

## **DIVORCE-INDUCED HEALTH DECLINE AND IMPACT ON MORTALITY RISK**

### **Short abstract**

Divorce has long been linked to elevated mortality, however, the causal mechanisms underlying this relationship is complex and remain insufficiently identified. Health is an important factor which may distort the relationship between divorce and mortality. Germany offers an ideal setting to examine the link between divorce, health and death: extensive pension-registry microdata combines life histories, detailed divorce measures, sickness-leave records and mortality. In our paper, we use propensity score matching to generate three controls for each divorced individual. We implement three matching specifications, 1) using only pre-divorce sociodemographic and rehabilitation related variables to capture life biographies and pre-divorce health, 2) additionally predicting rehabilitation risk two years after the year of divorce and 3) additionally predicting mortality risk five years after the year of divorce. The second and third specifications generates rehabilitation and death prognostics scores which allow us to further account for changes in health and mortality outcomes not attributed to divorce itself. We then calculated the weighted average treatment effect for rehabilitation incidence, duration, time to first rehabilitation after the divorce year and time to death after the divorce year. Preliminary results show a small positive effect of divorce on cumulative rehabilitation incidences and annual rehabilitation duration. Furthermore, divorce also increases the delay in the first rehabilitation after the divorce year while it decreases the time to death. Using the second and third specifications lessen the effect of divorce on annual rehabilitation duration and time to death, but increases the delay to first rehabilitation. The next step is for us to use mediation models to decompose the direct and indirect pathways to death from divorce.

### **Long abstract**

#### **Motivation**

Divorce has long been linked to elevated mortality, however, the causal mechanisms underlying this relationship is complex and remain insufficiently identified. Health is an important confounding factor that can be affected by divorce, however, reverse causality may also be an issue, since differences in health behaviors between couples can lead to divorce (Torvik, et al., 2015). In our study, which is part of the project, 'Divorce and Diagnosis (DiDi): Register-Based Analysis on the role of Divorce in Health and Employment Dynamics', we account for pre-existing differences in health to identify whether the effect that divorce has on post-divorce health and mortality persists. Germany offers an ideal setting. Up until now, there has been limited relevant studies due to data constraints. Since 2011, however, pension registries can be linked with a unique identifier, allowing us to combine life histories, detailed divorce measures, diagnoses, rehabilitation and mortality. Furthermore, Germany presents an ideal case for such an investigation due to its aging population. While younger cohorts might offer sharper attribution of immediate health shocks to divorce, their low mortality rates limit statistical power for studying time-to-death outcomes.

#### **Research question**

RQ1: How does divorce change the probability of and time until entering a rehabilitation spell and duration?

RQ2: Decomposition of rehabilitation spells on death into direct and indirect (through divorce) effects

#### **Literature**

The link between divorce and mortality risk has been widely discussed in sociological and epidemiological studies, but causal evidence remains scarce. Most studies simply treat divorce as

another life-course state in descriptive life trajectory approaches or include divorce as a dummy into a Cox regression. Leopold (2018), for example, looks at short, medium and long-term effects of divorce between genders and finds that while men are more vulnerable short-term in terms of well-being, there is less of a difference in the medium-term between genders in terms of health, wellbeing and social factors. In the long-term, however, women are more likely to suffer from poverty risk due to a loss in household income and single parenting.

Divorce per se is rarely a direct determinant of death, except in exceptional circumstances, such as suicides or homicides committed immediately after a separation. More commonly, however, divorce rather shortens lives through psychological, behavioral and social channels. In the psychology literature, biological indicators are linked to divorce and the onset of disease. Sbarra and Nietert (2009) find that being divorced is a key predictor of early death in the Charleston Heart Study. Sbarra et al. (2012) explain the mechanisms through which certain divorced people are at risk for an early death by looking at biological linkages, stress and the trajectory towards bad health outcomes.

