Changing associations of coronary heart disease incidence with current partnership status and marital history over three decades

Karri Silventoinen a,b,*, Kaarina Korhonen a, Pekka Martikainen a,c,d

a University of Helsinki, Faculty of Social Sciences, Population Research Unit, Finland
b University of Helsinki, Faculty of Medicine, Department of Public Health, Finland
c Stockholm University, Department of Public Health Sciences, Sweden
d Max-Planck-Institute for Demographic Research, Germany

ARTICLE INFO

Keywords:
Marital status
CHD incidence
Temporal change
Partnership history

ABSTRACT

Married men and women have better health than non-married, but little is known about how cohabitation and marital history are associated with coronary heart disease (CHD) incidence and how these associations have changed over time. We analyzed these associations by fitting Cox regression models to register data covering the whole Finnish population aged 35 years or older (N = 4,415,590), who experienced 530,560 first time non-fatal or fatal CHD events during the years 1990–2018. Further, we used stratified Cox regression models to analyze CHD incidence within same-sex sibling pairs (N = 377,730 pairs). Married men and women without previous divorce had the lowest CHD incidence whereas cohabitation and a history of divorce were associated with higher CHD incidence. The associations were stronger in younger (35–64 years old) than older participants (65 years or older). These associations remained after adjusting for several indicators of social position, and the lower CHD incidence among those married without previous divorce was also observed within sibling pairs with a shared family background. The differences in CHD incidence between the categories generally widened over time; the largest and most systematic widening was observed among women in the younger age category. The long standing negative effect of divorce suggests that selection may partly explain the association between partnership status and CHD incidence. Partnership status is an increasingly important factor contributing to social inequalities in health.

Marital status has received generally less attention in social epidemiology than some other social indicators, such as education and income. However, the importance of marital status as a social determinant of health has increased in recent decades when mortality differences between married and non-married persons have widened (Roelfs et al., 2011). This development has also affected gender differences in the association between marital status and health; when in the earlier studies the mortality difference between married and non-married persons was larger in men as compared to women, in the most recent studies this difference was roughly similar in men and women (Roelfs et al., 2011). Most of the studies concerning the association between marriage and health have concerned Western countries and different-sex marriages, but health benefits of marriage have also been found in other cultural contexts (Jee & Cho, 2019) and for same-sex marriages (Solazzo et al., 2020) demonstrating the universality of this association. However, much less is known about the associations between marital status and specific diseases. In this context, coronary heart disease (CHD) is especially important since it is not only the leading cause of death both globally and in Western societies (Lozano et al., 2012), but it is also strongly socially patterned (Mackenbach et al., 2000). In Northern European countries, CHD is the most important cause of socio-economic mortality inequalities (Kulhánová et al., 2014). Thus, understanding the determinants of CHD mortality is essential for both enhancing public health in general and for reducing social health inequalities.

Previous studies have shown that CHD incidence is higher in non-married as compared to married men and women (Wong et al., 2018). However, not only having never married, but also marital dissolution due to divorce (Shor, Roelfs, Bugyi, & Schwartz, 2012) or spousal death (Shor, Roelfs, Curreli, et al., 2012), is associated with higher mortality, CHD in particular (Martikainen & Valkonen, 1996). There is also previous evidence that in addition to current marital status, also marital history affects mortality (Blomgren et al., 2012; Grundy & Tomassini, 2011).

* Corresponding author. University of Helsinki, Population Research Unit, Faculty of Social Sciences, P.O. Box 18, FIN-00014, Finland.

E-mail address: karri.silventoinen@helsinki.fi (K. Silventoinen).

https://doi.org/10.1016/j.ssmph.2022.101080
Received 2 December 2021; Received in revised form 1 February 2022; Accepted 22 March 2022
Available online 26 March 2022
2352-8273/© 2022 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
The differences in CHD risk according to marital status can result from both selection to marriage (or divorce in those currently married) according to health and health related factors and beneficial effects of marriage on health directly or through health behavior (Umberson & Thomeer, 2020). The health effects of marriage can also vary according to marital quality; marital quality may decline over time (Umberson et al., 2006) and women typically report more marital stress than men (Umberson & Williams, 2005), which can also affect physical health. Further, socio-economic factors can partly explain these associations since especially in men low social position is associated with lower probability of marriage (Jalovaara, 2012) and higher risk of divorce (Jalovaara, 2013). These differences may also stem from childhood. Low social position of childhood family is associated with both higher CHD risk in adulthood (Kilpi et al., 2017) and higher likelihood to experience parental divorce (Jalovaara & Andersson, 2018), which can further affect later union formation and dissolution patterns (Amato & DeBoer, 2001). Thus, when studying the association between marital status and health, it is important to take into account both childhood family background and marital history.

