

Sustainable working life before and after ischemic heart disease – a prospective cohort study of Swedish twins

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Abstract

This study explored sustainable working life before and after an ischemic heart disease (IHD) diagnosis, considering genetics and early life environmental factors, and explored differences by sex and common mental disorders (CMDs). A prospective cohort of Swedish twins aged 20–60 years included 1929 individuals diagnosed with IHD and 3858 matched controls. Sustainable working life was assessed using national register data over six years. Generalized estimating equations (GEE) were used to calculate odds ratios (OR) with 95% confidence intervals (CI). Conditional models for complete twin pairs accounted for genetic and early life environmental confounding. Analyses were stratified by sex and CMDs. We found that both those with and without IHD had a decreased probability of sustainable working life three years after the cohort entry year, with IHD patients showing a slightly lower probability. No significant differences were observed based on sex or CMDs. In conditional models, associations between IHD and sustainable working life were attenuated among monozygotic twins, suggesting genetic and early life environmental influences. IHD is associated with a lower probability of sustainable working life after diagnosis. Findings highlight the importance of considering genetic and early life factors in understanding the effects of IHD on sustainable working life.

Introduction

Ischemic heart disease (IHD) is the leading cause of global mortality each year [1]. Among the overall costs of IHD, indirect costs due to work productivity losses are significant [2]. In Sweden, approximately 10 000 working-age individuals younger than 65 years are hospitalized for IHD annually [3]. IHD in the working-age population often results in sickness absence (SA) and premature exit from the labor market, either through disability pension (DP) or fatal events [3]. IHD is the third largest diagnostic group for DP in Sweden, profoundly impacting patients and their families [3].

IHD is known to be linked to an increased risk of SA and DP, particularly among men [4–10]. However, there is a scarcity of research on achieving a sustainable working life for patients with IHD. The concept of sustainable working life, which is relatively new, can be defined as the absence of long-term SA, DP, and unemployment [11–15]. Exploring sustainable working life is anticipated to yield important information about both risk and protective factors for vulnerable groups, including those with IHD.

One of the challenges in previous research on IHD, SA, and DP is the presence of unmeasured confounding factors. Twin studies provide a robust method to explore genetic and early life environment influences on the associations. Twins are naturally matched on genetics (100% for monozygotic (MZ) twins and about 50% for dizygotic (DZ) twins) and early life environment (100% for both MZ and DZ twins reared together) [16]. These familial factors (i.e., genetics and early life environment), along with age and sex (for same-sex pairs), are critical in such analyses. IHD has an estimated heritability of 40%–60% [17]. Also, SA has a moderate genetic effects, accounting for 36–50% of the variance in both sexes [18, 19], while DP has a genetic component of 42–49% [20, 21]. In a recent study, sustainable working life was shown to be influenced by genetics by 18–36% [14]. Hence, it is reasonable to hypothesize that familial

factors may play a role in the association between IHD and sustainable working life. In addition to familial factors, individual environmental factors, such as socioeconomic status, significantly influence cardiovascular diseases [22] and sustainable working life [12, 15]. For instance, older age and male sex have been shown to be associated with a higher risk of cardiovascular death and morbidity [23]. Previous studies also indicate an association between low education and income levels and an increased risk of cardiovascular disease [24, 25].

Clinically, patients with IHD often present with multiple comorbidities, including diabetes mellitus, hypertension, cancer, musculoskeletal disorders, and chronic kidney disease [26]. These factors, which have not been extensively studied in the context of IHD and sustainable working life, are examined in this study. Among these comorbidities, common mental disorders (CMDs) such as depression, anxiety, and stress-related conditions are particularly significant. Research has shown that depressive disorders and the use of antidepressants are linked to a higher risk of IHD [27–29]. However, it remains unknown whether CMDs, either prior to or concurrent with IHD, affect future sustainable working life.

The study aimed to investigate: 1) Sustainable working life before and after an IHD diagnosis, comparing individuals with and without IHD while accounting for socio-demographic, social-economic factors, comorbidity and familial confounding factors (genetics and shared early life environment); and 2) Possible differences in these associations based on sex and CMDs.