Potential proxies for health as a predictor of mortality are the spells and duration of medical rehabilitation for mental health related illnesses. A logistic regression was used to determine all-cause mortality and the 30-day readmission rate for mental health related issues in Wade and Pevalin (2004) who found that those who are in the process of divorcing or already divorced tend to have worse mental health than married individuals. Björkenstam et al. (2013) find that divorced individuals had a higher probability of receiving psychiatric inpatient care compared to married individuals. Bracke et al. (2010) find that divorced and separated individuals seek professional treatments for mental health care at a higher rate than married individuals. It is important to examine the mental health channel as physical health is often closely related. For instance, positive mental health is linked to reduced onset of chronic diseases. On the flip side, negative mental health is often linked to unhealthy behaviors, such as addiction, stress or poor sleeping habits, which then increases the probability of developing health complications (Doan, et al., 2022). Carter et al. (2025) find that being divorced can cause depression treatments to be less effective and lead to a longer time to remissions. Mental health is subsequently important for predicting the lives individuals lead shortly before death. Raab et al. (2018) map out the how individuals experience functional limitations and whether that is exacerbated by depression in the eight years leading up to death. Individuals who self-reported as depressed tend to have an increase in functional limitations over time.

## **Data and Methodology**

The Research Data Center of the German Pension Insurance Fund allows linkages of different datasets starting from the reporting year 2011 through a unique identifier (Forschungsdatenzentrum Rentenversicherung, 2025). The datasets we use are Active Insured Persons (AKVS), Latent Insured Persons (LTVS), Insured Persons' Pension Portfolio (RTBN), Termination of Pensions due to Death (RTWF), Completed Rehabilitation in the Insurance History (RSD) and Pension Equalization Statistics (VA).

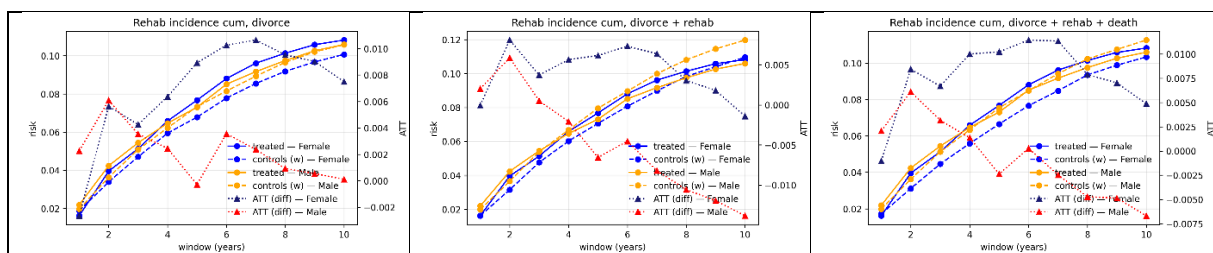
The AKVS, LTVS and RTBN are merged by the German Pension Insurance Fund. The AKVS dataset contains individuals who are still actively contributing to the pension fund hence it generally represents individuals who are employed. The LTVS dataset contains individuals who have paused pension fund contributions but have not yet retired (nor drawn from their pension fund). It may include individuals who are unemployed, undergoing further education, on parental leave, etc. The RTBN dataset contains individuals who are drawing from their pension fund, i.e. retired individuals. The merged dataset, BASE, allows us to map out the full life-course coverage of individuals. If we only considered only RTBN, the sample is biased towards individuals who have contributed and lived long enough to draw a pension, ignoring those individuals who have undergone rehabilitation or died before drawing a

pension. Considering only AKVS ignores rehabilitation efforts and gray divorces. To round up the dataset, it is also important to consider LTVS which details what happens between employment and retirement.