During the last decades, there has been a dramatic change in the formation of partnerships in Europe and the USA. Marriage has become a less common form of partnership and the rates of co-habitation and divorce have increased (Perelli-Harris et al., 2017). However, previous studies analyzing temporal changes in the association between partnership status and health have mainly focused on legal marriages and thus cannot capture the complexity of the changing forms of partnership. In this study, we aim to shed new light on the changing dynamics between partnership status, marital history and CHD incidence in the Finnish population over the last three decades. Based on detailed longitudinal register-based information, we can identify both cohabitation and divorce histories, and thus contribute to better understanding of how partnership characteristics are associated with CHD risk over time. Further, we use a quasi-experimental design of same-sex sibling pairs differing in their marital status. From the life course perspective, childhood family environment can importantly contribute to the association between marital status and health (Umberson & Thomeer, 2020), but measuring it retrospectively is difficult. Comparing discordant sibling pairs offers a powerful method to adjust for unobserved confounders shared by siblings and provide stronger evidence on causality. Finland provides an intriguing setting to study the changing dynamics between partnership history and health since, along with other Nordic countries, Finland has been a forerunner both in co-habitation and divorce followed by other European countries and the USA (Thomson, 2014).

1. Data and methods

We used data covering the whole Finnish population aged 35 years or older and residing in Finland in any year between 1990 and 2018. The population data from Statistics Finland were linked to administrative health registers using personal identification codes. The information from non-fatal CHD events were based on Hospital Discharge Register (ICD-10 codes I20.0 and I21–I22) and the fatal events on National Mortality Register (ICD-10 codes I20–I25, I46, R96 and R98). Because of the universal healthcare system in Finland, the hospital discharge register covers the whole Finnish population and includes virtually all non-fatal CHD events needing hospital-level care (Pajunen et al., 2005). Based on the Finnish law, also the mortality register covers the whole Finnish population. During the whole follow-up period from 1990 to 2018, we observed 530,560 incident CHD events (224,125 first time hospitalizations because of CHD and 306,435 CHD deaths without a prior hospitalization because of CHD) over 76,112,417 person-years at risk.

Current partnership status and marital history, abbreviated as marital history in the further sections, was classified as married, cohabiting, divorced, never married and widowed. Married and cohabiting participants were further stratified to those previously divorced and never divorced, and currently divorced to those divorced within the previous three years and those divorced more than three years ago. For those who had married after divorce and then re-divorced, the time to divorce was calculated from the latest divorce. Since the number of widowed who later married or cohabited was small (<1% of the study participants), no separate categories were used and they were classified as married or cohabiting. Information on marriage, divorce and widowhood was derived from the population register starting from 1987 and population censuses conducted in 1970, 1975, 1980, and 1985. Cohabitation was based on linkage between the population and household registers and defined as two non-married persons of different genders living together, not close relatives and with an age difference less than 16 years. Thus, same-gender cohabiting partners were classified as singles.

Other covariates were having any children younger than 18 years living in the household (a binary variable), education (basic education only, secondary education and tertiary education), economic activity (employed, unemployed, student, peer worker and others), social class (upper non-manual, lower non-manual with independent work or subordinates, lower non-manual with routine work, specialized manual, non-specialized manual, self-employed farmer, entrepreneur and no known occupation) and personal incomes. Previous studies have shown that socioeconomic resources are associated with union formation (Jalovaara, 2012), union dissolution (Jalovaara, 2013) and CHD risk (Mackenbach et al., 2000). Thus, adjusting for these covariates gives more information on how possible compositional changes in socioeconomic characteristics can explain temporal changes in the associations between marital history and CHD risk. Information on all covariates was derived from the population register except for personal incomes, which were derived from the Tax Administration database including all annual taxable incomes and social benefits.

We estimated hazard ratios (HR) according to marital history in Cox regression models for first incident CHD event (non-fatal or fatal case without a prior hospitalization) with 95% confidence intervals (CI). The follow-up period was divided into 5-year periods with baselines at 1990, 1995, 2000, 2005, 2010 and 2015 to analyze how the associations between marital history and incident CHD events had changed over the three decades. Information on marital history and covariates were based on the situation at the time of each separate baseline, and the HRs were calculated for incident CHD events before the next baseline (5-year follow-up periods except the latest period with a 3-year follow-up) to minimize the dilution effect due to changes in partnership status during the follow-up. All individuals with a CHD hospitalization before each baseline were removed from the data. Those who died from other causes than CHD were censored at the time of death. Since previous studies have found larger mortality differentials in young and middle aged adults compared to older adults (Roelfs et al., 2011), we stratified the analyses by two age-groups: those aged 35–64 years and those aged 65 years or more. We also adjusted for attained age in years within the age-group strata in all models. Cox proportional hazards assumptions were not violated when tested graphically (Kaplan-Meier curves available from the corresponding author). Additionally, we calculated population attributable fractions (PAF) to evaluate the population level importance of marital history and to account for the changing distribution of marital history categories across the decades. PAF indicates the proportion of CHD cases that would have been avoided if the whole population had the same CHD risk as those in the lowest risk category.