Methods

Study population

This prospective twin cohort study utilized data from the Swedish Twin project Of Disability pension and Sickness absence (STODS), encompassing all twins born between 1925 and 1990 in Sweden. We included twins aged 20–60 years, residing in Sweden, and not receiving old-age or disability pensions at the time of cohort entry. The cohort entry year (t_0) was defined as the year of diagnosis for IHD patients, while for individuals without IHD, it matched the cohort entry year of their corresponding IHD patients. Ischemic heart disease (IHD) was defined as the first main or secondary diagnosis from inpatient or specialized outpatient care, using the International Classification of Diseases (ICD) version 10 (ICD-10) codes I11, I13, I20-25, I50-51, during the period 1997–2017. Each patient diagnosed with IHD was matched using exact matching without replacement to up to two reference individuals from the general twin cohort. Matching was based on age, sex, educational level, and marital status as of December 31 of the year preceding cohort entry (i.e., between 1997 and 2017). Matched individuals were randomly selected and had no history of inpatient or specialized outpatient care for IHD between 1994 and 2020. Individuals died or emigrated during the follow-up time were excluded (Fig. 1).

The final sample included 5787 twins, comprising 302 complete twin pairs: 218 same-sex dizygotic (DZ) twins, 144 opposite-sex DZ twins, 160 monozygotic (MZ) twins, and 82 twins of unknown zygosity. There were 100 twin pairs discordant for IHD, meaning one twin had IHD during 1997–2017, while the other did

not have IHD during 1994–2020. The sample was then stratified by sex and previous common mental disorders (CMDs). For stratification by previous CMDs, individuals with a main or secondary diagnosis of depressive disorders (ICD-10 codes F32, F33), anxiety disorders (ICD-10 codes F40-42), and stress-related disorders (ICD-10 codes F43) from inpatient or specialized outpatient care before year $t - 1$ were included.

Data source

Information on exposure, covariates, and outcomes was obtained from national register data and linked using the unique personal identification numbers of the participants:

- Swedish Social Insurance Agency: The MicroData for Analyses of Social insurance (MiDAS) register provided dates for all SA (lasting more than 2 weeks) and DP spells.
- Statistics Sweden: The Longitudinal Integration Database for Health Insurance and Labor Market Studies (LISA) register data on old-age pensions, unemployment, income, and socio-demographic variables [30].
- National Board of Health and Welfare: Data on the history of diagnosed diseases were collected from the Swedish National Patient Register, including dates and diagnoses for inpatient and specialized outpatient care, as well as dates and types of prescriptions, medication dispensing, and causes of death.

Outcomes

Sustainable working life was assessed using data on the main labor market status for each year between 1994 and 2020. The labor market statuses considered were:

- SA/DP: More than 180 days receiving SA or DP benefits.
- Unemployment: More than 180 days receiving unemployment benefits.
- Old-age pension: More than half of the yearly income derived from old-age pension.
- Employment: Engaged in paid work without meeting the criteria for SA/DP, unemployment, or old-age pension.

The annual status of sustainable working life was categorized as 'Yes' if individuals were employed, and 'No' otherwise, at each time point for three years before ($t - 3$ to $t - 1$), the cohort entry year (t_0), and three years after ($t + 1$ to $t + 3$) the cohort entry year.

Covariates

Sex (male, female), age (continuous variable), levels of education (highest level of completed education, classified into elementary (< 10 years of education), high school (10–12 years in education) and

university/college (> 12 years in education)), marital status (unmarried, married) at cohort entry year and comorbidities before cohort entry year were used as covariates. Comorbidity was measured as any main or secondary diagnosis from inpatient or specialized outpatient care due to diabetes (ICD-10 codes: E10-E14 and the Anatomic Therapeutic Chemical classification system (ATC) code: A10), musculoskeletal diagnoses (ICD-10 codes: M00-99), renal insufficiency (ICD-10 codes: N17-N19), hypertension (ICD-10 codes: I10), stroke (ICD-codes: I60, I61, I63, I64), cancer (ICD-10 codes: C00-D48), other somatic disorders (ICD-10 codes: A00-B99, D50-E07, E15-E90, G00-H95, J00-L99, N00-N16, N20-O75, O85-O99, Q00-T98), common mental disorders (ICD-10 codes F32, F33, F40-42, F43) and other mental disorders (ICD-10 codes F00-99 other than F32, F33, F40-42, F43). Income from work, including social benefits, was measured at each time point in the 3 years before ($t - 3$ to $t - 1$) and 3 years after ($t + 1$ to $t + 3$) the cohort entry year, as well as at cohort entry year (t_0).

Statistical analyses

Statistical differences in the distributions of variables related to socio-demographic factors, zygosity, income, comorbidities, and sustainable working life were assessed using χ^2 -tests and Student's t tests. P-values less than 0.001 were considered statistically significant.