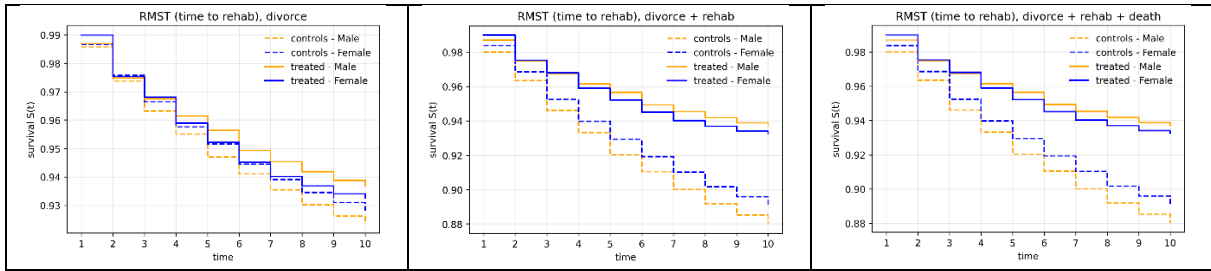
We then supplement the merged dataset with the RTWF, RSD and the VA. The RTWF details pension terminations due to deaths. If the death information from the merged dataset is inconsistent with the information in the RTWF, the individuals (cases) are dropped. The RSD dataset details the completed rehabilitations and include information such as the broad diagnosis group, the type of rehabilitation benefits applied for, start and end date of rehabilitation. The RSD dataset also includes individuals with withdrawn, transferred or rejected applications. We only include individuals whose applications were successful and who completed the rehabilitation spell. Furthermore, about 5% of individuals undergo three or more rehabilitation spells per year. We also drop these individuals. We then supplement the merged dataset by including the additional rehabilitation information for the remaining individuals in the RSD dataset. The VA dataset includes information related to divorce and only contains divorced individuals. From the VA, we can obtain the date of divorce, pension supplements and deductions which result from divorce.

Since divorce is not randomly assigned, it is important to ensure that divorced individuals are similar to non-divorced individuals. For each divorced individual, we draw three controls without replacement. To generate a comparable control group, we use three specifications. In the first specification, we used propensity score matching to match individuals on age, gender, number of rehab spells, number of days in rehab, years since end of last rehab, several variables related to earnings points, education, state, settlement type up to three years prior to the year of divorce. To prevent overfitting, we used out-of-fold propensity scores. The 24848 individuals were 92.1% matched with 68655 controls. In the second specification, we used propensity scores and 2-year rehabilitation prognostic scores to match individuals. 76.4% of divorced individuals were matched with 56952 controls. In the third specification, we used propensity scores, 2-year rehabilitation prognostics and 5-year death prognostics to match individuals. The third specification resulted in 75.7% of divorced individuals being matched with 56430 controls. With the matched and weighted sample, we compute the average treatment effect (ATT) for rehabilitation incidence, time to first rehabilitation, rehabilitation duration and time to death up to ten years after divorce.