We continued the analyses by studying the association between marital status and incident CHD events within sibling pairs. This method allows adjusting for unobserved childhood confounders since siblings share not only their childhood family but also many other environmental factors related to school and neighborhood. We selected one same-sex sibling pair from each family favoring the smallest age difference between siblings to minimize changes in family environment. The maximum age difference between siblings was limited to 5 years.
2. Results

Table 1 presents the population distribution and CHD incidence by categories of marital history over the total follow-up period. The proportion of those who were married and had not previously divorced steadily declined from the year 1990–2015 in men and in 35–64-year-old women. This decline was explained by the increasing proportions of those who were divorced, cohabiting and never-married. In women 65 years of age or older, the proportion of married without previous divorce increased, which was because of decreasing proportion of widowed. The decreasing proportion of widowed was also seen in men 65 years of age or older and 35–64-year-old women.

We first studied how marital history was associated with CHD risk in 35–64-year-olds. In men, the CHD risk was lowest among those married without previous divorce history and highest among those who had been divorced for 3 or more years (Table 2). The differences increased from the first five-year follow-up period starting in 1990 (PAF = 0.10) until the period starting in 2005 (PAF = 0.18), but after that remained unchanged. Adjusting for the indicators of socioeconomic position explained part of these differences: the PAFs decreased by 20–50% (Model 2). In women, the lowest risk was among married without previous divorce and the highest risk among the cohabiting who had previously divorced or those who had been divorced for 3 or more years depending on the follow-up period (Table 3). The differences increased over time: the PAF was 0.08 in the first follow-up period, and it increased up to 0.18 in the last follow-up period starting in 2015. The indicators of socioeconomic position explained a slightly smaller proportion of these differences (17–28%) than in men (Model 2). Women had smaller differences in CHD risk between the marital history categories in all other periods (p-value for gender interaction <0.0001) than the latest period when the PAF was slightly greater than in men (p-value}

![Table 1](image-url)
than in the younger age category (reduction in PAFs by 12% except
for gender interaction 0.123).

Table 2 presents the corresponding analyses for men 65 years of age or older. Also in this age category, married had generally the lowest risk of CHD, but the differences in CHD risk between the marital history categories were narrower as compared to the 35–64 years category (reduction in PAFs 25–55%). The adjustment for socioeconomic indicators slightly decreased the PAFs (10–20%, Model 2). In women, married had generally the lowest risk and the differences were narrower than in the younger age category (reduction in PAFs by 12–42% except during the follow-up period starting in 2005 where no difference in PAFs was seen) (Table 5). The PAFs were higher in women than in men in this age category in all follow-up periods indicating larger differences in CHD risk between marital history categories in women (p-values for gender interaction <0.0001). Among women, the effect of the adjust

Table 2
Hazard ratios (HR) of coronary heart disease events by marital history in men of 35–64 years of age at baselines.

| Marital history | Baseline year |
|-----------------|---------------|
|                 | 1990          | 1995          | 2000          | 2005          | 2010          | 2015          |
|                 | HR 95% CI     | HR 95% CI     | HR 95% CI     | HR 95% CI     | HR 95% CI     | HR 95% CI     |
| Model 1         |               |               |               |               |               |               |
| Married         | 1.00          | 1.00          | 1.00          | 1.00          | 1.00          | 1.00          |
| Married (divorced) | 1.10          | 1.01          | 1.20          | 1.18          | 1.10          | 1.27          |
| Cohabiting (divorced) | 1.28          | 1.19          | 1.38          | 1.35          | 1.27          | 1.44          |
| Divorced (<3 years) | 1.34          | 1.21          | 1.49          | 1.43          | 1.30          | 1.58          |
| Divorced (≥3 years) | 1.53          | 1.46          | 1.61          | 1.64          | 1.57          | 1.72          |
| Never married   | 1.44          | 1.39          | 1.50          | 1.49          | 1.43          | 1.55          |
| Widowed         | 1.34          | 1.23          | 1.46          | 1.40          | 1.28          | 1.53          |
| PAF             | 0.10          | 0.09          | 0.11          | 0.13          | 0.12          | 0.14          |

Model 1: Adjusted for age at the baseline.
Model 2: Adjusted for age at the baseline, having any children under 18 years of age in the family, education, occupation based socio-economic position, employment status and personal incomes.

