BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-017910
Article Type:	Research
Date Submitted by the Author:	26-May-2017
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Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Cardiovascular medicine, Occupational and environmental medicine, Public health
Keywords:	Ischaemic heart disease < CARDIOLOGY, Stroke < NEUROLOGY, EPIDEMIOLOGY, OCCUPATIONAL & INDUSTRIAL MEDICINE

Permanent work disability before and after ischemic heart disease or stroke event: A nationwide population-based cohort study in Sweden

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ABSTRACT

Objectives: We examined the risk of disability pension before and after ischemic heart disease (IHD) or stroke event, the burden of stroke compared to IHD, and which factors predicted disability pension after either event.

Design: A population cohort study with follow-up five years before and after the event. Register data were analysed with logistic and Poisson regression models including interaction tests for event type (IHD/stroke).

Setting and participants: All people living in Sweden, aged 25−60 years at the event year, who had been living in Sweden for five years before the event and had no indication of IHD or stroke prior to the index event in 2006−2008 were included, except for cases in which death occurred within 30 days of the event. People with both IHD and stroke were excluded, resulting in 18 480 cases of IHD (65%) and 9750 stroke cases (35%).

Primary outcome measures: Disability pension.

Results: Of those going to suffer IHD or stroke event, 25% were already on disability pension a year before the event. The adjusted odds ratio (OR) for disability pension was 2.64 fold (95% CI 2.25-3.11) for people with stroke compared to IHD at first post-event year. Economic inactivity predicted disability pension regardless of event type (OR=3.40; 95% CI 2.85-4.04). Comorbid mental disorder was associated with the greatest risk (OR=3.60; 95% CI 2.69-4.83) after an IHD event. As regards stroke, medical procedure, a proxy for event severity, was the largest contributor (OR=2.27, 95% CI 1.43-3.60).

Conclusions: While IHD event was more common, stroke caused more permanent work disability. Demographic, socioeconomic and comorbidity -related factors predicted disability

pension both before and after the event. The results help occupational and other health care professionals to identify vulnerable groups at risk for permanent exclusion from labour market after such an event.

Keywords: Cardiovascular disease; Cohort studies; Ischemic heart disease; Occupational Health; Stroke

Strengths and limitations of this study:

- With large population-based cohort data with reliable register-based measures and no loss to follow up, we provided information about how ischemic heart disease (IHD) and stroke events were linked with risk of permanent work disability, i.e., disability pension.
- Compared to previous studies focusing on IHD, we had a longer follow up – five years – both before and after the event.
- We were able to include a large set of predictors of disability pension, including sociodemographic factors, comorbid conditions, and medical procedure.
- The results may help when planning preventive measures for permanent work disability after IHD or stroke event.
- As we were only able to include information that was available in administrative registers, we had no data on quality and outcome of post-event care, individuals' health behaviours or workplace psychosocial factors.

INTRODUCTION

Worldwide, 11% of the total disease burden as measured with disability-adjusted life years, is attributed to ischemic heart disease (IHD) and stroke.[1] Due to improved treatment of both IHD and stroke contributing to declining mortality,[2] and because of the pressures of extended working careers, the proportion of working-age people with cardiovascular disease is likely to increase. While 53-73% of people suffering a cardiovascular event return to work,[3-6] significantly higher proportion leaves working life permanently during the years following a cardiovascular event than among people without such disability.[7] In order to help people with this disability to continue working, it is important to study the risk factors leading to permanent work disability (i.e., disability pension) after a cardiovascular event.

Disease severity, comorbidity, female sex, higher age, and lower socioeconomic status have been found to predict disability pension after an IHD event.[7-12] However, we found no previous research that specifically examined the predictors of disability pension after a stroke event. Research on stroke has focused on return to work, which has been associated with a less serious disability, younger age, higher socioeconomic position, and less cardiovascular risk factors.[4-6] While IHD and stroke share several common risk factors, some discrepancies also point to differential pattern of predictors.[13] Previous studies have not examined whether differences exist between the predictors of disability pension after IHD and stroke events.

Our aim was to (a) determine the proportion and characteristics of people who suffered an IHD or stroke event at working age who were initially on disability pension prior to the event; and (b) examine the medical (comorbidity, event severity) and non-medical

(demographic and socioeconomic) predictors of disability pension in the first post-event year, including examining difference in IHD and stroke cases.

From a labour force policy perspective, it is important to determine whether the predictors of disability pension shortly after the event are different from those that predict disability pension in the longer run. Thus, as a sensitivity analysis, we studied the medical and non-medical predictors of disability pension in the fifth post-event year and whether there were differences between IHD and stroke cases.

METHODS

Study design

The study was a part of the Insurance Medicine All Sweden project, approved by the Regional Ethical Review Board, Stockholm, Sweden. Data are obtained from Swedish authorities and from several administrative registers and linked using the personal identity number assigned to all residents in Sweden. The following registers were used:

1. Statistics Sweden: Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA) on sex, age, education, family situation, place of birth, type of living area, and labour market activity
2. National Board of Health and Welfare: diagnosis-specific data on hospitalizations and specialized outpatient care (coded according to the International Classification of Diseases (ICD-10)[14]; medical procedures; cancer register; date of death
3. National Social Insurance Agency: Annual sickness absence data (pre-event) and disability pension data.

Our study cohort consisted of all people living in Sweden, who at the event year were aged 25 to 60 years, had been living in Sweden for five years before the event, and had no indication of cardiovascular events in the registers between 2001 and the event year. First event dates in 2006, 2007, and 2008 were included, except for cases in which death occurred within 30 days of the event. This resulted in a sample of 28 374 cases. The data on cumulative disability pension were gathered five years prior to the event date, and five years

after the event. People with both IHD and stroke were excluded (n=144), resulting in 18 480 cases of IHD and 9750 stroke cases.

In prospective analyses on the predictors of disability pension in the first and fifth post-event year, individuals already on disability pension at the time of the event and people with more than 730 sickness absence days (two years) prior to the event were excluded (n=7547), resulting in a cohort of 20 683 individuals. Those who died were excluded from the death year onwards. This resulted in a final sample of 20 498 individuals for analyses of the onset of disability pension during the first post-event year (185 individuals died during the first year), and 19 771 for analysis of the onset of disability pension in the fifth post-event year (912 individuals died during the five subsequent years). Supplementary Figure 1 shows a flow chart of inclusion and exclusion criteria regarding each of the study questions.

Measures

An IHD event was based on hospitalization for myocardial infarction or other IHD, excluding angina pectoris (i.e., codes I21–I25 were included). A stroke event was based on hospitalization for stroke (ICD-10 codes I60, I61, I63, and I64).

For the outcome, annual data on granted disability pensions were gathered. In Sweden, all individuals aged 30 to 64, including people with no previous income, can be granted disability pension if their working capacity is permanently reduced owing to disease or injury. Individuals aged 19 to 29 can be granted temporary disability pension in cases of reduced work capacity or in order to complete compulsory education.

The predictors of disability pension, all measured in the event year, were age, sex, education, economic inactivity, type of living area, family situation, birth country, mental disorder, cancer, diabetes, and medical procedure during the event. Age was dichotomized as "50 years or less" and "more than 50 years". Education was classified as "low" (<10 years), "intermediate" (10–12 years) or "high" (>12 years). Economic activity was coded as "economically active" (in paid work) or "economically inactive" (not in paid work, including for example the unemployed, students, and those on parental leave). Family situation was classified as "married/cohabiting", "not married/cohabiting without children" (i.e., single), or "not married/cohabiting with children" (i.e., single parent). Birth country was dichotomized into "Sweden" or "country other than Sweden". Type of living area was classified as "large city", "medium-sized town", or "small town/village".

Cancer (ICD-10 codes C00-D48) was based on information in the cancer register, and mental disorders (F00-F99) and diabetes (E10-E14) were based on information from the patient register (inpatient and specialized outpatient care). All the diseases were coded "yes" or "no"

Medical procedures at T-1 (year prior to the event) or T1 (year after the event) included coronary artery bypass graft, percutaneous transluminal coronary angioplasty, other coronary distension procedure, or intravenous intracranial procedure. People who had undergone at least one such procedure were coded "yes" and those without "no".

Statistical analysis

The cumulative incidence trend in disability pension five years before and five years after the event was calculated with frequencies (percentage of individuals on disability pension each

year with 95% confidence intervals [CI]) and between-group differences in disability pension were tested with Chi^2 tests. To assess the risk of new disability pension during the first year after the event (outcome incidence 3%), we used logistic regression with a logit link function, which produced odds ratios (OR) with 95% CI. To examine the differences between the predictors of disability pension for IHD and stroke cases, we tested the effect modification of event type (IHD/stroke) and each of the predictors. When a statistically significant ($p<0.05$) interaction effect was observed, we performed stratified analyses. Least square means adjusted for all predictor variables were produced using Poisson regression analysis.

In sensitivity analyses, we used the Poisson regression procedure with a log link function to produce relative risks (RR) with 95% CI to estimate predictors of disability pension in the fifth year after the cardiovascular event (outcome incidence 18%). Different regression methods were used for the fifth and the first post-event year since OR is not a good approximation of risk ratio when outcome prevalence is above 10%.[15] SAS 9.4 was used for all analyses.

RESULTS

Cumulative incidence of disability pension

Figure 1 illustrates the cumulative incidence of disability pension five years before and five years after a cardiovascular event of IHD or stroke: The cumulative incidence of disability pension was similar (up to 25%) until the event for both IHD and stroke. Thus, about a quarter of working-age people who had suffered incident IHD or a stroke were already on disability pension before the event. The highest prevalence of pre-event disability pension was observed among women (37%), people who were economically inactive (69%), had low education (36%), were born outside Sweden (35%), and had comorbid cancer (36%), mental disorder (58%), or diabetes (48%) at event year (Table 1).

After the event, the cumulative incidence of disability pension was substantially higher (reaching 50%) among people who suffered a stroke event than among those who suffered an IHD event (slightly above 30%) (Figure 1). Similar characteristics were associated with first and fifth post-event year disability pensioning, as observed before the event (Table 1.)

Table 1. Characteristics of study participants by disability pension before and after a cardiovascular (ischemic heart disease or stroke) event

		Pre-event disability pension			Disability pension in first post-event year			Disability pension in fifth post-event year		
			No (n=20683)	Yes (n=7547)		No (n=19802)	Yes (n=696)		No (n=16317)	Yes (n=3454)
Characteristics		n	%	%	n	%	%	n	%	%
Sex:	Men	19713	78	22	15222	97	3	14661	85	15
	Women	8517	63	37	5276	96	4	5110	74	26
Age:	≤50 years	8332	79	21	6575	97	3	6412	85	15
	>50 years	19898	71	29	13923	96	4	13359	81	19
Education:	Low	7854	64	36	4981	95	5	4774	80	20
	Intermediate	14095	73	27	10274	97	3	9902	83	17
	High	6281	84	16	5243	97	3	5095	84	16
Economically:	Active	20076	91	9	18045	97	3	17460	85	15
	Inactive	8154	31	69	2453	90	10	2366	75	25
Family	Married/cohab.	16121	78	22	12513	97	3	12181	84	16
	Single, no childr.	10310	66	34	6693	96	4	6339	81	19
	Single, childr.	1799	72	28	1292	97	3	1251	80	20
Birth country:	Sweden	23126	75	25	17198	97	3	16582	83	17
	Other	5104	65	35	3300	95	5	3189	80	20
Living area:	Large city	9163	75	25	6776	97	3	6527	84	16
	Medium-size	10019	73	27	7212	97	3	6979	82	18

	Small town	9048	73	27	6510	96	4	6265	82	18
Cancer:	Yes	847	64	36	482	93	7	382	75	25
	No	27383	74	26	20016	97	3	19389	83	17
Mental disorder:	Yes	3286	42	58	1352	90	10	1236	71	29
	No	24944	77	23	19146	97	3	18535	83	17
Diabetes:	Yes	2887	52	48	1490	94	6	1381	75	25
	No	25343	76	24	19008	97	3	18390	83	17
Procedure*:	Yes	3077	78	22	2379	97	3	2318	85	15
	No	25153	73	27	18119	97	3	17453	82	18
Type of event:	IHD	18480	73	27	13450	98	2	13028	91	9
	Stroke	9750	73	27	7048	94	6	6743	67	33

*Medical procedure=coronary artery bypass graft, percutaneous transluminal coronary angioplasty, other coronary distension procedure, or intravenous intracranial procedure

Note. All p-values for difference between groups (Chi^2) were <0.01 except for 'pre-event disability pension and type of event', 'disability pension during the event year and living area', and 'disability pension during the event year and medical procedure.