The observation period covered three years before and three years after the cohort entry year (t_0), specifically from $t - 3$ to $t - 1$ and from $t + 1$ to $t + 3$. To account for variations in covariates between the groups, the adjusted probability of sustainable working life was calculated using least square means over a seven-year period. To estimate the probability of sustainable working life days before ($t - 3$ to $t - 1$), around ($t - 1$ to $t + 1$), and after ($t + 1$ to $t + 3$) the cohort entry year, repeated measures regression with a generalized estimating equations (GEE) method and an exchangeable correlation structure was used to produce odds ratios (ORs) and 95% confidence intervals (CIs) between the compared time points within specific groups (i.e., 'IHD' and 'No IHD') [31]. The estimates were calculated based on the differences in the adjusted means between the compared time points. Socio-demographic, socio-economic factors and comorbidities were adjusted in the model. Income at each time point was categorized as a binary variable based on the mean income (272 941 SEK) to mitigate convergence issues. Additionally, renal insufficiency, hypertension, stroke, and diabetes were combined due to low numbers to further reduce convergence issues.

To evaluate the impact of familial confounding (genetics and early life environment) on the association between IHD and sustainable working life, co-twin analyses using a conditional GEE model were performed. Complete same-sex monozygotic (MZ) and dizygotic (DZ) twin pairs discordant for the diagnosis of IHD (100 twin pairs) were included in the analyses. The confounding influence of genetic factors and shared early life environment can be fully controlled in discordant twin pairs in the conditional GEE model. MZ twins share 100% of their genetic factors, while DZ twins share 50%, and both share 100% of their common rearing environment. Therefore, if the association observed in the unconditional analysis is attenuated in analyses of discordant twin pairs, it suggests that genetic factors and early life environment influence the association [32].

All analyses were conducted using SAS Statistical Software version 9.4.

Ethics approval

This study was approved by the Regional Ethical Review Board in Stockholm, Sweden (Dnr 2007/524 – 31; 2010/1346-32-5; 2014/311 – 32; 2017/128 – 32) and the Swedish Ethical Review Authority (2022-03878-02). All methods were performed in accordance with the relevant guidelines and regulations.

Informed consent

The study population was based on linkage of several public national registers. Ethical vetting is always required when using register data in Sweden. The ethical vetting is performed by regional ethical review boards (i.e., the Regional Ethical Review Board in Stockholm, Sweden and the Swedish Ethical Review Authority) and the risk appraisal associated with the Law on Public Disclosure and Secrecy is done by data owners (Statistics Sweden, the National Board of Health and Welfare, and the Social Insurance Agency). The Regional Ethical Review Board in Stockholm and the Swedish Ethical Review Authority can however waive the requirement to consult the data subjects (or in case of minors/children the next of kin, careers or guardians) directly to obtain their informed consent, and will often do so if the research is supported by the ethical review board and the data has already been collected in some other context. This means that for this specific study no written informed consent was required from participants (or next of kin/caregiver in the case of children) for their clinical records to be used. Patient records/information were anonymized and de-identified prior to analysis by the authority, Statistics Sweden, the National Board of Health and Welfare, and the Social Insurance Agency, who were responsible for data linkage. Researchers received de-identified data. This study was approved by the Regional Ethical Committee of Stockholm, and by the Ethical Committees of the data providers.

Results

Table 1 presents the socio-demographic characteristics, income, comorbidities, and sustainable working life of women and men with and without IHD. Generally, women were younger, particularly those without IHD (mean age: 50.3 years, SD: 8.8). Additionally, women had more often high educational level (29.9% vs. 21.7% for men) but lower income compared to men. Before the cohort entry year (t_0), 55.9% of women and 49.1% of men had inpatient or outpatient care for other somatic disorders. However, most of the sample did not have a somatic or mental diagnosis from inpatient or outpatient care before the cohort entry year. Overall, a higher proportion of women were diagnosed with cancer (14.6% vs, 6.1% for men) based on data from inpatient or outpatient care registries.

The adjusted probability of sustainable working life three years before and three years after inclusion in the IHD and non-IHD groups is illustrated in Fig. 2. Both groups exhibited a relatively constant trend in sustainable working life before the cohort entry year. However, after t_0 , both groups experienced a

decline in the probability of sustainable working life. Individuals with IHD showed a slightly lower probability of sustainable working life than those without IHD from $t - 1$ onwards (Fig. 2).

Table 2 displays the ORs of sustainable working life among individuals with and without IHD, stratified by sex and previous CMDs while adjusting for covariates. The results indicate a relatively stable slope from $t - 3$ to $t - 1$, with a downward trend from $t - 1$ to $t + 1$ and from $t + 1$ to $t + 3$. In general, individuals showed significantly lower ORs of sustainable working life from $t - 1$ to $t + 1$ and from $t + 1$ to $t + 3$ compared to the period from $t - 3$ to $t - 1$. Particularly, individuals with IHD showed a slightly lower trend of sustainable working life (RR: 0.46, 95% CI: 0.40–0.54) than those without IHD (RR: 0.76, 95% CI: 0.66–0.86) from $t - 1$ to $t + 1$. No significant differences were observed between sex and previous CMD subgroups.