Table 3
Hazard ratios (HR) of coronary heart disease events by marital history in women of 35–64 years of age at baselines.

| Marital history | Baseline year |
|-----------------|---------------|
|                 | 1990          | 1995          | 2000          | 2005          | 2010          | 2015          |
|                 | HR 95% CI     | HR 95% CI     | HR 95% CI     | HR 95% CI     | HR 95% CI     | HR 95% CI     |
| Model 1         |               |               |               |               |               |               |
| Married         | 1.00          | 1.00          | 1.00          | 1.00          | 1.00          | 1.00          |
| Married (divorced) | 1.22          | 1.01          | 1.47          | 1.08          | 1.44          | 1.26          |
| Cohabiting      | 1.41          | 1.19          | 1.67          | 1.36          | 1.17          | 1.58          |
| Cohabiting (divorced) | 1.56          | 1.34          | 1.83          | 1.54          | 1.36          | 1.74          |
| Divorced (<3 years) | 1.35          | 1.08          | 1.69          | 1.11          | 0.88          | 1.39          |
| Divorced (≥3 years) | 1.31          | 1.21          | 1.42          | 1.49          | 1.39          | 1.60          |
| Never married   | 1.13          | 0.84          | 1.23          | 1.18          | 1.09          | 1.29          |
| Widowed         | 1.24          | 1.14          | 1.35          | 1.29          | 1.18          | 1.42          |
| PAF             | 0.08          | 0.06          | 0.10          | 0.12          | 0.10          | 0.12          |

Model 1: Adjusted for age at the baseline.
Model 2: Adjusted for age at the baseline, having any children under 18 years of age in the family, education, occupation based socio-economic position, employment status and personal incomes.
The systematically higher CHD risk compared to those married without a previous divorce was seen in all follow-up periods in the within-pair analyses as compared to the individual level analyses. However, in women, the differences were unsystematic and both lower and higher HRs were seen in the within-pair analyses as compared to the individual level analyses.

3. Discussion

In this study covering the whole population of Finland in years 1990–2018, we found that not only current partnership status but also marital history affected the CHD risk in men and women. Previous studies have consistently shown that marriage is associated with lower

studying the difference in CHD risk within same-sex sibling pairs where one sibling was married and had not previously divorced and the other sibling belonged to any of the other marital history categories (Table 6). The systematically higher CHD risk compared to those married without previous divorce was seen in all follow-up periods in the within-pair analyses. The adjustment for within-pair differences in the socioeconomic indicators somewhat attenuated the HRs in men and women (Model 2). The HRs in men were slightly but systematically lower in the within-pair than individual level analyses. However, in women, the differences were unsystematic and both lower and higher HRs were seen in the within-pair analyses as compared to the individual level analyses.

### Table 4

| Marital history | Baseline year | Hazard ratios (HR) of coronary heart disease events by marital history in men of 65 years of age or older at baselines. |
|----------------|--------------|------------------------------------------------------------------------------------------------------------------|
|                | 1990         | 1995 | 2000 | 2005 | 2010 | 2015 |
|                | HR | 95% CI | HR | 95% CI | HR | 95% CI | HR | 95% CI | HR | 95% CI | HR | 95% CI |
| Married        | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Married (divorced) | 1.11 | 0.95 | 1.29 | 1.03 | 0.91 | 1.16 | 0.95 | 0.87 | 1.05 | 1.01 | 0.93 | 1.09 | 1.07 | 1.00 | 1.14 | 1.02 | 0.96 | 1.10 |
| Cohabiting     | 1.12 | 1.00 | 1.25 | 1.17 | 1.05 | 1.30 | 1.12 | 1.01 | 1.24 | 1.24 | 1.13 | 1.37 | 1.09 | 0.99 | 1.20 | 1.14 | 1.03 | 1.27 |
| Cohabiting (divorced) | 1.09 | 0.94 | 1.26 | 1.21 | 1.07 | 1.35 | 1.14 | 1.03 | 1.26 | 1.19 | 1.09 | 1.30 | 1.08 | 1.00 | 1.17 | 1.18 | 1.08 | 1.28 |
| Divorced (<3 years) | 1.10 | 0.88 | 1.38 | 1.15 | 0.92 | 1.45 | 1.07 | 0.84 | 1.36 | 1.23 | 0.98 | 1.56 | 1.39 | 1.12 | 1.72 | 1.37 | 1.05 | 1.77 |
| Divorced (≥3 years) | 1.18 | 1.11 | 1.25 | 1.24 | 1.18 | 1.31 | 1.37 | 1.31 | 1.43 | 1.48 | 1.41 | 1.54 | 1.44 | 1.38 | 1.50 | 1.49 | 1.43 | 1.56 |
| Never married  | 1.17 | 1.12 | 1.22 | 1.25 | 1.20 | 1.30 | 1.28 | 1.23 | 1.34 | 1.46 | 1.41 | 1.52 | 1.48 | 1.42 | 1.54 | 1.52 | 1.45 | 1.59 |
| Widowed        | 1.15 | 1.11 | 1.19 | 1.13 | 1.10 | 1.17 | 1.20 | 1.16 | 1.24 | 1.26 | 1.22 | 1.30 | 1.26 | 1.22 | 1.31 | 1.27 | 1.22 | 1.33 |
| PAF            | 0.05 | 0.04 | 0.05 | 0.05 | 0.05 | 0.06 | 0.07 | 0.06 | 0.08 | 0.10 | 0.09 | 0.11 | 0.10 | 0.09 | 0.11 | 0.12 | 0.10 | 0.13 |