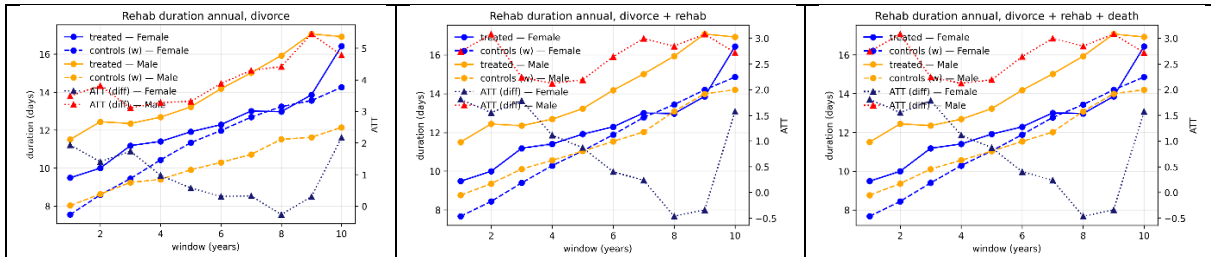
## Preliminary results



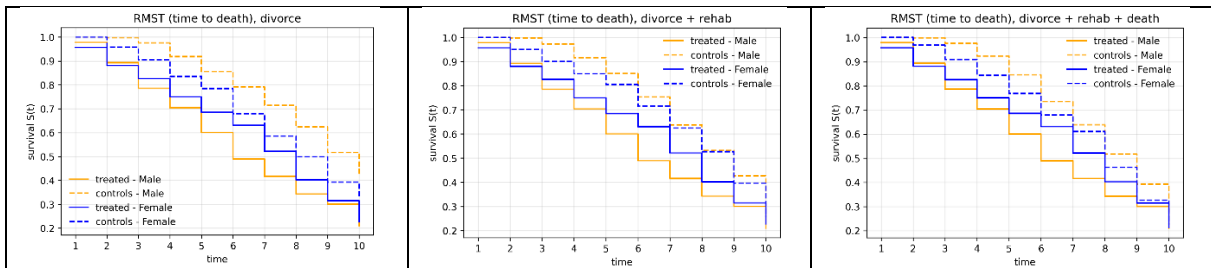
There is no huge difference in the ATT in incidence from using different specifications for matching. When considering only the propensity score, it seems that divorced individuals experience a slightly higher cumulative rehabilitation incidence. When rehabilitation prognostics scores are included, the effect disappears. When rehabilitation and death prognostics are included, the effect reappears for women.



In the first specification, divorced individuals experience a longer delay until the first rehabilitation in the year since divorce. Divorced men especially experience a longer delay compared to divorced women, while non-divorced men tend to experience the shortest delay. When rehabilitation and death prognostics are included when matching individuals, the control groups experience an even shorter delay when accessing rehabilitation care.



In terms of annual rehabilitation duration, the ATT is 2 days shorter when rehabilitation and death prognostics are used for matching in addition to the divorce propensity. Divorced individuals tend to undergo longer rehabilitation, with divorced men experiencing a longer duration by 1 to 2 days compared to divorced women.



In terms of time to death, the time to death rather constant from 3 to 5 years after divorce, but after 5 years of divorce, the gap is larger between treated and controls when using only divorce propensity to match. However, when divorce propensity and rehabilitation prognostics are used for matching, the gap narrows. The gap narrows further when death prognostics are considered, especially when a longer time has elapsed since divorce, since factors related to mortality might dominate in later years. These results suggest that there may be health selection and the effect of divorce on mortality may be overestimated.

## Next steps

To solidify this connection between divorce, health and death, a possible next step would be to use a mediation model to explain the health mechanism that underlies the relationship between divorce and death. Here, health is basically the mediator variable. First, we need to check whether divorce is a statistically significant predictor of death, where death is measured as survival time or a dummy that indicates death. Second, we need to check whether divorce is a statistically significant predictor of health, which we measure as duration of days spent in rehab. Finally, we regress survival time or the death dummy on both divorce and rehab duration. The coefficient on divorce should be smaller than directly regression death on divorce (partial mediation). If the coefficient on divorce drops to zero, this means that there is full mediation, i.e. it is basically health that affects death and not divorce. To

determine whether the relationship between the divorce and death have been significantly reduced after the inclusion of rehab duration (mediator variable), we can use Sobel's test. We can also use Preacher-Hayes bootstrap and lend more validity to the mediation model.

## References

Abbott, A. & Forrest, J., 1986. Optimal matching methods for historical sequences. *The Journal of Interdisciplinary History*, 16(3), pp. 471-494.

Bambra, C. & Norman, P., 2006. What is the association between sickness absence, mortality and morbidity?. *Health & Place*, 12(4), pp. 728-733.

Björkenstam, E., Hallqvist, J., Dalman, C. & Ljung, R., 2013. Risk of new psychiatric episodes in the year following divorce in midlife: cause or selection? A nationwide register-based study of 703,960 individuals. *International Journal of Social Psychiatry*, 59(8), pp. 801-804.

Bottazzi, R. J. T. a. P. M., 2006. Retirement expectations, pension reforms, and their impact on private wealth accumulation. *Journal of Public Economics*, 90(12), pp. 2187-2212.