Table 3 shows the ORs of sustainable working life among IHD discordant twin pairs. Similar patterns were observed in the main analyses, with a steeper decline in sustainable working life from $t - 1$ to $t + 1$ and from $t + 1$ to $t + 3$, particularly among twins with IHD. However, all results became non-significant among MZ twins, suggesting an influence from familial factors on the association between IHD and sustainable working life.

Discussion

This study aimed to investigate the impact of ischemic heart disease (IHD) on sustainable working life, defined as the absence of long-term sickness absence (SA), disability pension (DP), and unemployment, using a sample of 5787 Swedish twins. We also examined the influence of familial factors, sex, and common mental disorders (CMDs) on the association between IHD and sustainable working life. The findings provide valuable insights into the challenges faced by individuals with IHD in maintaining a sustainable working life and highlight the importance of considering genetic and early life environment factors in this context.

Both individuals with IHD and those without IHD experienced a decline in sustainable working life three years after the cohort entry year, even after controlling for socio-demographic, socio-economic factors, and comorbidities. However, the decline was more pronounced in individuals with IHD, indicating that IHD affects the ability to maintain a sustainable working life. Previous studies have consistently shown that IHD is associated with an increased risk of work disability [4–10]. For instance, a Swedish cohort study found that an IHD event was strongly associated with an increase in work disability, particularly in the first post-diagnosis year [8]. According to the SWEDEHEART (Swedish Web-system for Enhancement and Development of Evidence-based Care in Heart Disease Evaluated According to Recommended Therapies) national quality register, after percutaneous coronary intervention, patients are typically on sick leave for 2–4 weeks, while coronary artery bypass surgery usually leads to a sick leave of 2.5–3 months [3]. In our study, a decline in sustainable working life was observed even three years after the first IHD diagnosis, reflecting deteriorated health conditions or poor rehabilitation in this patient group. This prolonged impact suggests that the initial health event has long-term consequences on an

individual's ability to maintain a sustainable work capacity. The link between IHD and sustainable working life could also be due to uncontrolled confounding factors such as occupations and work environment. For example, individuals in physically demanding jobs may find it more challenging to return to work after an IHD event compared to those in less physically demanding roles [33]. Additionally, work environment factors such as stress levels, support from employers, and workplace accommodation can play a significant role in an individual's ability to maintain a sustainable working life post-diagnosis [34, 35]. This, however, warrants further research to explore these factors in more detail.

Previous studies have also underscored the complex association between IHD and CMDs. For instance, conditions such as diabetes, heart disease, and stroke have been linked to an elevated risk of depression [36–38], and research suggests that men and women may experience different risks and outcomes related to IHD [39]. Our study builds on this existing body of knowledge by specifically addressing the impact of sex and CMDs on sustainable working life among IHD patients. However, we found no significant differences in sustainable working life trends based on sex or the presence of CMDs. Instead, our results suggest that the influence of IHD on sustainable working life remains consistent regardless of sex and CMDs.

Although it is widely accepted that genetic background and early life environmental factors are of importance for SA/DP as well as for the development of IHD, few studies have assessed the roles of these factors in the association between IHD and sustainable working life. The co-twin analyses of this study revealed that familial factors influence the association between IHD and sustainable working life. Specifically, the results among MZ twins, who share 100% of their genetics and common rearing environment, were non-significant, suggesting that genetic factors may mitigate the impact of IHD on sustainable working life. This finding underscores the importance of considering familial influences when examining the association between IHD and sustainable working life. Results also highlight the need for future research to delve deeper into how these genetic and environmental factors interact to affect individuals' ability to maintain a sustainable working life despite the presence of IHD. By doing so, we can better understand the underlying mechanisms and potentially develop more targeted interventions to support those affected by IHD in their working careers.

The strengths of this study include its population-based cohort design, which allows for a thorough examination of the role of IHD in sustainable working life. Utilizing high-quality nationwide register data minimizes recall bias, ensuring comprehensive and accurate information on sustainable working life and diagnoses. This improves the validity and reliability of the findings. Additionally, the long follow-up period (1994–2020) offers a comprehensive view of the long-term impact of IHD on sustainable working life. Another notable strength is the use of a twin cohort, which provides a robust method for examining the influence of familial factors on the association between IHD and sustainable working life. However, the observed pattern among MZ twins should be interpreted with caution. The MZ group represents less than 25% of the total sample, which results in substantially wider confidence intervals and reduced statistical power. Therefore, the lack of significance among MZ twins may reflect sample size limitations rather than true absence of association.