Model 1: Adjusted for age at the baseline.
Model 2: Adjusted for age at the baseline, having any children under 18 years of age in the family, education, occupation based socio-economic position, employment status and personal incomes.
and divorce with higher CHD risk (Martikainen et al., 2005). Our results showed that previous divorce increases the CHD risk also in men and women who are currently married or cohabiting. Among currently divorced, the CHD risk was higher in those who had been divorced at least 3 years as compared to those who had been divorced less than three years. This suggests that CHD risk is higher among those not finding a new partner after the divorce. These results are consistent with the hypothesis that selection mechanisms may partly explain the association between CHD risk and divorce status, and there may be some factors affecting CHD risk and the probability to divorce and find a new partner after the divorce. Health behavioral factors are likely candidates for these common factors since being married is associated with better health behavior, such as non-smoking and regular physical activity (Manfredini et al., 2017), whereas heavy use of alcohol is associated with a higher divorce risk (Collins et al., 2007). In a Scottish study, physical activity, smoking and alcohol use explained a third of the excess risk of CHD of divorced men and around fifth of divorced women when compared to married men and women (Molloy et al., 2009). Another explanation for these findings is that divorce has a long-standing effect on health not removed even by a new partnership. Both explanations received some support from a previous Finnish study on psychotropic medication use. The authors found higher levels of medication use among divorced than among continuously married already several years before the divorce, which peaked at the time of divorce and remained at a higher level over an eight-year period after the divorce (Metsä-Simola & Martikainen, 2013).

We also found that cohabiting men and women had higher CHD risk than those who were married. There are previous studies showing that heavy alcohol use (Joutteniemi et al., 2007) and mental health problems (van Hedel et al., 2018) are more common in cohabiting than in married couples. Well-being is also found to be lower in cohabitants than married couples even in many European countries where cohabitation is a culturally widely accepted form of partnership (Soons & Kalminj, 2009). This excess risk among cohabitants can thus be caused both by health behavior but also weaker emotional and task support from the cohabiting relationship. It is noteworthy that cohabitation usually leads to separation or marriage, with only a small minority staying in the cohabiting relationship for an extended period (Jalovaara & Hull, 2018). Thus, the cohabiting couples are a mixture of those who will eventually marry and those who will become non-married.

When studying these associations over time, we found that the differences increased more in middle aged women than in middle aged men leading to the disappearance of the gender difference in the association between marital history and CHD incidence in the latest follow-up period. A similar pattern of a narrowing gender gap in all-cause mortality between married and non-married has previously been reported in a meta-analysis (Roelfs et al., 2011), and thus this seems to be a universal trend. In the more recent follow-up periods, the differences between marital history categories were more strongly attributable to socioeconomic factors than in the earlier follow-up periods. During this study period in Finland, partnership status was an important factor behind income inequality in the middle-aged population (Erola & Kilpi-Jakonen, 2021). Our results indicate that socioeconomic inequalities between the marital history categories have increased during the follow-up period, also having implications for CHD risk. However, clear differences were also found after adjusting the results for adult socioeconomic position and when we adjusted the results for childhood family background by using a quasi-experimental design of discordant sibling pairs.

The differences in CHD risk between the marital history categories were substantially smaller in older participants as compared to middle-aged adults. This age difference for married vs. non-married has also been found in previous studies for general mortality risk (Roelfs et al., 2011). However, also in the elderly population, CHD risk was lowest in the married men and women, in line with a previous meta-analysis of general mortality in the older population (Manzoli et al., 2007). Interestingly, we found that in the older participants, the CHD difference between marital history categories were typically larger in females than in males. This was particularly true towards the end of the study period. Further, the adjustment for socioeconomic indicators slightly widened the CHD differences between the categories of marital history in older women contrasting men. This indicates that the dynamics between partnership and socioeconomic factors in older women is different than in men and in middle-aged women: non-marital groups are socioeconomically more privileged among older women than the married. This may suggest that better educated women in older birth cohorts decided to remain non-married in order to fully participate in employment and develop careers.

