, a medical doctor might be more likely to diagnose a mental health disease if they know the patient is undergoing a divorce. Furthermore, our analysis is descriptive and does not investigate the complex mechanisms that link divorce and mental health diagnoses. It is often not the divorce itself, but rather the strain of a dysfunctional marriage that contributes to mental health issues and which can have long-lasting effects on psychological well-being. In some cases, depression may precede marriage, potentially affecting marital quality and ultimately contributing to the likelihood of divorce. Thus, the mental health of divorced individuals may have already been affected before the union dissolution. Longitudinal data would be needed to unravel the complex interplay between the onset of mental health and union behavior. Moreover, we did not examine the long-term ramifications of divorce for mental health, which may be different for women than for men. Finally, it should be noted that, even though register data offers comprehensive population coverage, some uncertainty remains in the estimates, and the model results must be interpreted with caution. Our findings therefore highlight associations between divorce and mental health rather than causal effects. Despite these limitations, we trust that this paper provides rich and robust estimates of health correlates of divorce, which can inform future studies in this area of research with more sophisticated and causal analyses.

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Declarations

Competing interests The authors have no relevant financial or non-financial interests to disclose.

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