Despite its strengths, the study has several limitations. First, the absence of data from primary care could result in an underestimation of CMD diagnoses in the study. Future research should address these gaps to provide a more comprehensive understanding of how CMDs affect the working life of individuals with IHD. However, since the majority of IHD cases are treated in hospitals, the lack of primary healthcare data for IHD is likely to have only a minor impact on our results. Second, even though several covariates were included, there may be other factors that are not possible to examine in the present study that are associated with both IHD and sustainable working life. Such factors include lifestyle (e.g., smoking, physical activity), workplace characteristics (e.g., work demands, work stress) and recurrent IHD [40]. Future research should aim to include a broad spectrum of factors to provide a more comprehensive understanding of the association between IHD and sustainable working life.

In conclusion, our study indicates that those with IHD in working ages experience a decline in sustainable working life post-diagnosis. Familial factors (genetics and early life environmental factors) seem to influence this association. Our findings highlight the significance of accounting for genetic factors and early life environment when examining the impact of IHD on sustainable working life.

Declarations

Competing Interests Statement

The Authors declare that there is no conflict of interest.

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Author Contribution

AR, MW, PS, and TI conceived and designed the study. MW conducted the statistical analysis and drafted the manuscript. All authors contributed to the analytic plan, interpretation of results and participated in revising the manuscript. All authors read and approved the final manuscript.

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We acknowledge the Swedish Twin Registry (STR) for access to twin data.

Data Availability

The data that support the findings of this study are available from the original sources: the Swedish Twin Registry, Statistics Sweden, Swedish Social Insurance Agency and the Swedish National Board of Health and Welfare. Restrictions apply to the availability of the data used in this study based on the Swedish Twin project Of Disability pension and Sickness absence (STODS), which were used with ethical permission for the current study and therefore are not publicly available.

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Tables

Table 1

Frequencies of socio-demographic factors, zygosity, comorbidities, and sustainable working life among total participants and between group of individuals with ischaemic heart disease (IHD) and without.

	All		Twins with IHD		Twins without IHD	
	Men N = 4092	Women N = 1695	Men N = 1364	Women N = 565	Men N = 2728	Women N = 1130
Variables	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Age (Mean, SD)	51.2 (7.6)	50.6 (8.6)	52.0 (7.1)	51.4 (8.1)	50.8 (7.9)	50.3 (8.8)
Zygosity						
Monozygotic	849 (20.7%)	417 (24.6%)	289 (21.2%)	138 (24.4%)	560 (20.5%)	279 (24.7%)
Dizygotic same sex	1262 (30.8%)	524 (30.9%)	411 (30.1%)	184 (32.6%)	851 (31.2%)	340 (30.1%)
Dizygotic opposite sex	1486 (36.3%)	613 (36.2%)	501 (36.7%)	198 (35.0%)	985 (36.1%)	415 (36.7%)
Unknown zygosity	495 (12.1%)	141 (8.3%)	163 (12.0%)	45 (8.0%)	332 (12.2%)	96 (8.5%)
Education (years) *						
Elementary education (< 10)	1158 (28.3%)	291 (17.2%)	386 (28.3%)	97 (17.2%)	772 (28.3%)	194 (17.2%)
Medium education (10–12)	2046 (50.0%)	897 (52.9%)	682 (50.0%)	299 (52.9%)	1364 (50.0%)	598 (52.9%)
Higher education (> 12)	888 (21.7%)	507 (29.9%)	296 (21.7%)	169 (29.9%)	592 (21.7%)	338 (29.9%)
Marital status						
Married	2229 (54.5%)	936 (55.2%)	743 (54.5%)	312 (55.2%)	1486 (54.5%)	624 (55.2%)
Unmarried	1863 (45.5%)	759 (44.8%)	621 (45.5%)	253 (44.8%)	1242 (45.5%)	506 (44.8%)
Income (k SEK) (Mean, SD) *						
Pre-Inclusion Period	296 (225.4)	224 (123.7)	283 (162.2)	221 (127.7)	303 (250.9)	226 (121.7)
* Significant between group differences tested by Chi ² or t-test at level of p < 0.001.						