Although our results lend some support to the hypothesis that selection to partnership contributes to the associations between partnership status and CHD risk, they do not exclude the possibility that partnership also affects CHD risk. These effects may be mediated by health behaviors as was suggested by the finding that living in an intimate relationship can suppress the genetic susceptibility to heavy alcohol use (Barr et al., 2019) and the effect of decreasing alcohol price on the risk of alcohol related deaths (Herttua et al., 2011). Further, both

### Table 6

| Baseline year | Men | Women |
|-------------|-----|-------|
|              | Model 1 | Model 2 | Model 1 | Model 2 |
|              | HR, 95% CI | HR, 95% CI | HR, 95% CI | HR, 95% CI |
| Within- pair analyses | | | |
| 1995 | 1.53 | 1.25 | 1.87 | 1.32 | 1.04 | 1.68 | 2.08 | 1.21 | 3.59 | 1.60 | 0.81 | 3.14 |
| 2000 | 1.39 | 1.22 | 1.58 | 1.27 | 1.09 | 1.47 | 1.55 | 1.17 | 2.65 | 1.29 | 0.95 | 1.76 |
| 2005 | 1.30 | 1.17 | 1.44 | 1.12 | 1.00 | 1.26 | 1.20 | 0.98 | 1.45 | 1.00 | 0.81 | 1.24 |
| 2010 | 1.20 | 1.09 | 1.31 | 1.10 | 1.00 | 1.21 | 1.43 | 1.21 | 1.69 | 1.29 | 1.09 | 1.53 |
| 2015 | 1.29 | 1.16 | 1.43 | 1.17 | 1.04 | 1.31 | 1.28 | 1.07 | 1.53 | 1.19 | 0.99 | 1.43 |
| Between- pair analyses | | | |
| 1995 | 1.58 | 1.39 | 1.79 | 1.23 | 1.03 | 1.47 | 1.70 | 1.23 | 2.35 | 1.28 | 0.89 | 1.84 |
| 2000 | 1.48 | 1.36 | 1.62 | 1.16 | 1.05 | 1.29 | 1.51 | 1.27 | 1.81 | 1.17 | 0.97 | 1.42 |
| 2005 | 1.42 | 1.33 | 1.53 | 1.13 | 1.04 | 1.22 | 1.37 | 1.19 | 1.57 | 1.12 | 0.98 | 1.30 |
| 2010 | 1.34 | 1.27 | 1.42 | 1.13 | 1.06 | 1.21 | 1.43 | 1.28 | 1.59 | 1.23 | 1.10 | 1.37 |
| 2015 | 1.40 | 1.31 | 1.51 | 1.19 | 1.11 | 1.28 | 1.39 | 1.24 | 1.56 | 1.23 | 1.09 | 1.39 |

Model 1: Adjusted for age at the baseline.
Model 2: Adjusted for age at the baseline, having any children under 18 years of age in the family, education, occupation based socio-economic position, employment status and personal incomes.
positive (Alexander et al., 2021) and negative emotions (Arias et al., 2020) have widespread effects on human neurobiology, which can directly affect CHD risk through, for example, hormonal mechanisms, although the biological pathways are still poorly understood. It is well known that depression (Gan et al., 2014) and social isolation (Valtorta et al., 2016) are associated with increased CHD risk, and that they are more common in those living alone than those living with a partner (Frehch & Williams, 2007). Furthermore, these protective effects of partnership social support on CHD risk may be stronger in marriage than in cohabitation.

Our data have strengths but also limitations. Our data cover the total Finnish population across three decades. This offers strong statistical power to analyze long-term changes in the association between marital history, using a detailed classification, and CHD incidence. Further, there is no non-participation or drop out in our data, which could otherwise create bias in the results. It is also a major advantage that the Finnish registers allow to identify not only legal marriages, divorces and widowhood but also cohabitation, which has become an important form of partnership in Europe and the USA (Thomson, 2014). However, needing to rely only on register based data is also a weakness since we do not have any direct information on health behaviors or social support from partners. Thus, we can only speculate on possible mediating factors between partnership status and CHD risk. Furthermore, we cannot identify same-sex cohabiting couples and legal registration for same-sex couples become possible in Finland only in 2003 after which year they were recorded as marriages. Thus, those living in same-sex partnerships are incorrectly classified as singles in our data. There is evidence that same-sex marriages offer at least the same level of social and emotional support as different-sex marriages (Thomeer et al., 2021). Thus, we assume that those living with a same-sex partner have the same health benefits as those in different-sex partnerships, and consequently this misclassification probably decreases the CHD incidence in the never married category. Thus, without this misclassification, the differences between never married and those married or cohabiting would probably be larger than we observed in this study.