New-onset disability pension in first post-event year

Table 2 presents the both the unadjusted and adjusted results on factors associated with the risk of disability pension during the first post-event year. After adjustment for sociodemographic factors, comorbid conditions and medical procedures, stroke patients were at a higher risk of disability pension during the first post-event year than people who had suffered an IHD event (OR=2.79; 95% CI 2.37-3.29). Among both IHD and stroke patients, older age (OR=1.66; 95% CI 1.38-1.98), low education (OR=1.58; 95% CI 1.27-1.97), economic inactivity (OR=3.40; 95% CI 2.85-4.04), being single without children (OR=1.25; 95% CI 1.06-1.48), birth country other than Sweden (OR=1.27; 95% CI 1.04-1.55), living in small towns (OR=1.32; 95% CI 1.08-1.61), and comorbid cancer (OR=1.85; 95% CI 1.27-2.69) were associated with higher odds of disability pension in the first post-event year.

Table 2. Predictors of disability pension during first year after cardiovascular event. In case of significant interaction ($p<0.05$), analyses are stratified by event type.

		IHD or stroke				P for interaction with event type (IHD/stroke)	IHD		Stroke	
		Crude OR	95% CI	OR*	95% CI		OR†	95% CI	OR†	95% CI
Age:	≤50 years	1 (=Ref.)		1 (=Ref.)		0.26				
	>50 years	1.35	1.13-1.60	1.66	1.38-1.98					
Sex:	Men	1 (=Ref.)		1 (=Ref.)		0.03	1 (=Ref.)		1 (=Ref.)	
	Women	1.48	1.26-1.74	1.34	1.13-1.59		1.62	1.25-2.11	1.12	0.90-1.39
Education:	High	1 (=Ref.)		1 (=Ref.)		0.57				
	Intermediate	1.19	0.97-1.45	1.10	0.89-1.35					
	Low	1.86	1.51-2.31	1.58	1.27-1.97					
Economically:	Active	1 (=Ref.)		1 (=Ref.)		0.14				
	Inactive	4.15	3.53-4.89	3.40	2.85-4.04					
Family	Married/cohab.	1 (=Ref.)		1 (=Ref.)		0.82				
	Single, no childr.	1.56	1.33-1.83	1.25	1.06-					

					1.48					
	Single, childr.	1.20	0.87-1.65	0.94	0.67-1.31					
Birth country:	Sweden	1 (=Ref.)		1 (=Ref.)		0.51				
	Other	1.52	1.26-1.82	1.27	1.04-1.55					
Living area:	Large city	1 (=Ref.)		1 (=Ref.)		0.14				
	Medium-size	1.03	0.85-1.24	1.16	0.96-1.41					
	Small town	1.13	0.93-1.35	1.32	1.08-1.61					
Cancer:	Yes	1 (=Ref.)		1 (=Ref.)		0.38				
	No	2.15	1.49-3.08	1.85	1.27-2.69					
Mental disorder:	Yes	1 (=Ref.)		1 (=Ref.)		0.006	1 (=Ref.)		1 (=Ref.)	
	No	3.46	2.83-4.22	2.54	2.05-3.14		3.60	2.69-4.83	1.90	1.41-2.55
Diabetes:	Yes	1 (=Ref.)		1 (=Ref.)		0.02	1 (=Ref.)		1 (=Ref.)	
	No	2.01	1.60-2.51	1.98	1.56-2.51		2.49	1.85-3.34	1.40	0.94-2.08
Procedure‡:	Yes	1 (=Ref.)		1 (=Ref.)		0.02	1 (=Ref.)		1 (=Ref.)	
	No	0.81	0.62-1.04	1.12	0.85-1.46		0.88	0.64-1.22	2.13	1.33-3.42
Type of event:	IHD	1 (=Ref.)		1 (=Ref.)						
	Stroke	2.64	2.27-3.08	2.79	2.37-					

	3.29

* Multivariable model; all variables are entered simultaneously into the model

† Estimates are adjusted for all other variables

‡ Medical procedure =coronary artery bypass graft, percutaneous transluminal coronary angioplasty, other coronary distension procedure, or intravenous intracranial procedure

Differences between IHD and stroke

The following interactions with event type were significant: sex, mental disorder, diabetes, and medical procedure. Women who had suffered an IHD event had 1.62 (95% CI 1.25-2.11) times higher odds of disability pension in the first post-event year than male IHD patients, whereas sex was not associated with disability pension among stroke patients. Among IHD cases, mental disorder was associated with 3.60 (95% CI 2.69-4.83) times higher odds of disability pension during the first post-event year compared with people without a mental disorder, whereas the corresponding odds ratio among stroke cases was 1.90 (95% CI 1.41-2.55). Comorbid diabetes was associated with 2.49 (95% CI 1.85-3.34) times higher odds of disability pension. It was not associated with the risk of disability pension among people who had suffered a stroke. Among stroke cases, having undergone a medical procedure was associated with 2.13 (95% CI 1.33-3.42) times higher odds of disability pension in the first year after the event than among those who did not receive such procedure. (Table 2.) These interactions, and absolute differences between IHD and stroke cases, are further illustrated in Figure 2, where we present percentages of those who ended up on disability pension adjusted for other predictor variables.

Sensitivity analysis: Disability pension in fifth post-event year

Supplementary Table 1 presents the results regarding the factors associated with the risk of disability pension in the fifth post-event year after an IHD or stroke event. The main effects corresponded to those in first post-event year, but effect modification by event type was observed more often, indicating larger differences between IHD and stroke in disability

pension in the fifth post-year. Interaction terms observed at first post-year remained statistically significant, but also several other interactions emerged. Those with less education, economically inactive, and who were born elsewhere than Sweden were at a higher risk of disability pension, especially among the IHD cases.

DISCUSSION

We found that among the working-age population of Sweden, the incidence of disability pension was similar five years before the first IHD or stroke event. About 25% of the cohort were already on disability pension one year prior to the event, with significant overrepresentation of socioeconomically disadvantaged. This corresponds to earlier studies which have reported pre-event disability pension prevalence of 22–29%.[3, 16-18] We showed that similar sociodemographic characteristics and pre-existing comorbid conditions were associated with pre-event and post-event disability pension.

People who had suffered a stroke had a substantially higher incidence of disability pension after the event (up to 50% during the five subsequent years) than people who had suffered an IHD event (up to 30%). Thus, although the incidence of an IHD event (18 480 cases in three years) was more common than the incidence of stroke (9750 cases in three years), the disability burden of stroke was greater than that of IHD.

Female sex, older age, lower education, economic inactivity, immigrant status, living in rural areas, and having comorbid conditions were all risk factors for disability pension after cardiovascular events, which corresponds to previous studies.[4, 5, 7, 9-12, 19]. The risk of disability pension after the event was higher among women than among men with IHD, but we observed no sex difference regarding stroke. Other research has reported significantly better long-term prognosis among women,[20] but no sex difference in mortality due to stroke.[21] Thus, the higher risk of disability pension after an IHD event among women may reflect women's higher probability of disability pension in general,[22] or may be related to men's higher risk of cardiovascular mortality before disability pension is granted.

As comorbid conditions contributed to exit to disability pension, it is possible that part of these disability pension awards are due to causes other than cardiovascular diseases. As the incidence of disability pension increased markedly after the cardiovascular event, it is unlikely that comorbid conditions can explain all disability pensions. Having had medical procedure related to the event was associated with disability pension shortly after a stroke event. Medical procedure can be viewed as a proxy for the severity of the event. Thus, risk groups for disability pension shortly after a stroke are those who suffer a more severe event, which corresponds to earlier results regarding return to work.[4, 5]

Although the relative difference in the risk of disability pension between those with and without comorbid mental disorder and diabetes was larger for IHD cases than for stroke cases, the highest absolute risk was found among those who had suffered a stroke and had mental disorder or diabetes. Mental disorders, particularly depression, associated with an IHD or stroke event might decrease working capacity by reducing functional capacity, and by preventing the patient from participating in physical rehabilitation and cognitive therapies, adhering to medical procedures, or making the necessary lifestyle changes needed to achieve working capacity after IHD or a stroke.[23] Diabetes has been associated with excess risk of death following myocardial infarction.[24]

In Sweden, people can be granted disability pension even without a history of sick leave. However, even if it is rather certain that the person will not return to work after, for example, a severe stroke, the patient or the relatives seldom apply for disability pension as the benefit is usually lower than that for sick leave. The main reason for applying for disability pension immediately after the disability event is that one cannot get sickness absence benefits (not having had income from work or unemployment benefit). Apart from certain specific exceptions (e.g., ongoing treatment), one cannot be on sick leave for more than 365 consecutive days. Thus, people who were awarded disability pension during the first

post-event year were possibly in a poorer labour market position, which prevented them from applying for sickness absence benefits. This corresponds to our findings, since economic inactivity was the strongest predictor of disability pension in the first post-event year regardless of event type. Other indicators of poorer labour market position, such as low education and birth country other than Sweden, were also predictive of fast exit to disability pension.

Socioeconomic background and comorbid conditions explained the risk of disability pension five years after the event to a greater extent among IHD than stroke cases. This is noteworthy, since poorer labour market position and not fulfilling the criteria for entitlement to sickness absence benefits cannot explain disability pension in the fifth post-event year. The often higher severity of stroke compared to IHD may explain this difference; after an IHD event, the probability of recovering to relatively good working capacity may be higher. However, the observed differences in this recovery seem to relate to socioeconomic characteristics and resources; the background factors may affect people's recovery and rehabilitation.[25] Stroke, often a more disabling cardiovascular event, may more totally reduce working capacity, and hence we found smaller individual differences. However, a socioeconomic gradient has also been observed in short- and long-term outcomes after a stroke.[26]

The major strength of this study was its large population-based cohort data with reliable register-based measures of high coverage and specificity,[27] and no loss to follow up. Compared to previous studies, we also had a longer follow up – five years – both before and after the event. We were able to include a large set of predictors of disability pension, including sociodemographic factors, comorbid conditions, and medical procedure.

The register data also have some limitations: we were only able to include information that was available in administrative registers. This meant that we had no information on quality and outcome of post-event care, individuals' health behaviours or workplace psychosocial factors, which are typically collected in surveys, and have previously been linked to disability pension in general populations.[28] However, a recent study among Finnish public sector employees demonstrated that the contribution of health behaviours and workplace psychosocial factors to the risk of disability pension was relatively small compared to the contribution of comorbidity, especially mental comorbidity.[7] As regards post-event care, men were more likely to enrol in disease management program than women after coronary heart disease in Germany.[29]

Conclusions

Our results quantify and emphasize the burden of IHD and stroke to the labour market, and help occupational and other health care professionals to identify vulnerable groups at risk for permanent exclusion from labour market after such an event. While IHD event was more common, stroke caused more permanent work disability. As regards IHD, non-medical risk factors contributed to the risk of disability pension, whereas medical factors contributed to the risk of disability pension after stroke. This knowledge may be beneficial when planning interventions to prevent permanent work disability after either event.