Bracke, P., Colman, E., Symoens, S. & Van Praag, L., 2010. Divorce, divorce rates, and professional care seeking for mental health problems in Europe: a cross-sectional population-based study. *BMC Public Health*, 10(224).

Breiman, L., Friedman, J., Olshen, R. & Stone, C., 1984. *Classification and Regression Trees*. New York: Chapman and Hall/CRC.

Capitaine, L., 2020. *LongituRF: Random forests for longitudinal data*. [Online] Available at: <https://cran.r-project.org/web/packages/LongituRF/index.html> [Zugriff am 16 May 2025].

Capitaine, L., Genuer, R. & Thiébaud, R., 2021. Random forests for high-dimensional longitudinal data. *Statistical Methods in Medical Research*, 30(1), pp. 166-184.

Carter, E. B. S. et al., 2025. Prediction of remission of pharmacologically treated psychotic depression: A machine learning approach. *Journal of Affective Disorders*, Band 381, pp. 291-297.

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

de bondt, G., Gieseck, A. & Tujula, M., 2020. Household wealth and consumption in the euro area. *ECB Economic Bulletin Articles*, Issue 1.

Deutsche Rentenversicherung, 2025. *Der ärztliche Reha-Entlassungsbericht*. [Online] Available at: [https://www.deutsche-rentenversicherung.de/SharedDocs/Downloads/DE/Experten/infos\\_reha\\_einrichtungen/qualitaet\\_allgemein/download\\_leitfaden\\_einheitliche\\_bericht.html](https://www.deutsche-rentenversicherung.de/SharedDocs/Downloads/DE/Experten/infos_reha_einrichtungen/qualitaet_allgemein/download_leitfaden_einheitliche_bericht.html) [Zugriff am 7 July 2025].

Doan, T., Ha, V., Strazdins, L. & Chateau, D., 2022. Healthy minds live in healthy bodies - effect of physical health on mental health: Evidence from Australian longitudinal data. *Current Psychology*, Band 42, pp. 18702-18713.

Etzkorn, L. et al., 2024. A joint frailty model for recurrent and competing terminal events: Application to delirium in the ICU. *Statistics in Medicine*, 43(12), pp. 2389-2402.

Forschungsdatenzentrum Rentenversicherung, 2025. *Zugangsbedingungen*. [Online] Available at: <https://fdz-rv.de/datennutzung/zugangsbedingungen> [Zugriff am 21 07 2025].

Garbinti, B., Lamarche, P. & Savignac, F., 2024. Wealth heterogeneity and the marginal propensity to consume out of wealth. *Banque de France Working Paper*, Issue 962.

GKV-Spitzenverband, kein Datum *Informationen zur medizinischen Rehabilitation*. [Online] Available at: [https://www.gkv-spitzenverband.de/service/medizinische\\_rehabilitation/reha\\_infos\\_1.jsp?utm\\_source=chatgpt.com](https://www.gkv-spitzenverband.de/service/medizinische_rehabilitation/reha_infos_1.jsp?utm_source=chatgpt.com) [Zugriff am 7 July 2025].

Hajjem, A., Bellavance, F. & Larocque, D., 2011. Mixed effects regression trees for clustered data. *Statistics and Probability Letters*, Band 81, pp. 451-459.

Hajjem, A., Bellavance, F. & Larocque, D., 2014. Mixed-effects random forest for clustered data. *Journal of Statistical Computation and Simulation*, 84(6), pp. 1313-1328.

Hallberg, H. & Mattsson, B., 1992. Separation and distress - sickness absence and health screening in newly divorced middle-aged Swedish men. *Scandinavian Journal of Primary Health Care*, 10(2), pp. 91-97.

Hu, J. & Szymczak, S., 2023. A review on longitudinal data analysis with random forest. *Briefings in Bioinformatics*, 24(2).

Kreyenfeld, M. S. S. a. M. T., 2023. The gender pension gap in Germany: is divorce a gender-equaliser?. *Ageing & Society*, 43(11), pp. 2700-2720.

Leopold, T., 2018. Gender differences in the consequences of divorce: A study of multiple outcomes. *Demography*, 55(3), pp. 769-797.