In conclusion, both current partnership status and marital history are associated with CHD risk. Being married is associated with lower CHD risk exceeding the benefits of cohabitation whereas divorce can have long-lasting negative effects on CHD risk even in those currently living with a partner. These results emphasize that marriages should be better supported in social policy and legislation since marriage generally creates a healthy environment. Divorced and never married men and women may suffer from health problems and should be recognized in a society as a group needing special support. However, because these associations can only partly be explained by adult socioeconomic factors or childhood family background shared by siblings, further research is needed to identify other pertinent factors underlying these associations. Finally, marital status differentials have increased considerably over time, and these differentials should be better recognized as substantial driver of health inequalities in addition to the more commonly investigated socioeconomic disparities.

Author statement

Karri Silventoinen: Conceptualization, Writing - Original Draft; Kaarina Korhonen: Conceptualization, Formal analysis, Writing - Review & Editing Pekka Martikainen: Conceptualization, Writing - Review & Editing, Resources, Funding acquisition.

Ethical approval

The data used in the study is based on Finnish registers with data linkage by the Statistics Finland (permission TK-53-1490-18). The data and its use for research have been approved by the Statistics Finland.

Declaration of competing interest

None to declare.

Acknowledgements

KK was supported by the Finnish Cultural Foundation. PM was supported by the Academy of Finland (#308247, #345219) and the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (grant agreement No 101019329). The study does not necessarily reflect the Commission’s views and in no way anticipates the Commission’s future policy in this area. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. Open access funded by Helsinki University Library.

References

Alexander, R., Aragon, O. R., Bookwala, J., Sherburn, N., Gatt, J. M., Kabrillas, I. J., Kattner, N., Lawrence, A., Lowe, L., Morrison, R. G., Mueller, S. C., Nuslock, R., Papadellis, C., Polnarek, K. L., Helene Richter, S., Silton, R. L., & Styliadis, C. (2021). The neuroscience of positive emotions and affect: Implications for cultivating happiness and wellbeing. Neuroscience & Biobehavioral Reviews, 121, 220-249.

Amato, P. R., & DeLoro, D. D. (2001). The transmission of marital instability across generations: Relationship skills or commitment to marriage? Journal of Marriage and Family, 63, 1038–1051.

Arias, J. A., Williams, C., Raghvani, R., Aghajani, M., Baer, S., Belzung, C., Boij, I., Busatto, G., Chiarella, J., Fu, C. H., Ibanez, A., Liddell, B. J., Lowe, L., Penninx, B. W. J. H., Rosa, P., & Kemp, A. H. (2020). The neuroscience of sadness: A multidisciplinary synthesis and collaborative review. Neuroscience & Biobehavioral Reviews, 111, 199–226.

Barr, P. B., Kuo, S. I., Aliev, F., Latvala, A., Viken, R., Rose, R. J., Kaprio, J., Salvador, J. E., & Dick, D. M. (2019). Polygenic risk for alcohol misuse is moderated by romantic partnerships. Addiction, 114, 1753–1762.

Blomgren, J., Martikainen, P., Grundy, E., & Koskinen, S. (2012). Marital history 1971-91 and mortality 1991-2004 in England & Wales and Finland. Journal of Epidemiology & Community Health, 66, 30–36.

Collins, R. L., Ellickson, P. I., & Klein, D. J. (2007). The role of substance use in young adult divorce. Addiction, 102, 786-794.

Erola, J., & Kilpi-Jakonen, E. (2021). The role of partnering and assortative mating for income inequality: The case of Finland, 1991-2014. Acta Sociologica. e-pub ahead of print.

Frehch, A., & Williams, K. (2007). Depression and the psychological benefits of entering marriage. Journal of Health and Social Behavior, 48, 149–163.

Gan, Y., Gong, Y., Tong, X., Sun, H., Gong, Y., Dong, X., Wang, Y., Xu, X., Yin, X., Deng, J., Li, L., Cao, S., & Liu, Z. (2014). Depression and the risk of coronary heart disease: A meta-analysis of prospective cohort studies. BMC Psychiatry, 14, 371.

Grundy, E. M., & Tomassini, C. (2010). Marital history, health and mortality among older men and women in England and Wales. BMC Public Health, 10, 554.

van Hedel, K., Martikainen, P., Mountgourard, H., & Myrkylä, M. (2018). Cohabitation and mental health: Is psychotropic medication use more common in cohabitation than marriage? SSM Population Health, 4, 244-253.