	All		Twins with IHD		Twins without IHD	
	Men N = 4092	Women N = 1695	Men N = 1364	Women N = 565	Men N = 2728	Women N = 1130
Variables	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
At Inclusion Period	308 (225.9)	232 (134.8)	282 (177.2)	220 (142.6)	321 (245.7)	238 (130.4)
Post-Inclusion Period	309 (264.4)	239 (143.1)	273 (190.0)	217 (149.6)	327 (293.3)	250 (138.5)
Somatic disorders						
Diabetes	114 (2.8%)	46 (2.7%)	70 (5.1%)	30 (5.3%)	44 (1.6%)	16 (1.4%)
Musculoskeletal disorders	691 (16.9%)	292 (17.2%)	265 (19.4%)	134 (23.7%)	426 (15.6%)	158 (14.0%)
Renal insufficiency	17 (0.4%)	7 (0.4%)	12 (0.9%)	4 (0.7%)	5 (0.2%)	3 (0.3%)
Stroke	27 (0.7%)	12 (0.7%)	13 (1.0%)	8 (1.4%)	14 (0.5%)	4 (0.4%)
Hypertension	145 (3.5%)	55 (3.2%)	91 (6.7%)	43 (7.6%)	54 (2.0%)	12 (1.1%)
Cancer *	250 (6.1%)	248 (14.6%)	79 (5.8%)	96 (17.0%)	171 (6.3%)	152 (13.5%)
Other somatic disorders *	2008 (49.1%)	948 (55.9%)	730 (53.5%)	357 (63.2%)	1278 (46.8%)	591 (52.3%)
Mental disorders						
Common mental disorders	117 (2.9%)	68 (4.0%)	48 (3.5%)	34 (6.0%)	69 (2.5%)	34 (3.0%)
Other mental disorders	161 (3.9%)	54 (3.2%)	72 (5.3%)	24 (4.2%)	89 (3.3%)	30 (2.7%)
Sustainable working life						
Pre-Inclusion Period	3918 (95.7%)	1608 (94.9%)	1286 (94.3%)	529 (93.6%)	2632 (96.5%)	1079 (95.5%)
At Inclusion Period	3726 (91.1%)	1539 (90.8%)	1195 (87.6%)	491 (86.9%)	2531 (92.8%)	1048 (92.7%)
Post-Inclusion Period	3741 (91.4%)	1540 (90.9%)	1184 (86.8%)	484 (85.7%)	2557 (93.7%)	1056 (93.5%)
* Significant between group differences tested by Chi ² or t-test at level of p < 0.001.						

Table 2

Relative risk (RR) with confidence intervals (CI) of trends in sustainable working life¹ among twins with ischaemic heart disease (IHD) and without IHD in whole sample and stratified by sex and previous common mental disorders (CMDs).

	Pre-Inclusion Period (Year t – 1 vs. t – 3*)	Near-Inclusion Period (Year t + 1 vs. t – 1*)	Post-Inclusion Period (Year t + 3 vs. t + 1*)
	RR (95% CI)	RR (95% CI)	RR (95% CI)
All			
IHD	0.89 (0.76–1.04)	0.46 (0.40–0.54)	0.63 (0.56–0.70)
No diagnosis of IHD	0.87 (0.76–1.00)	0.76 (0.66–0.86)	0.60 (0.53–0.67)
Men			
IHD	0.94 (0.78–1.13)	0.47 (0.39–0.56)	0.61 (0.53–0.70)
No diagnosis of IHD	0.89 (0.75–1.06)	0.74 (0.63–0.87)	0.61 (0.53–0.70)
Women			
IHD	0.78 (0.57–1.05)	0.45 (0.32–0.63)	0.63 (0.50–0.79)
No diagnosis of IHD	0.84 (0.69–1.03)	0.80 (0.66–0.98)	0.58 (0.48–0.70)
With previous CMDs			
IHD	0.73 (0.47–1.13)	0.83 (0.47–1.48)	0.96 (0.60–1.53)
No diagnosis of IHD	0.78 (0.40–1.49)	0.97 (0.51–1.86)	0.41 (0.24–0.72)
Without previous CMDs			
IHD	0.91 (0.77–1.07)	0.43 (0.37–0.51)	0.61 (0.54–0.68)
No diagnosis of IHD	0.88 (0.76–1.01)	0.75 (0.66–0.85)	0.60 (0.54–0.68)
* Reference year			
¹ Adjusted for sex, age, education, marital status, income, diabetes, musculoskeletal disorders, renal insufficiency, stroke, hypertension, cancer, other somatic disorders and mental disorders			
Note: 1) In the stratified analysis with sex, sex was not adjusted in the model. 2) In the stratified analysis with previous CMDs, previous CMDs was not adjusted in the model.			

Table 3

Relative risk (RR) with confidence intervals (CI) of trends in sustainable working life among twin pairs discordant for ischaemic heart disease.