Contributors: JE, MV, TL, EMR and KA contributed to conception and design. JE analysed the data and drafted the manuscript. All authors contributed either to analysis, interpretation or acquisition of the data, and critically revised the manuscript. All gave final approval and agree to be accountable for all aspects ensuring integrity and accuracy.

Funding: This study was supported by the Swedish Research Council for Health, Working Life and Welfare. JE, MV and TL were supported by the Academy of Finland (projects 258598, 292824, 287488). The funding organizations had no role in the study design, data collection, analysis, interpretation of the data, writing the report or in the decision to submit the paper.

Competing interest: None declared.

Ethics approval: Ethical approval was obtained from the Regional Ethical Review Board, Stockholm, Sweden.

Data sharing statement: No additional data available.

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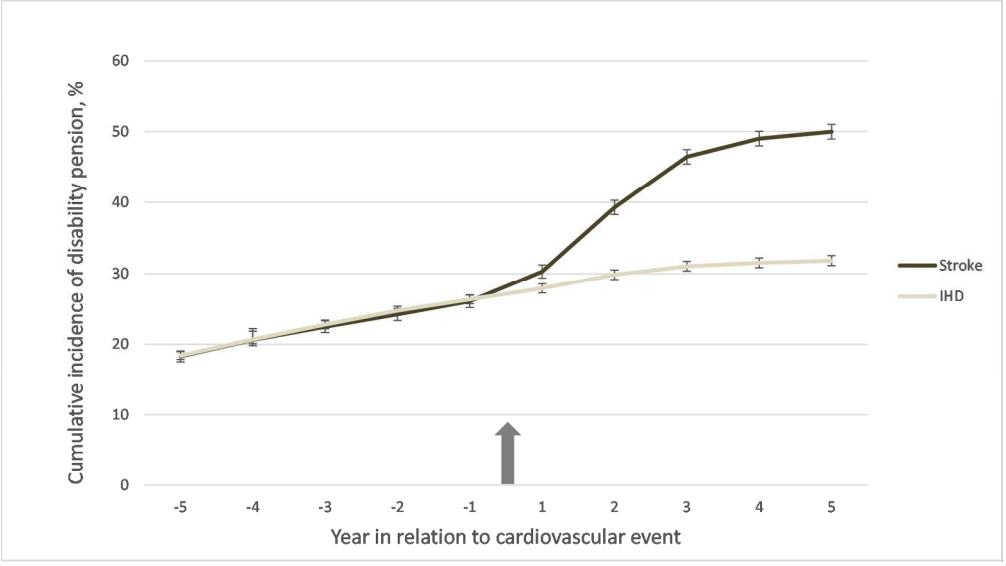
Figure legends:

Figure 1. Cumulative incidence of disability pension 5 years before and 5 years after cardiovascular event, unadjusted. The arrow indicates the event. IHD=ischemic heart disease.

Figure 2. Adjusted percentage of people suffering an IHD or stroke event ending up on disability pension during first post-event year. Exponentiated least square means (×100) adjusted for sex, age, education, economic inactivity, family situation, birth country, type of living area, mental disorder, diabetes, cancer, and medical procedure. Error bars indicate 95% confidence intervals. IHD=ischemic heart disease.



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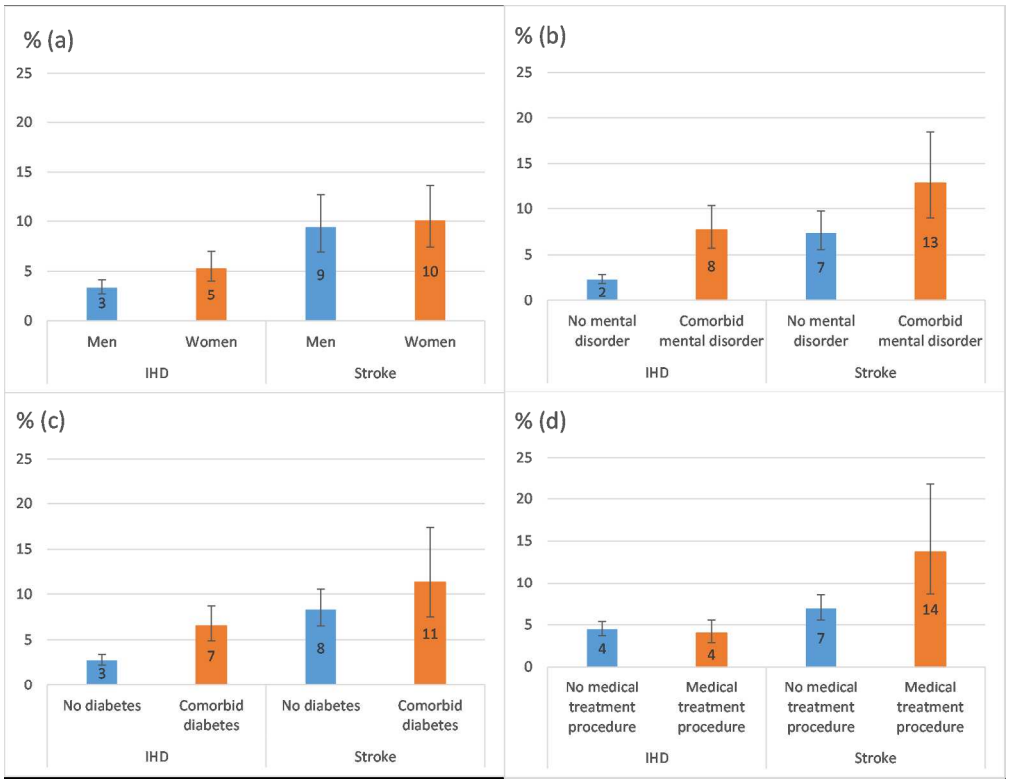


Figure 2. Adjusted percentage of people suffering an IHD or stroke event ending up on disability pension during first post-event year. Exponentiated least square means (×100) adjusted for sex, age, education, economic inactivity, family situation, birth country, type of living area, mental disorder, diabetes, cancer, and medical procedure. Error bars indicate 95% confidence intervals. IHD=ischemic heart disease.

Supplementary Table 1. Predictors of disability pension in five year follow-up after cardiovascular (ischemic heart disease or stroke) event. In case of significant interaction (p<0.05), analyses are stratified by event type.

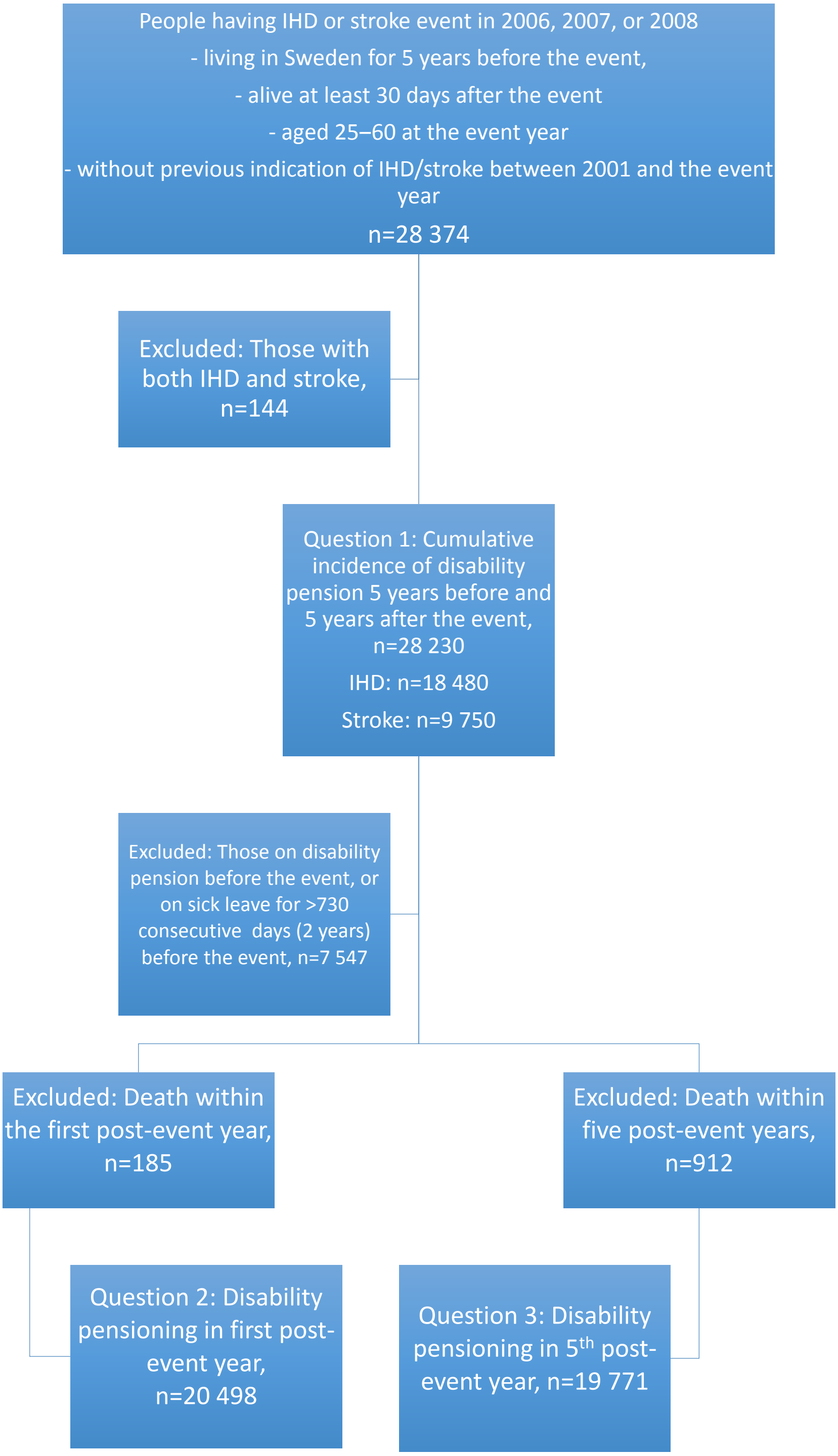
		IHD or stroke				P for interaction with event type (IHD/stroke)	IHD		Stroke	
		Crude RR	**95% CI**	**RR***	**95% CI**		**RR†**	**95% CI**	**RR†**	**95% CI**
Age:	≤50 years	1 (=Ref.)		1 (=Ref.)		0.99				
	>50 years	1.23	1.14-1.32	1.45	1.35-1.57					
Sex:	Men	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
	Women	1.77	1.65-1.90	1.45	1.35-1.55		1.81	1.60-2.04	1.29	1.10-1.40
Education:	High	1 (=Ref.)		1 (=Ref.)		0.013	1 (=Ref.)		1 (=Ref.)	
	Intermediate	1.11	1.02-1.21	1.11	1.02-1.21		1.07	0.92-1.25	1.13	1.02-1.26
	Low	1.30	1.19-1.43	1.29	1.17-1.42		1.46	1.24-1.71	1.20	1.07-1.36
Economically:	Active	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
	Inactive	1.54	1.41-1.68	1.35	1.23-1.48		1.78	1.54-2.05	1.16	1.03-1.30
Family	Married/cohab.	1 (=Ref.)		1 (=Ref.)		0.19				
	Single, no childr.	1.19	1.11-1.27	1.11	1.03-1.19					
	Single, childr.	1.22	1.07-1.39	1.04	0.91-1.19					
Birth country:	Sweden	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	