Herttu, K., Martikainen, P., Valteera, J., & Kiivimäki, M. (2011). Living alone and alcohol-related mortality: A population-based cohort study from Finland. PLoS Medicine, 8, Article e1001094.

Jalovaara, M. (2013). Socioeconomic resources and the dissolution of cohabitations and marriages. European Journal of Population, 29, 167–193.

Jalovaara, M., & Anderson, G. (2018). Disparities in children’s family experiences by mother’s socioeconomic status: The case of Finland. Population Research and Policy Review, 37, 751–768.

Jalovaara, M., & Hull, K. (2018). Separation risk over union duration: An immediate itch. European Sociological Review, 34, 486–500.

Jee, Y., & Cho, Y. (2019). Health behaviors and health status of Korean middle aged men by marital status: Korea Community Health Study, 2015. Epidemiology and Health, 41, Article e2019019.

Joutneniemi, K., Martell, T., Kestila, L., Martikainen, P., Pirikka, S., & Koskinen, S. (2007). Living arrangements, heavy drinking and alcohol dependence. Alcohol and Alcoholism, 42, 480–491.

Kilpi, F., Silventoinen, K., Kontinen, H., & Martikainen, P. (2017). Early-life and adult socioeconomic determinants of myocardial infarction incidence and mortality. Social Science & Medicine, 177, 100–109.

Kulhmann, J., Bicagulape, A., Elkemo, T. A., Borrell, C., Regidor, E., Ennosa, S., Mackenbach, J. P., & Eurothine consortium. (2014). Why does Spain have smaller inequalities in mortality? An exploration of potential explanations. The European Journal of Public Health, 24, 370-377.

Lozano, R., Naghavi, M., Foreman, K., Lim, S., Shibuya, K., Aboyans, V., et al. (2012). Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: A systematic analysis for the global burden of disease study 2010. Lancet, 380, 2095–2128.
Martikainen, P., & Valkonen, T. (1996). Mortality after the death of a spouse: Rates and
Martelli, T., Nihtila, E., Majamaa, K., & Koskinen, S. (2005). Differences in mortality by marital status in Finland from 1976 to 2000: Analyses of changes in marital-status distributions, socio-demographic and household composition, and cause of death. Population Studies, 59, 99-115.
Martikainen, P., Martelin, T., Nihtilä, E., Majamaa, K., & Koskinen, S. (2005). Differences in mortality by marital status in Finland from 1976 to 2000: Analyses of changes in marital-status distributions, socio-demographic and household composition, and cause of death. Population Studies, 59, 99-115.
Metsähovi, P., Villari, P. M., Pirone, G., & Boccia, A. (2007). Marital status and mortality in the elderly: A systematic review and meta-analysis. Social Science & Medicine, 64, 77-94.
Manfredini, R., Manfredini, F., Mikhailidis, D. P., & Fabbian, F. (2017). Marital status, cardiovascular diseases, and cardiovascular risk factors: A review of the evidence. Journal of Women’s Health, 26, 624-632.
Manzoli, L., Villari, P. M., Pirone, G., & Boccia, A. (2007). Marital status and mortality in the elderly: A systematic review and meta-analysis. Social Science & Medicine, 64, 77-94.
Manzoli, L., Villari, P. M., Pirone, G., & Boccia, A. (2007). Marital status and mortality in the elderly: A systematic review and meta-analysis. Social Science & Medicine, 64, 77-94.
Moldovan, G. J., Stamatakis, E., Randall, G., & Hamer, M. (2009). Marital status, gender and cardiovascular disease: Behavioural, psychological distress and metabolic explanations. Social Science & Medicine, 69, 223-228.
Pajunen, P., Koukkunen, H., Ketonen, M., Jernkkola, T., Immonen-Raaja, P., Karja-Koskenkari, P., Mahonen, M., Niemela, M., Kuitasmaa, K., Palomaki, P., Mustonen, J., Lehtonen, A., Arstila, M., Vuorenmaa, T., Lehto, S., Miettinen, H., Torppa, J., Tuomilehto, J., Kesaniemi, Y. A., Pyorala, K., & Salomaa, V. (2005). The validity of the Finnish hospital discharge register and causes of death register data on coronary heart disease. European Journal of Cardiovascular Prevention & Rehabilitation, 12, 152-157.
Perelli-Harris, B., Berrington, A., Sánchez Gassen, N., Galewksa, P., & Holland, J. A. (2017). The rise in divorce and cohabitation: Is there a link? Population and Development Review, 43, 303-329.