	Pre-Inclusion Period (Year t – 1 vs. t – 3*)	Near-Inclusion Period (Year t + 1 vs. t – 1*)	Post-Inclusion Period (Year t + 3 vs. t + 1*)
	RR (95% CI)	RR (95% CI)	RR (95% CI)
All discordant twins			
IHD	1.00 (0.71–1.40)	0.40 (0.22–0.71)	0.64 (0.48–0.86)
No diagnosis of IHD	0.39 (0.09–1.61)	0.82 (0.35–1.92)	1.21 (0.63–2.33)
DZ ^a twins			
IHD	1.00 (0.64–1.55)	0.44 (0.23–0.87)	0.63 (0.43–0.90)
No diagnosis of IHD	0.24 (0.04–1.34)	0.65 (0.35–1.18)	1.00 (0.60–1.66)
MZ ^b twins			
IHD	1.00 (1.00–1.00)	0.15 (0.02–0.98)	0.76 (0.46–1.28)
No diagnosis of IHD	0.47 (0.11–2.05)	1.00 (0.21–4.81)	2.13 (0.49–9.33)
* Reference year			
^a DZ: Dizygotic twins.			
^b MZ: Monozygotic twins.			

Figures

Study population

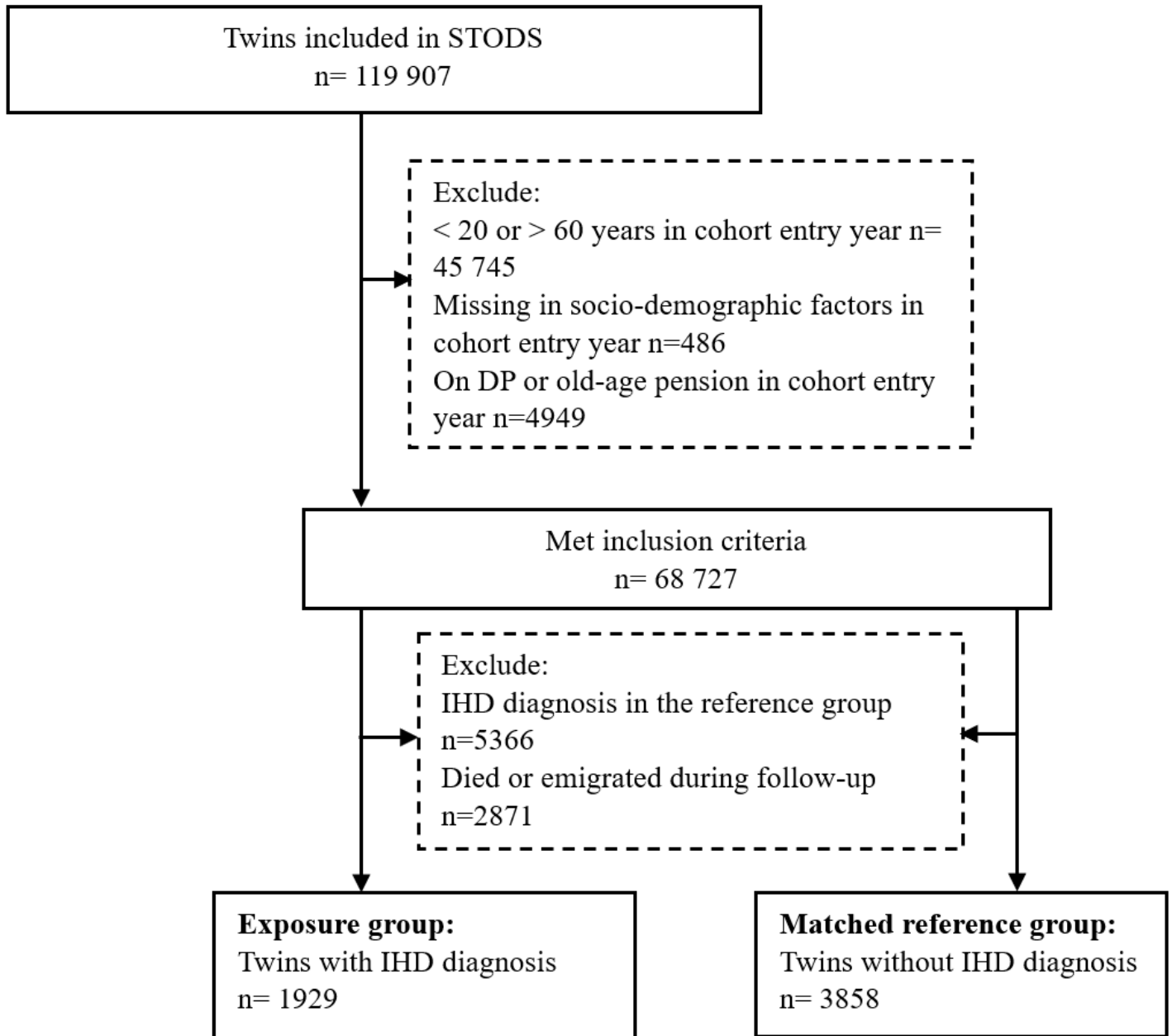


Figure 1

Flow chart for the study population.