	Other		1.15	1.06-1.26	1.20	1.10-1.31		1.49	1.30-1.70	1.04	0.92-1.17
Living area:	Large city		1 (=Ref.)		1 (=Ref.)		0.77				
	Medium-size		1.19	1.10-1.29	1.26	1.16-1.36					
	Small town		1.18	1.08-1.28	1.27	1.17-1.39					
Cancer:	Yes		1 (=Ref.)		1 (=Ref.)		0.065				
	No		1.47	1.20-1.79	1.32	1.08-1.61					
Mental disorder:		Yes	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
		No	1.76	1.58-1.96	1.52	1.36-1.70		2.35	1.99-2.78	1.19	1.03-1.38
Diabetes:	Yes		1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
	No		1.45	1.30-1.63	1.64	1.46-1.83		2.05	1.76-2.39	1.30	1.10-1.54
Procedure‡:	Yes		1 (=Ref.)		1 (=Ref.)		0.28				
	No		0.83	0.74-0.93	1.29	1.15-1.45					
Type of event:	IHD		1 (=Ref.)		1 (=Ref.)						
		Stroke	3.64	3.39-3.90	3.77	3.50-4.06					

* Multivariable model; all variables are entered simultaneously into the model

† Estimates are adjusted for all other variables

‡ Medical procedure =coronary artery bypass graft, percutaneous transluminal coronary angioplasty, other coronary distension procedure, or intravenous intracranial procedure



Supplementary Figure 1. Flow chart of study inclusion and exclusion criteria.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6-7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-8
Bias	9	Describe any efforts to address potential sources of bias	6,7
Study size	10	Explain how the study size was arrived at	Supplementary Fig 1.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and	9

		interactions	
		(*c*) Explain how missing data were addressed	no missing data
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	no loss to follow-up
		€ Describe any sensitivity analyses	9
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Supplementary Fig 1.
		(b) Give reasons for non-participation at each stage	Supplementary Fig 1.
		(c) Consider use of a flow diagram	Supplementary Fig 1.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	no missing data
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Supplementary Fig 1.
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	Table 1
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Figure 1, Figure 2
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Table 2, Supplementary Table 1.
Discussion			
Key results	18	Summarise key results with reference to study objectives	19-20
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22

Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	22
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Permanent work disability before and after ischemic heart disease or stroke event: A nationwide population-based cohort study in Sweden

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-017910.R1
Article Type:	Research
Date Submitted by the Author:	24-Jul-2017
Complete List of Authors:	Ervasti, Jenni; Finnish Institute of Occupational Health, Centre of Expertise for Work Organizations Virtanen, Marianna; Finnish Institute of Occupational Health, Centre of Expertise for Work Organizations Lallukka, Tea; Finnish Institute of Occupational Health, Friberg, Emilie Mittendorfer-Rutz, Ellenor; Karolinska Institutet, Clinical Neuroscience Lundström, Erik; Karolinska Institutet Department of Clinical Neuroscience Alexanderson, Kristina; Karolinska Institutet,
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Cardiovascular medicine, Occupational and environmental medicine, Public health
Keywords:	Ischaemic heart disease < CARDIOLOGY, Stroke < NEUROLOGY, EPIDEMIOLOGY, OCCUPATIONAL & INDUSTRIAL MEDICINE, sick leave, disability pension

Permanent work disability before and after ischemic heart disease or stroke event: A nationwide population-based cohort study in Sweden

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ABSTRACT

Objectives: We examined the risk of disability pension before and after ischemic heart disease (IHD) or stroke event, the burden of stroke compared to IHD, and which factors predicted disability pension after either event.

Design: A population-based cohort study with follow-up five years before and after the event. Register data were analysed with general linear modelling with binary and Poisson distributions including interaction tests for event type (IHD/stroke).

Setting and participants: All people living in Sweden, aged 25−60 years at the first event year, who had been living in Sweden for five years before the event and had no indication of IHD or stroke prior to the index event in 2006−2008 were included, except for cases in which death occurred within 30 days of the event. People with both IHD and stroke were excluded, resulting in 18 480 cases of IHD (65%) and 9750 stroke cases (35%).

Primary outcome measures: Disability pension.

Results: Of those going to suffer IHD or stroke event, 25% were already on disability pension a year before the event. The adjusted odds ratio (OR) for disability pension at first post-event year was 2.64 fold (95% CI 2.25-3.11) for people with stroke compared to IHD. Economic inactivity predicted disability pension regardless of event type (OR=3.40; 95% CI 2.85-4.04). Comorbid mental disorder was associated with the greatest risk (OR=3.60; 95% CI 2.69-4.83) after an IHD event. Regarding stroke, medical procedure, a proxy for event severity, was the largest contributor (OR=2.27, 95% CI 1.43-3.60).

Conclusions: While IHD event was more common, stroke involved more permanent work disability. Demographic, socioeconomic, and comorbidity-related factors were associated

with disability pension both before and after the event. The results help occupational and other healthcare professionals to identify vulnerable groups at risk for permanent labour market exclusion after such an event.

Keywords: Cardiovascular disease; Cohort studies; Disability pension; Ischemic heart disease; Occupational Health; Sick-leave; Stroke

Strengths and limitations of this study:

- With large population-based cohort data with reliable register-based measures and no loss to follow up, we provided information about how ischemic heart disease (IHD) and stroke events were linked with risk of permanent work disability, i.e., disability pension.
- Compared to previous studies focusing on IHD, we had a longer follow-up time – five years – both before and after the event.
- We were able to include a large set of predictors of disability pension, including sociodemographic factors, comorbid conditions, and medical procedure.
- The results may help when planning preventive measures for permanent work disability after IHD or stroke event.
- As we were only able to include information that was available in administrative registers, we had no data on quality and outcome of post-event care, individuals' health behaviours, or workplace psychosocial factors.

INTRODUCTION

Worldwide, 11% of the total disease burden as measured with disability-adjusted life years, is attributed to ischemic heart disease (IHD) and stroke.[1] Due to improved treatment of both IHD and stroke contributing to declining mortality,[2] and because of the pressures of extended working careers, the proportion of working-age people with cardiovascular disease is likely to increase. While 53-73% of people suffering a cardiovascular event return to work,[3-6] significantly higher proportion leaves working life permanently during the years following a cardiovascular event than among people without such diagnosis.[7] In order to help people with this disease to continue working, it is important to study the risk factors leading to permanent work disability (i.e., disability pension) after a cardiovascular event.

Disease severity, comorbidity, female sex, higher age, and lower socioeconomic status have been found to predict disability pension after an IHD event.[7-12] However, we found no previous research that specifically examined the predictors of disability pension after a stroke event. Research on stroke has focused on return to work, which has been associated with a less serious disability, younger age, higher socioeconomic position, and less cardiovascular risk factors.[4-6] While IHD and stroke share several common risk factors, some discrepancies also point to differential pattern of predictors.[13] Previous studies have not examined whether differences exist between the predictors of disability pension after IHD and stroke events.

Our aim was to (a) determine the proportion and characteristics of people who suffered an IHD or stroke event at working age who were already on disability pension prior to the event; and (b) examine the medical (comorbidity, event severity) and non-medical

(demographic and socioeconomic) predictors of disability pension in the first post-event year, including examining difference in IHD and stroke cases.

From a labour force policy perspective, it is important to determine whether the predictors of disability pension shortly after the event are different from those that predict disability pension in the longer run. Thus, as a sensitivity analysis, we studied the medical and non-medical predictors of disability pension in the fifth post-event year and whether there were differences between IHD and stroke cases.

METHODS

Study design

The population-based longitudinal cohort study was conducted based on register data obtained from three Swedish authorities and linked using the personal identity number assigned to all residents in Sweden. The following registers were used:

1. Statistics Sweden: Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA) on sex, age, education, family situation, place of birth, type of living area, and labour market activity
2. National Board of Health and Welfare: diagnosis-specific data on hospitalizations and specialized outpatient care (coded according to the International Classification of Diseases (ICD-10)[14]); medical procedures; cancer register; date of death
3. National Social Insurance Agency: Annual sickness absence data (pre-event) and disability pension data.

Our study cohort consisted of all people living in Sweden, who at the event year were aged 25 to 60 years, had been living in Sweden for five years before the event, and had no indication of cardiovascular events in the registers between 2001 and the event year. First event dates in 2006, 2007, and 2008 were included, except for cases in which death occurred within 30 days of the event. This resulted in a sample of 28 374 cases. The data on cumulative disability pension were gathered for five years prior to the event date, and five years after the event. People with both IHD and stroke were excluded (n=144), resulting in 18 480 cases of IHD and 9750 stroke cases.

In prospective analyses on the predictors of disability pension in the first and fifth post-event year, individuals already on disability pension at the time of the event and people with more than 730 sickness absence days (two years) prior to the event were excluded (n=7547), resulting in a cohort of 20 683 individuals. Those who died were excluded from the death year onwards. This resulted in a final sample of 20 498 individuals for analyses of the onset of disability pension during the first post-event year (185 individuals died during the first year), and 19 771 for analysis of the onset of disability pension in the fifth post-event year (912 individuals died during the five subsequent years). Supplementary Figure 1 shows a flow chart of inclusion and exclusion criteria regarding each of the study questions.

Measures

An IHD event was based on hospitalization for myocardial infarction or other IHD, excluding angina pectoris (i.e., codes I21–I25 were included). A stroke event was based on hospitalization for stroke (ICD-10 codes I60, I61, I63, and I64).

For the outcome, annual data on disability pension days were gathered. In Sweden, all individuals aged 30 to 64, including people with no previous income, can be granted disability pension if their work capacity is permanently reduced owing to disease or injury. Individuals aged 19 to 29 can be granted temporary disability pension in cases of such reduced work capacity or in order to complete compulsory education.

The predictors of disability pension, all measured in the event year, were age, sex, education, economic inactivity, type of living area, family situation, birth country, mental disorder, cancer, diabetes, and medical procedure during the event. Age was

dichotomized as “50 years or less” and “more than 50 years”. Education was classified as “low” (<10 years), “intermediate” (10–12 years = high school), or “high” (>12 years = college or university). Economic activity was coded as “economically active” (in paid work) or “economically inactive” (not in paid work, including for example the unemployed, students, and those on parental leave). Family situation was classified as “married/cohabiting”, “not married/cohabiting without children” (i.e., single), or “not married/cohabiting with children” (i.e., single parent). Birth country was dichotomized into “Sweden” or “country other than Sweden”. Type of living area was classified as “large city”, “medium-sized town”, or “small town/village”.

Cancer (ICD-10 codes C00-D48) was based on information in the cancer register, and mental disorders (F00-F99) and diabetes (E10-E14) were based on information from the patient register (inpatient and specialized outpatient care). All the diseases were coded “yes” or “no”

Medical procedures at T-1 (year prior to the event) or T1 (year after the event) included coronary artery bypass graft, percutaneous coronary intervention, other coronary distension procedure, or intravenous intracranial procedure. People who had undergone at least one such procedure were coded “yes” and those without “no”.

Statistical analysis

The cumulative incidence trend in disability pension five years before and five years after the event was calculated with frequencies (percentage of individuals on disability pension each year, with 95% confidence intervals [CI]). Between-group differences in disability pension were tested with Chi^2 tests. To assess the risk of new disability pension during the first year

after the event (outcome incidence 3%), we used generalized linear model with binary distribution and logit link function, which produced odds ratios (OR) with 95% CI. To examine the differences between the predictors of disability pension for IHD and stroke cases, we tested the effect modification (interaction) of event type (IHD/stroke) and each of the predictors. When a statistically significant ($p<0.05$) interaction effect was observed, we performed stratified subgroup analyses. The relative and absolute differences in disability pensioning by these subgroups were illustrated with least square means adjusted for all predictor variables. These adjusted means were produced using Poisson distribution due to conversion problems with binary logistic models.