Liao, T. et al., 2022. Sequence analysis: Its past, present and future. *Social Science Research*, Band 107, p. 102772.

Lu, M. et al., 2016. Marital status and living condition as predictors of mortality and readmissions among African Americans with heart failure. *International Journal of Cardiology*, 1(222), pp. 313-318.

Mittendorfer-Rutz, E. K. L. et al., 2012. Sickness absence due to specific mental diagnoses and all-cause and cause-specific mortality: a cohort study of 4.9 million inhabitants of Sweden. *PLOS One*, 7(9), p. e45788.

Raab, M., Fasang, A. & Hess, M., 2018. Pathways to death: The co-occurrence of physical and mental health in the last years of life. *Demographic Research*, Band 38, pp. 1619-1634.

Rondeau, V. et al., 2007. Joint frailty models for recurring events and death using maximum penalized likelihood estimation: application on cancer events. *Biostatistics*, 4(708-721), p. 8.

Sbarra, D. a. N. P. 2., 2009. Divorce and death: Forty years of the Charleston Heart Study. *Psychological Science*, 20(1), pp. 107-113.

Sbarra, D. H. K. a. N. W., 2012. Divorce and death: A case study for health psychology. *Social and personality psychology compass*, 6(12), pp. 905-919.

Sbarra, D. H. K. a. N. W., 2012. Divorce and death: A case study for health psychology. *Social and personality psychology compass*.

- Schaubert, M. & Köckeis, J., 2025. Demanding financial self-sufficiency after divorce: understanding the consequences of the 2008 Alimony Reform. *Review of Economics of the Household*, 23(2), pp. 737-761.
- Schmauk, S., 2024. Pathways to retirement in West Germany: Does divorce matter?. *Advances in Life Course Research*, Band 60, p. 100595.
- Segal, M., 1992. Tree-Structured Methods for Longitudinal Data. *Journal of the American Statistical Association*, 87(418), pp. 407-418.
- Shkolnikov, V. et al., 2007. Length of life and the pensions of five million retired German men. *European Journal of Public Health*, 18(3), pp. 264-269.
- Terza, J., Basu, A. & Rathouz, P., 2008. Two-stage residual inclusion estimation: addressing endogeneity in health econometric modeling. *Journal of Health Economics*, 27(3), pp. 531-543.
- Torvik, F., Gustavson, K., Røysamb, E. & Tambs, K., 2015. Health, health behaviors, and health dissimilarities predict divorce: Results from the HUNT study. *BMC Psychology*, 3(1<sup>^</sup>), p. 13.
- Vahtera, J., Pentti, J. & Kivimäki, M., 2004. Sickness absence as a predictor of mortality among male and female employees. *Journal of Epidemiology and Community Health*, 58(4), pp. 321-326.
- von Gaudecker, H. & Scholz, R., 2006. Lifetime earnings and life expectancy. *Sonderforschungsbereich, Rationalitätskonzepte, Entscheidungsverhalten und Ökonomische Modellierung*, 7(504).
- Wade, T. & Pevalin, D., 2004. Marital transitions and mental health. *Journal of Health and Social Behavior*, Band 45, pp. 155-170.
- Wenau, G., Grigoriev, P. & Shkolnikov, V., 2019. Socioeconomic disparities in life expectancy gains among retired German men, 1997-2016. *Journal of Epidemiology and Community Health*, Band 73, pp. 605-611.
- Wobrock, T. et al., 2010. Qualitätsindikatoren in der Psychiatrie. *Die Psychiatrie*, 3(179-189), p. 7.
- Wu, L., 2000. Some comments on "Sequence analysis and optimal matching methods in sociology: Review and prospect". *Sociological Methods & Research*, 29(1), pp. 41-64.
- Zheng, W. L. Y. J. R. a. H. K., 2023. The impact of expected pensions on consumption: Evidence from China. *Journal of Pension Economics & Finance*, 22(1), pp. 69-87.