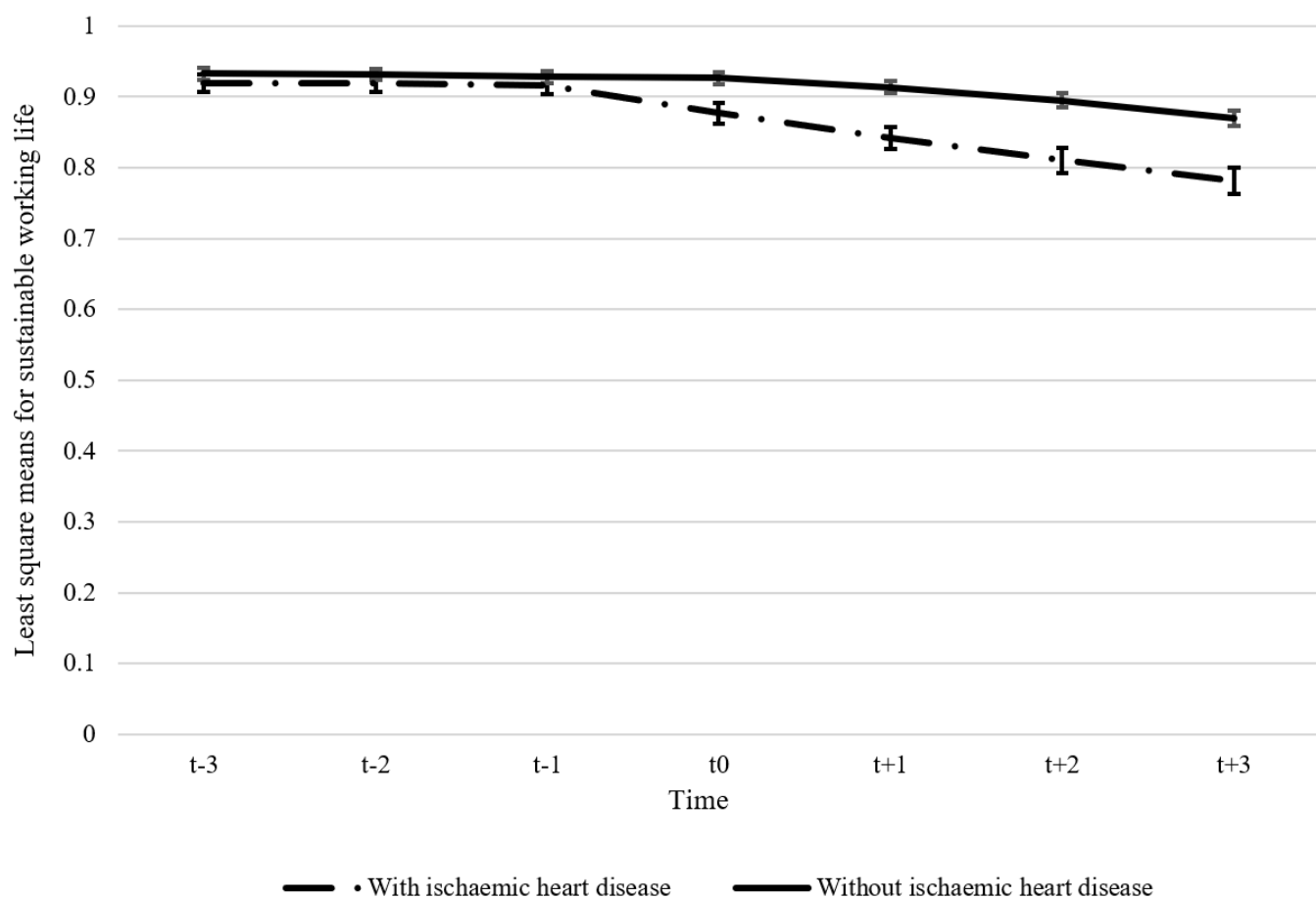


Figure 2

Adjusted probability of sustainable working life among twins aged 20-60 years, living in Sweden, with ischaemic heart disease during 1997-2017 or without ischaemic heart disease during 1994-2020. Adjusted for sex, age, education, marital status, income, diabetes, musculoskeletal disorders, renal insufficiency, stroke, hypertension, cancer, other somatic disorders and mental disorders.