In sensitivity analyses, we used generalized linear model with Poisson distribution and log link function to produce relative risks (RR) with 95% CI to estimate predictors of disability pension by the fifth year after the cardiovascular event (outcome incidence 18%). Different regression methods were used for the fifth and the first post-event year since OR is not a good approximation of risk ratio when outcome prevalence is above 10%.[15-17] SAS 9.4 was used for all analyses.

RESULTS

Cumulative incidence of disability pension

Figure 1 illustrates the cumulative incidence of disability pension five years before and five years after a cardiovascular event of IHD or stroke: The cumulative incidence of disability pension was similar (up to 25%) until the event for both IHD and stroke. Thus, about a quarter of working-age people who had suffered incident IHD or a stroke were already on disability pension before the event. The highest prevalence of pre-event disability pension was observed among women (37%), people who were economically inactive (69%), had low education (36%), were born outside Sweden (35%), and had comorbid cancer (36%), mental disorder (58%), or diabetes (48%) at the event year (Table 1).

After the event, the cumulative incidence of disability pension was substantially higher (reaching 50%) among people who suffered a stroke event than among those who suffered an IHD event (slightly above 30%) (Figure 1). Similar characteristics were associated with first and fifth post-event year disability pensioning, as observed before the event (Table 1.)

Table 1. Characteristics of study participants by disability pension before and after a cardiovascular (ischemic heart disease or stroke) event

		Pre-event disability pension			Disability pension in first post-event year			Disability pension in fifth post-event year		
			No (n=20683)	Yes (n=7547)		No (n=19802)	Yes (n=696)		No (n=16317)	Yes (n=3454)
Characteristics		n	%	%	n	%	%	n	%	%
Sex:	Men	19713	78	22	15222	97	3	14661	85	15
	Women	8517	63	37	5276	96	4	5110	74	26
Age:	≤50 years	8332	79	21	6575	97	3	6412	85	15
	>50 years	19898	71	29	13923	96	4	13359	81	19
Education:	Low	7854	64	36	4981	95	5	4774	80	20
	Intermediate	14095	73	27	10274	97	3	9902	83	17
	High	6281	84	16	5243	97	3	5095	84	16
Economically:	Active	20076	91	9	18045	97	3	17460	85	15
	Inactive	8154	31	69	2453	90	10	2366	75	25
Family	Married/cohab.	16121	78	22	12513	97	3	12181	84	16
	Single, no childr.	10310	66	34	6693	96	4	6339	81	19
	Single, childr.	1799	72	28	1292	97	3	1251	80	20
Birth country:	Sweden	23126	75	25	17198	97	3	16582	83	17
	Other	5104	65	35	3300	95	5	3189	80	20
Living area:	Large city	9163	75	25	6776	97	3	6527	84	16
	Medium-size	10019	73	27	7212	97	3	6979	82	18

	Small town	9048	73	27	6510	96	4	6265	82	18
Cancer:	Yes	847	64	36	482	93	7	382	75	25
	No	27383	74	26	20016	97	3	19389	83	17
Mental disorder:	Yes	3286	42	58	1352	90	10	1236	71	29
	No	24944	77	23	19146	97	3	18535	83	17
Diabetes:	Yes	2887	52	48	1490	94	6	1381	75	25
	No	25343	76	24	19008	97	3	18390	83	17
Procedure*:	Yes	3077	78	22	2379	97	3	2318	85	15
	No	25153	73	27	18119	97	3	17453	82	18
Type of event:	IHD	18480	73	27	13450	98	2	13028	91	9
	Stroke	9750	73	27	7048	94	6	6743	67	33

*Medical procedure=coronary artery bypass graft, percutaneous coronary intervention, other coronary distension procedure, or intravenous intracranial procedure

Note. All p-values for difference between groups (Chi^2) were <0.01 except for 'pre-event disability pension and type of event', 'disability pension during the event year and living area', and 'disability pension during the event year and medical procedure.

New-onset disability pension in first post-event year

Table 2 presents the both the unadjusted and adjusted results on factors associated with the risk of disability pension during the first post-event year. After adjustment for sociodemographic factors, comorbid conditions, and medical procedures, stroke patients were at a higher risk of disability pension during the first post-event year than people who had suffered an IHD event (OR=2.79; 95% CI 2.37-3.29). Among both IHD and stroke patients, older age (OR=1.66; 95% CI 1.38-1.98), low education (OR=1.58; 95% CI 1.27-1.97), economic inactivity (OR=3.40; 95% CI 2.85-4.04), being single without children (OR=1.25; 95% CI 1.06-1.48), birth country other than Sweden (OR=1.27; 95% CI 1.04-1.55), living in small towns (OR=1.32; 95% CI 1.08-1.61), and comorbid cancer (OR=1.85; 95% CI 1.27-2.69) were associated with higher odds of disability pension in the first post-event year.

Table 2. Predictors of disability pension during first year after cardiovascular event. In case of significant interaction ($p<0.05$), analyses are stratified by event type.

		IHD or stroke				P for interaction with event type (IHD/stroke)	IHD		Stroke	
		Crude OR	95% CI	OR*	95% CI		OR†	95% CI	OR†	95% CI
Age:	≤50 years	1 (=Ref.)		1 (=Ref.)		0.26				
	>50 years	1.35	1.13-1.60	1.66	1.38-1.98					
Sex:	Men	1 (=Ref.)		1 (=Ref.)		0.03	1 (=Ref.)		1 (=Ref.)	
	Women	1.48	1.26-1.74	1.34	1.13-1.59		1.62	1.25-2.11	1.12	0.90-1.39
Education:	High	1 (=Ref.)		1 (=Ref.)		0.57				
	Intermediate	1.19	0.97-1.45	1.10	0.89-1.35					
	Low	1.86	1.51-2.31	1.58	1.27-1.97					
Economically:	Active	1 (=Ref.)		1 (=Ref.)		0.14				
	Inactive	4.15	3.53-4.89	3.40	2.85-4.04					
Family	Married/cohab.	1 (=Ref.)		1 (=Ref.)		0.82				
	Single, no childr.	1.56	1.33-1.83	1.25	1.06-					

					1.48					
	Single, childr.	1.20	0.87-1.65	0.94	0.67-1.31					
Birth country:	Sweden	1 (=Ref.)		1 (=Ref.)		0.51				
	Other	1.52	1.26-1.82	1.27	1.04-1.55					
Living area:	Large city	1 (=Ref.)		1 (=Ref.)		0.14				
	Medium-size	1.03	0.85-1.24	1.16	0.96-1.41					
	Small town	1.13	0.93-1.35	1.32	1.08-1.61					
Cancer:	Yes	1 (=Ref.)		1 (=Ref.)		0.38				
	No	2.15	1.49-3.08	1.85	1.27-2.69					
Mental disorder:	Yes	1 (=Ref.)		1 (=Ref.)		0.006	1 (=Ref.)		1 (=Ref.)	
	No	3.46	2.83-4.22	2.54	2.05-3.14		3.60	2.69-4.83	1.90	1.41-2.55
Diabetes:	Yes	1 (=Ref.)		1 (=Ref.)		0.02	1 (=Ref.)		1 (=Ref.)	
	No	2.01	1.60-2.51	1.98	1.56-2.51		2.49	1.85-3.34	1.40	0.94-2.08
Procedure‡:	Yes	1 (=Ref.)		1 (=Ref.)		0.02	1 (=Ref.)		1 (=Ref.)	
	No	0.81	0.62-1.04	1.12	0.85-1.46		0.88	0.64-1.22	2.13	1.33-3.42
Type of event:	IHD	1 (=Ref.)		1 (=Ref.)						
	Stroke	2.64	2.27-3.08	2.79	2.37-					

16

	3.29

* Multivariable model; all variables are entered simultaneously into the model

† Estimates are adjusted for all other variables

‡ Medical procedure =coronary artery bypass graft, percutaneous coronary intervention, other coronary distension procedure, or intravenous intracranial procedure

Differences between IHD and stroke

The following interactions with event type were significant: sex, mental disorder, diabetes, and medical procedure. Women who had suffered an IHD event had 1.62 (95% CI 1.25-2.11) times higher odds of disability pension in the first post-event year than male IHD patients, whereas sex was not associated with disability pension among stroke patients. Among IHD cases, mental disorder was associated with 3.60 (95% CI 2.69-4.83) times higher odds of disability pension during the first post-event year compared with people without a mental disorder, whereas the corresponding odds ratio among stroke cases was 1.90 (95% CI 1.41-2.55). Comorbid diabetes was associated with 2.49 (95% CI 1.85-3.34) times higher odds of disability pension, while it was not associated with the risk of disability pension among people who had suffered a stroke. Among stroke cases, having undergone a medical procedure was associated with 2.13 (95% CI 1.33-3.42) times higher odds of disability pension in the first year after the event than among those who did not receive such procedure (Table 2.) These interactions, and absolute differences between IHD and stroke cases, are further illustrated in Figure 2, where we present percentages of those who ended up on disability pension adjusted for other predictor variables.

Sensitivity analysis: Disability pension in fifth post-event year

Supplementary Table 1 presents the results regarding the factors associated with the risk of disability pension in the fifth post-event year after an IHD or stroke event. The main effects corresponded to those in first post-event year, but effect modification by event type was observed more often, indicating larger differences between IHD and stroke regarding

disability pension in the fifth post-year. Interaction terms observed at first post-year remained statistically significant, but also several other interactions emerged. Those with less education, economically inactive, and who were born outside of Sweden were at a higher risk of disability pension, especially among the IHD cases.

DISCUSSION

In this population-based longitudinal cohort study of people of working ages in Sweden who had a new IHD or stroke event, we found that the incidence of disability pension was similar five years before the first IHD or stroke event. About 25% of the cohort were already on disability pension one year prior to the event, with significant overrepresentation of socioeconomically disadvantaged. This corresponds to previous studies which have reported pre-event disability pension prevalence of 22–29%.[3, 18-20] We showed that similar sociodemographic characteristics and pre-existing comorbid conditions were associated with pre-event and post-event disability pension.

People who had suffered a stroke had a substantially higher incidence of disability pension after the event (up to 50% during the five subsequent years) than people who had suffered an IHD event (up to 30%). Thus, although the incidence of an IHD event (18 480 cases in three years) was more common than the incidence of stroke (9750 cases in three years), the disability burden of stroke was greater than that of IHD.

Female sex, older age, lower education, economic inactivity, immigrant status, living in rural areas, and having comorbid conditions were all risk factors for disability pension after cardiovascular events, which corresponds to previous studies.[4, 5, 7, 9-12, 21]. The risk of disability pension after the event was higher among women than among men with IHD, but we observed no sex difference regarding stroke. Other research has reported significantly better long-term prognosis among women,[22] but no sex difference in mortality due to stroke.[23] Thus, the higher risk of disability pension after an IHD event among women may reflect women's higher probability of disability pension in general,[24] or may

be related to men's higher risk of cardiovascular mortality before disability pension is granted.

As comorbid conditions contributed to exit to disability pension, it is possible that part of these disability pensions were due to diagnoses other than cardiovascular diseases. However, as the incidence of disability pension increased markedly after the cardiovascular event, it is unlikely that comorbid conditions can explain all disability pensions. Having had medical procedure related to the event was associated with disability pension shortly after a stroke event. Medical procedure can be viewed as a proxy for the severity of the event. Thus, risk groups for disability pension shortly after a stroke are those who suffer a more severe event, which corresponds to previous results regarding return to work.[4, 5]

Although the relative difference in the risk of disability pension between those with and without comorbid mental disorder and diabetes was larger for IHD cases than for stroke cases, the highest absolute risk was found among those who had suffered a stroke and had mental disorder or diabetes. Mental disorders, particularly depression, associated with an IHD or stroke event might decrease work capacity by reducing functional capacity, and by preventing the patient from participating in physical rehabilitation and cognitive therapies, adhering to medical procedures, or making the necessary lifestyle changes needed to achieve work capacity after IHD or a stroke.[25] Diabetes has been associated with excess risk of death following myocardial infarction.[26]

In Sweden, people can be granted disability pension even without a history of sick leave. However, even if it is rather likely that the individual will not return to work after, e.g., a severe stroke, the patient or the relatives seldom apply for disability pension as the benefit is usually lower than that for sick leave. The main reason for applying for disability

pension immediately after the disability event is that one cannot get sickness absence benefits (not having had income from work or unemployment benefit). Apart from certain specific exceptions (e.g., ongoing treatment), one cannot be on sick leave for more than 365 consecutive days. Thus, people who were granted disability pension during the first post-event year were possibly in a poorer labour market position, which prevented them from applying for sickness absence benefits. This corresponds to our findings, since economic inactivity was the strongest predictor of disability pension in the first post-event year regardless of event type. Other indicators of poorer labour market position, such as low education and birth country other than Sweden, were also predictive of fast exit to disability pension.

Socioeconomic background and comorbid conditions explained the risk of disability pension five years after the event to a greater extent among IHD than stroke cases. This is noteworthy, since poorer labour market position and not fulfilling the criteria for entitlement to sickness absence benefits cannot explain disability pension in the fifth post-event year. The often higher severity of stroke compared to IHD may explain this difference; after an IHD event, the probability of recovering to relatively good work capacity may be higher. However, the observed differences in this recovery seem to relate to socioeconomic characteristics and resources; the background factors may affect people's recovery and rehabilitation.[27] Stroke, often a more disabling cardiovascular event, may more totally reduce work capacity, and hence we found smaller individual differences. However, a socioeconomic gradient has also been observed in short- and long-term outcomes after a stroke.[28]

The major strength of this study was its large population-based cohort data with reliable register-based measures of high coverage and specificity,[29] and no loss to follow up. Compared to previous studies, we also had a longer follow-up – five years – both before

and after the event. We were able to include a large set of predictors of disability pension, including sociodemographic factors, comorbid conditions, and medical procedure.

The register data also have some limitations: we were only able to include information that was available in administrative registers. This meant that we had no information on quality and outcome of post-event care, individuals' health behaviours or workplace psychosocial factors, which are typically collected in surveys, and have previously been linked to disability pension in general populations.[30] However, a recent study among Finnish public sector employees demonstrated that the contribution of health behaviours and workplace psychosocial factors to the risk of disability pension was relatively small compared to the contribution of comorbidity, especially mental comorbidity.[7] Regarding post-event care, men were more likely to enrol in disease management program than women after coronary heart disease in Germany.[31] We also did not have direct measure of event severity, but used medical procedure as a proxy measure. In future studies, also recurrent events could be included. Finally, the high employment frequency in higher ages and among women in Sweden as well as the universal coverage with relatively high benefit levels might limit the generalizability of the results.[32]

Conclusions

Our results quantify and emphasize the burden of IHD and stroke to the labour market, and can help occupational and other healthcare professionals to identify vulnerable groups at risk for permanent exclusion from labour market after such an event. While IHD event was more common, stroke caused more permanent work disability. As regards IHD, non-medical risk factors contributed to the risk of disability pension, whereas medical factors contributed to

the risk of disability pension after stroke. This knowledge may be beneficial when planning interventions to prevent permanent work disability after either event.

Contributors: JE, MV, TL, EMR, and KA contributed to conception and design. JE analysed the data and drafted the manuscript. All authors contributed either to analysis, interpretation or acquisition of the data, and critically revised the manuscript. All gave final approval and agree to be accountable for all aspects ensuring integrity and accuracy.

Funding: This study was supported by the Swedish Research Council for Health, Working Life and Welfare. JE, MV, and TL were supported by the Academy of Finland (projects 258598, 292824, 287488). The funding organizations had no role in the study design, data collection, analysis, interpretation of the data, writing the report, or in the decision to submit the paper.

Competing interest: None declared.

Ethics approval: Ethical approval was obtained from the Regional Ethical Review Board, Stockholm, Sweden.

Data sharing statement: No additional data available.

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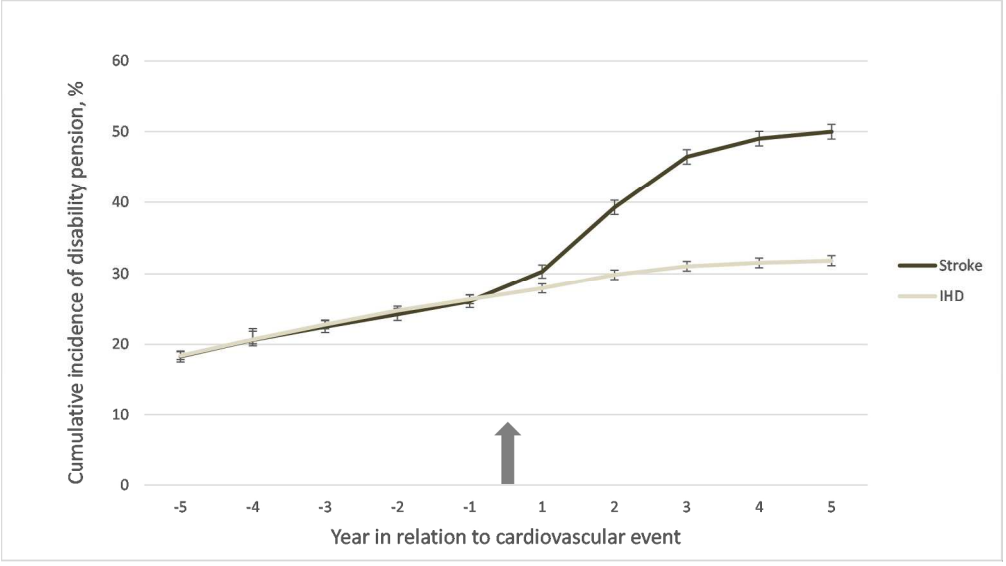
Figure legends:

Figure 1. Cumulative incidence of disability pension 5 years before and 5 years after cardiovascular event, unadjusted. The arrow indicates the event. IHD=ischemic heart disease.

Figure 2. Adjusted percentage of people suffering an IHD or stroke event ending up on disability pension during first post-event year. Exponentiated least square means (×100) adjusted for sex, age, education, economic inactivity, family situation, birth country, type of living area, mental disorder, diabetes, cancer, and medical procedure. Error bars indicate 95% confidence intervals. IHD=ischemic heart disease.



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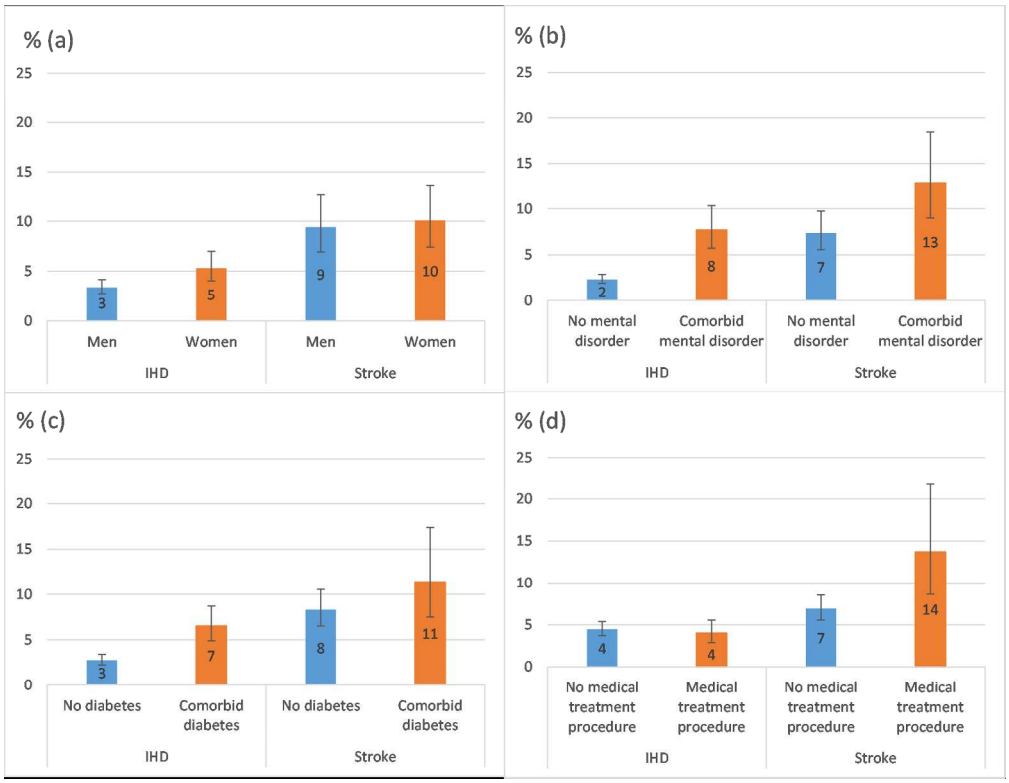


Figure 2. Adjusted percentage of people suffering an IHD or stroke event ending up on disability pension during first post-event year. Exponentiated least square means (×100) adjusted for sex, age, education, economic inactivity, family situation, birth country, type of living area, mental disorder, diabetes, cancer, and medical procedure. Error bars indicate 95% confidence intervals. IHD=ischemic heart disease.

Supplementary Table 1. Predictors of disability pension in five year follow-up after cardiovascular (ischemic heart disease or stroke) event. In case of significant interaction ($p<0.05$), analyses are stratified by event type.

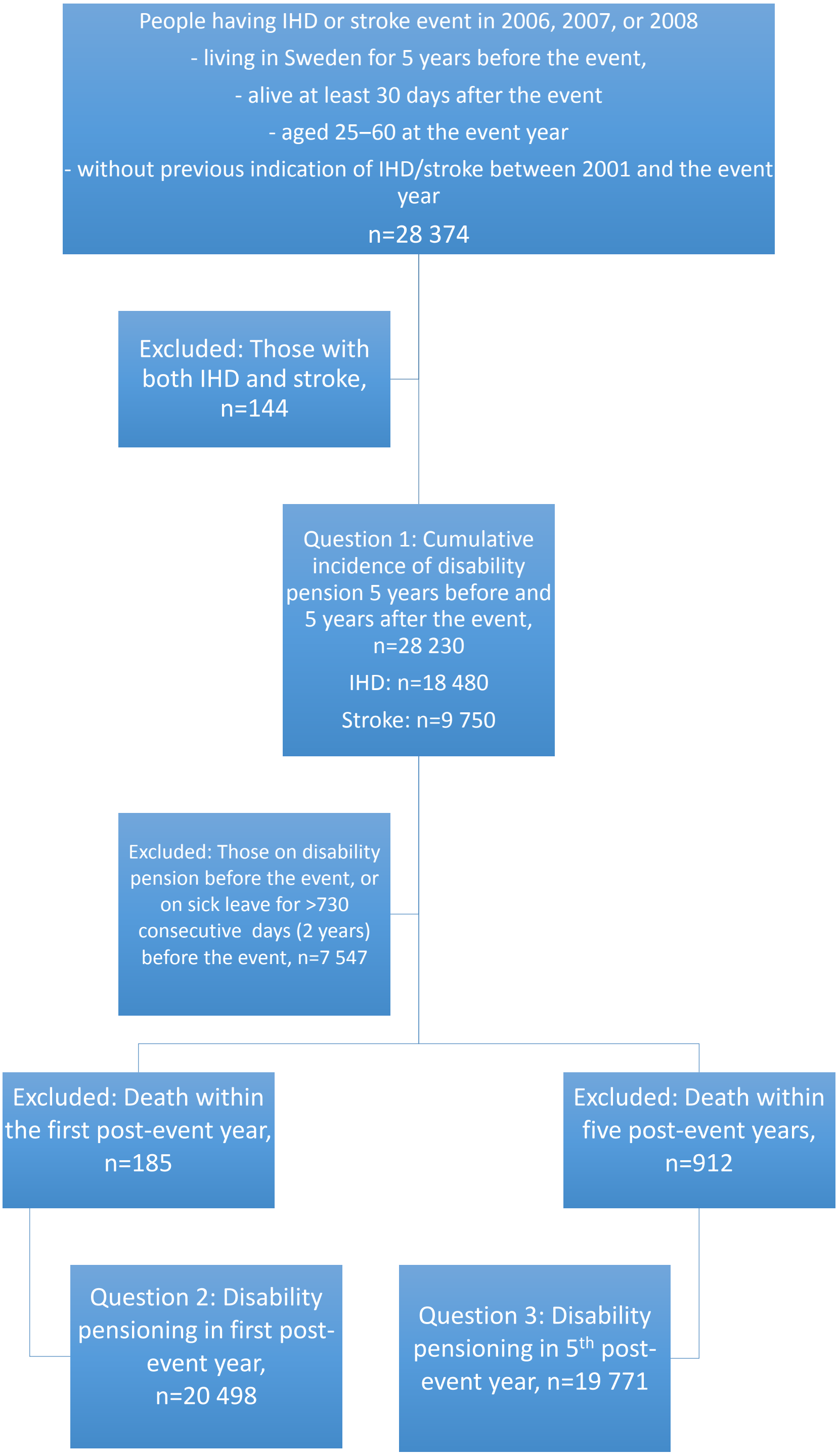
		IHD or stroke				P for interaction with event type (IHD/stroke)	IHD		Stroke	
		Crude RR	**95% CI**	**RR***	**95% CI**		**RR†**	**95% CI**	**RR†**	**95% CI**
Age:	≤50 years	1 (=Ref.)		1 (=Ref.)		0.99				
	>50 years	1.23	1.14-1.32	1.45	1.35-1.57					
Sex:	Men	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
	Women	1.77	1.65-1.90	1.45	1.35-1.55		1.81	1.60-2.04	1.29	1.10-1.40
Education:	High	1 (=Ref.)		1 (=Ref.)		0.013	1 (=Ref.)		1 (=Ref.)	
	Intermediate	1.11	1.02-1.21	1.11	1.02-1.21		1.07	0.92-1.25	1.13	1.02-1.26
	Low	1.30	1.19-1.43	1.29	1.17-1.42		1.46	1.24-1.71	1.20	1.07-1.36
Economically:	Active	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
	Inactive	1.54	1.41-1.68	1.35	1.23-1.48		1.78	1.54-2.05	1.16	1.03-1.30
Family	Married/cohab.	1 (=Ref.)		1 (=Ref.)		0.19				
	Single, no childr.	1.19	1.11-1.27	1.11	1.03-1.19					
	Single, childr.	1.22	1.07-1.39	1.04	0.91-1.19					
Birth country:	Sweden	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	

	Other		1.15	1.06-1.26	1.20	1.10-1.31		1.49	1.30-1.70	1.04	0.92-1.17
Living area:	Large city		1 (=Ref.)		1 (=Ref.)		0.77				
	Medium-size		1.19	1.10-1.29	1.26	1.16-1.36					
	Small town		1.18	1.08-1.28	1.27	1.17-1.39					
Cancer:	Yes		1 (=Ref.)		1 (=Ref.)		0.065				
	No		1.47	1.20-1.79	1.32	1.08-1.61					
Mental disorder:		Yes	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
		No	1.76	1.58-1.96	1.52	1.36-1.70		2.35	1.99-2.78	1.19	1.03-1.38
Diabetes:	Yes		1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
	No		1.45	1.30-1.63	1.64	1.46-1.83		2.05	1.76-2.39	1.30	1.10-1.54
Procedure‡:	Yes		1 (=Ref.)		1 (=Ref.)		0.28				
	No		0.83	0.74-0.93	1.29	1.15-1.45					
Type of event:	IHD		1 (=Ref.)		1 (=Ref.)						
		Stroke	3.64	3.39-3.90	3.77	3.50-4.06					

* Multivariable model; all variables are entered simultaneously into the model

† Estimates are adjusted for all other variables

‡ Medical procedure =coronary artery bypass graft, percutaneous transluminal coronary angioplasty, other coronary distension procedure, or intravenous intracranial procedure



Supplementary Figure 1. Flow chart of study inclusion and exclusion criteria.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6-7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-8
Bias	9	Describe any efforts to address potential sources of bias	6,7
Study size	10	Explain how the study size was arrived at	Supplementary Fig 1.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and	9

		interactions	
		(*c*) Explain how missing data were addressed	no missing data
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	no loss to follow-up
		€ Describe any sensitivity analyses	9
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Supplementary Fig 1.
		(b) Give reasons for non-participation at each stage	Supplementary Fig 1.
		(c) Consider use of a flow diagram	Supplementary Fig 1.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	no missing data
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Supplementary Fig 1.
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	Table 1
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Figure 1, Figure 2
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Table 2, Supplementary Table 1.
Discussion			
Key results	18	Summarise key results with reference to study objectives	19-20
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22

Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	22
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Permanent work disability before and after ischemic heart disease or stroke event: A nationwide population-based cohort study in Sweden

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-017910.R2
Article Type:	Research
Date Submitted by the Author:	17-Aug-2017
Complete List of Authors:	Ervasti, Jenni; Finnish Institute of Occupational Health, Centre of Expertise for Work Organizations Virtanen, Marianna; Finnish Institute of Occupational Health, Centre of Expertise for Work Organizations Lallukka, Tea; Finnish Institute of Occupational Health, Friberg, Emilie Mittendorfer-Rutz, Ellenor; Karolinska Institutet, Clinical Neuroscience Lundström, Erik; Karolinska Institutet Department of Clinical Neuroscience Alexanderson, Kristina; Karolinska Institutet,
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Cardiovascular medicine, Occupational and environmental medicine, Public health
Keywords:	Ischaemic heart disease < CARDIOLOGY, Stroke < NEUROLOGY, EPIDEMIOLOGY, OCCUPATIONAL & INDUSTRIAL MEDICINE, sick leave, disability pension

Permanent work disability before and after ischemic heart disease or stroke event: A nationwide population-based cohort study in Sweden

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ABSTRACT

Objectives: We examined the risk of disability pension before and after ischemic heart disease (IHD) or stroke event, the burden of stroke compared to IHD, and which factors predicted disability pension after either event.

Design: A population-based cohort study with follow-up five years before and after the event. Register data were analysed with general linear modelling with binary and Poisson distributions including interaction tests for event type (IHD/stroke).

Setting and participants: All people living in Sweden, aged 25−60 years at the first event year, who had been living in Sweden for five years before the event and had no indication of IHD or stroke prior to the index event in 2006−2008 were included, except for cases in which death occurred within 30 days of the event. People with both IHD and stroke were excluded, resulting in 18 480 cases of IHD (65%) and 9750 stroke cases (35%).

Primary outcome measures: Disability pension.

Results: Of those going to suffer IHD or stroke event, 25% were already on disability pension a year before the event. The adjusted odds ratio (OR) for disability pension at first post-event year was 2.64 fold (95% CI 2.25-3.11) for people with stroke compared to IHD. Economic inactivity predicted disability pension regardless of event type (OR=3.40; 95% CI 2.85-4.04). Comorbid mental disorder was associated with the greatest risk (OR=3.60; 95% CI 2.69-4.83) after an IHD event. Regarding stroke, medical procedure, a proxy for event severity, was the largest contributor (OR=2.27, 95% CI 1.43-3.60).

Conclusions: While IHD event was more common, stroke involved more permanent work disability. Demographic, socioeconomic, and comorbidity-related factors were associated

with disability pension both before and after the event. The results help occupational and other healthcare professionals to identify vulnerable groups at risk for permanent labour market exclusion after such an event.

Keywords: Cardiovascular disease; Cohort studies; Disability pension; Ischemic heart disease; Occupational Health; Sick-leave; Stroke

Strengths and limitations of this study:

- With large population-based cohort data with reliable register-based measures and no loss to follow up, we provided information about how ischemic heart disease (IHD) and stroke events were linked with risk of permanent work disability, i.e., disability pension.
- Compared to previous studies focusing on IHD, we had a longer follow-up time – five years – both before and after the event.
- We were able to include a large set of predictors of disability pension, including sociodemographic factors, comorbid conditions, and medical procedure.
- The results may help when planning preventive measures for permanent work disability after IHD or stroke event.
- As we were only able to include information that was available in administrative registers, we had no data on quality and outcome of post-event care, individuals' health behaviours, or workplace psychosocial factors.

INTRODUCTION

Worldwide, 11% of the total disease burden as measured with disability-adjusted life years, is attributed to ischemic heart disease (IHD) and stroke.[1] Due to improved treatment of both IHD and stroke contributing to declining mortality,[2] and because of the pressures of extended working careers, the proportion of working-age people with cardiovascular disease is likely to increase. While 53-73% of people suffering a cardiovascular event return to work,[3-6] significantly higher proportion leaves working life permanently during the years following a cardiovascular event than among people without such diagnosis.[7] In order to help people with this disease to continue working, it is important to study the risk factors leading to permanent work disability (i.e., disability pension) after a cardiovascular event.

Disease severity, comorbidity, female sex, higher age, and lower socioeconomic status have been found to predict disability pension after an IHD event.[7-12] However, we found no previous research that specifically examined the predictors of disability pension after a stroke event. Research on stroke has focused on return to work, which has been associated with a less serious disability, younger age, higher socioeconomic position, and less cardiovascular risk factors.[4-6] While IHD and stroke share several common risk factors, some discrepancies also point to differential pattern of predictors.[13] Previous studies have not examined whether differences exist between the predictors of disability pension after IHD and stroke events.

Our aim was to (a) determine the proportion and characteristics of people who suffered an IHD or stroke event at working age who were already on disability pension prior to the event; and (b) examine the medical (comorbidity, event severity) and non-medical

(demographic and socioeconomic) predictors of disability pension in the first post-event year, including examining difference in IHD and stroke cases.

From a labour force policy perspective, it is important to determine whether the predictors of disability pension shortly after the event are different from those that predict disability pension in the longer run. Thus, as a sensitivity analysis, we studied the medical and non-medical predictors of disability pension in the fifth post-event year and whether there were differences between IHD and stroke cases.

METHODS

Study design

The population-based longitudinal cohort study was conducted based on register data obtained from three Swedish authorities and linked using the personal identity number assigned to all residents in Sweden. The following registers were used:

1. Statistics Sweden: Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA) on sex, age, education, family situation, place of birth, type of living area, and labour market activity
2. National Board of Health and Welfare: diagnosis-specific data on hospitalizations and specialized outpatient care (coded according to the International Classification of Diseases (ICD-10)[14]); medical procedures; cancer register; date of death
3. National Social Insurance Agency: Annual sickness absence data (pre-event) and disability pension data.

Our study cohort consisted of all people living in Sweden, who at the event year were aged 25 to 60 years, had been living in Sweden for five years before the event, and had no indication of cardiovascular events in the registers between 2001 and the event year. First event dates in 2006, 2007, and 2008 were included, except for cases in which death occurred within 30 days of the event. This resulted in a sample of 28 374 cases. The data on cumulative disability pension were gathered for five years prior to the event date, and five years after the event. People with both IHD and stroke were excluded (n=144), resulting in 18 480 cases of IHD and 9750 stroke cases.

In prospective analyses on the predictors of disability pension in the first and fifth post-event year, individuals already on disability pension at the time of the event and people with more than 730 sickness absence days (two years) prior to the event were excluded (n=7547), resulting in a cohort of 20 683 individuals. Those who died or moved abroad were excluded from the death/emigration year onwards. This resulted in a final sample of 20 498 individuals for analyses of the onset of disability pension during the first post-event year (185 individuals died or moved abroad during the first year), and 19 771 for analysis of the onset of disability pension in the fifth post-event year (912 individuals died or moved abroad during the five follow-up years). Supplementary Figure 1 shows a flow chart of inclusion and exclusion criteria regarding each of the study questions.

Measures

An IHD event was based on hospitalization for myocardial infarction or other IHD, excluding angina pectoris (i.e., codes I21–I25 were included). A stroke event was based on hospitalization for stroke (ICD-10 codes I60, I61, I63, and I64).

For the outcome, annual data on disability pension days were gathered. In Sweden, all individuals aged 30 to 64, including people with no previous income, can be granted disability pension if their work capacity is permanently reduced owing to disease or injury. Individuals aged 19 to 29 can be granted temporary disability pension in cases of such reduced work capacity or in order to complete compulsory education.

The predictors of disability pension, all measured in the event year, were age, sex, education, economic inactivity, type of living area, family situation, birth country, mental disorder, cancer, diabetes, and medical procedure during the event. Age was

dichotomized as “50 years or less” and “more than 50 years”. Education was classified as “low” (<10 years), “intermediate” (10–12 years = high school), or “high” (>12 years = college or university). Economic activity was coded as “economically active” (in paid work) or “economically inactive” (not in paid work, including for example the unemployed, students, and those on parental leave). Family situation was classified as “married/cohabiting”, “not married/cohabiting without children” (i.e., single), or “not married/cohabiting with children” (i.e., single parent). Birth country was dichotomized into “Sweden” or “country other than Sweden”. Type of living area was classified as “large city”, “medium-sized town”, or “small town/village”.

Cancer (ICD-10 codes C00-D48) was based on information in the cancer register, and mental disorders (F00-F99) and diabetes (E10-E14) were based on information from the patient register (inpatient and specialized outpatient care). All the diseases were coded “yes” or “no”

Medical procedures at T-1 (year prior to the event) or T1 (year after the event) included coronary artery bypass graft, percutaneous coronary intervention, other coronary distension procedure, or intravenous intracranial procedure. People who had undergone at least one such procedure were coded “yes” and those without “no”.

Statistical analysis

The cumulative incidence trend in disability pension five years before and five years after the event was calculated with frequencies (percentage of individuals on disability pension each year, with 95% confidence intervals [CI]). Between-group differences in disability pension were tested with Chi^2 tests. To assess the risk of new disability pension during the first year

after the event (outcome incidence 3%), we used generalized linear model with binary distribution and logit link function, which produced odds ratios (OR) with 95% CI. To examine the differences between the predictors of disability pension for IHD and stroke cases, we tested the effect modification (interaction) of event type (IHD/stroke) and each of the predictors. When a statistically significant ($p<0.05$) interaction effect was observed, we performed stratified subgroup analyses. The relative and absolute differences in disability pensioning by these subgroups were illustrated with least square means adjusted for all predictor variables. These adjusted means were produced using Poisson distribution due to conversion problems with binary logistic models.

In sensitivity analyses, we used generalized linear model with Poisson distribution and log link function to produce relative risks (RR) with 95% CI to estimate predictors of disability pension by the fifth year after the cardiovascular event (outcome incidence 18%). Different regression methods were used for the fifth and the first post-event year since OR is not a good approximation of risk ratio when outcome prevalence is above 10%.[15-17] SAS 9.4 was used for all analyses.

RESULTS

Cumulative incidence of disability pension

Figure 1 illustrates the cumulative incidence of disability pension five years before and five years after a cardiovascular event of IHD or stroke: The cumulative incidence of disability pension was similar (up to 25%) until the event for both IHD and stroke. Thus, about a quarter of working-age people who had suffered incident IHD or a stroke were already on disability pension before the event. The highest prevalence of pre-event disability pension was observed among women (37%), people who were economically inactive (69%), had low education (36%), were born outside Sweden (35%), and had comorbid cancer (36%), mental disorder (58%), or diabetes (48%) at the event year (Table 1).

After the event, the cumulative incidence of disability pension was substantially higher (reaching 50%) among people who suffered a stroke event than among those who suffered an IHD event (slightly above 30%) (Figure 1). Similar characteristics were associated with first and fifth post-event year disability pensioning, as observed before the event (Table 1.)

Table 1. Characteristics of study participants by disability pension before and after a cardiovascular (ischemic heart disease or stroke) event

		Pre-event disability pension			Disability pension in first post-event year			Disability pension in fifth post-event year		
			No (n=20683)	Yes (n=7547)		No (n=19802)	Yes (n=696)		No (n=16317)	Yes (n=3454)
Characteristics		n	%	%	n	%	%	n	%	%
Sex:	Men	19713	78	22	15222	97	3	14661	85	15
	Women	8517	63	37	5276	96	4	5110	74	26
Age:	≤50 years	8332	79	21	6575	97	3	6412	85	15
	>50 years	19898	71	29	13923	96	4	13359	81	19
Education:	Low	7854	64	36	4981	95	5	4774	80	20
	Intermediate	14095	73	27	10274	97	3	9902	83	17
	High	6281	84	16	5243	97	3	5095	84	16
Economically:	Active	20076	91	9	18045	97	3	17460	85	15
	Inactive	8154	31	69	2453	90	10	2366	75	25
Family	Married/cohab.	16121	78	22	12513	97	3	12181	84	16
	Single, no childr.	10310	66	34	6693	96	4	6339	81	19
	Single, childr.	1799	72	28	1292	97	3	1251	80	20
Birth country:	Sweden	23126	75	25	17198	97	3	16582	83	17
	Other	5104	65	35	3300	95	5	3189	80	20
Living area:	Large city	9163	75	25	6776	97	3	6527	84	16
	Medium-size	10019	73	27	7212	97	3	6979	82	18

	Small town	9048	73	27	6510	96	4	6265	82	18
Cancer:	Yes	847	64	36	482	93	7	382	75	25
	No	27383	74	26	20016	97	3	19389	83	17
Mental disorder:	Yes	3286	42	58	1352	90	10	1236	71	29
	No	24944	77	23	19146	97	3	18535	83	17
Diabetes:	Yes	2887	52	48	1490	94	6	1381	75	25
	No	25343	76	24	19008	97	3	18390	83	17
Procedure*:	Yes	3077	78	22	2379	97	3	2318	85	15
	No	25153	73	27	18119	97	3	17453	82	18
Type of event:	IHD	18480	73	27	13450	98	2	13028	91	9
	Stroke	9750	73	27	7048	94	6	6743	67	33

*Medical procedure=coronary artery bypass graft, percutaneous coronary intervention, other coronary distension procedure, or intravenous intracranial procedure

Note. All p-values for difference between groups (Chi^2) were <0.01 except for 'pre-event disability pension and type of event', 'disability pension during the event year and living area', and 'disability pension during the event year and medical procedure.

New-onset disability pension in first post-event year

Table 2 presents the both the unadjusted and adjusted results on factors associated with the risk of disability pension during the first post-event year. After adjustment for sociodemographic factors, comorbid conditions, and medical procedures, stroke patients were at a higher risk of disability pension during the first post-event year than people who had suffered an IHD event (OR=2.79; 95% CI 2.37-3.29). Among both IHD and stroke patients, older age (OR=1.66; 95% CI 1.38-1.98), low education (OR=1.58; 95% CI 1.27-1.97), economic inactivity (OR=3.40; 95% CI 2.85-4.04), being single without children (OR=1.25; 95% CI 1.06-1.48), birth country other than Sweden (OR=1.27; 95% CI 1.04-1.55), living in small towns (OR=1.32; 95% CI 1.08-1.61), and comorbid cancer (OR=1.85; 95% CI 1.27-2.69) were associated with higher odds of disability pension in the first post-event year.

Table 2. Predictors of disability pension during first year after cardiovascular event. In case of significant interaction ($p<0.05$), analyses are stratified by event type.

		IHD or stroke				P for interaction with event type (IHD/stroke)	IHD		Stroke	
		Crude OR	95% CI	OR*	95% CI		OR†	95% CI	OR†	95% CI
Age:	≤50 years	1 (=Ref.)		1 (=Ref.)		0.26				
	>50 years	1.35	1.13-1.60	1.66	1.38-1.98					
Sex:	Men	1 (=Ref.)		1 (=Ref.)		0.03	1 (=Ref.)		1 (=Ref.)	
	Women	1.48	1.26-1.74	1.34	1.13-1.59		1.62	1.25-2.11	1.12	0.90-1.39
Education:	High	1 (=Ref.)		1 (=Ref.)		0.57				
	Intermediate	1.19	0.97-1.45	1.10	0.89-1.35					
	Low	1.86	1.51-2.31	1.58	1.27-1.97					
Economically:	Active	1 (=Ref.)		1 (=Ref.)		0.14				
	Inactive	4.15	3.53-4.89	3.40	2.85-4.04					
Family	Married/cohab.	1 (=Ref.)		1 (=Ref.)		0.82				
	Single, no childr.	1.56	1.33-1.83	1.25	1.06-					

					1.48					
	Single, childr.	1.20	0.87-1.65	0.94	0.67-1.31					
Birth country:	Sweden	1 (=Ref.)		1 (=Ref.)		0.51				
	Other	1.52	1.26-1.82	1.27	1.04-1.55					
Living area:	Large city	1 (=Ref.)		1 (=Ref.)		0.14				
	Medium-size	1.03	0.85-1.24	1.16	0.96-1.41					
	Small town	1.13	0.93-1.35	1.32	1.08-1.61					
Cancer:	Yes	1 (=Ref.)		1 (=Ref.)		0.38				
	No	2.15	1.49-3.08	1.85	1.27-2.69					
Mental disorder:	Yes	1 (=Ref.)		1 (=Ref.)		0.006	1 (=Ref.)		1 (=Ref.)	
	No	3.46	2.83-4.22	2.54	2.05-3.14		3.60	2.69-4.83	1.90	1.41-2.55
Diabetes:	Yes	1 (=Ref.)		1 (=Ref.)		0.02	1 (=Ref.)		1 (=Ref.)	
	No	2.01	1.60-2.51	1.98	1.56-2.51		2.49	1.85-3.34	1.40	0.94-2.08
Procedure‡:	Yes	1 (=Ref.)		1 (=Ref.)		0.02	1 (=Ref.)		1 (=Ref.)	
	No	0.81	0.62-1.04	1.12	0.85-1.46		0.88	0.64-1.22	2.13	1.33-3.42
Type of event:	IHD	1 (=Ref.)		1 (=Ref.)						
	Stroke	2.64	2.27-3.08	2.79	2.37-					

16

	3.29

* Multivariable model; all variables are entered simultaneously into the model

† Estimates are adjusted for all other variables

‡ Medical procedure =coronary artery bypass graft, percutaneous coronary intervention, other coronary distension procedure, or intravenous intracranial procedure

Differences between IHD and stroke

The following interactions with event type were significant: sex, mental disorder, diabetes, and medical procedure. Women who had suffered an IHD event had 1.62 (95% CI 1.25-2.11) times higher odds of disability pension in the first post-event year than male IHD patients, whereas sex was not associated with disability pension among stroke patients. Among IHD cases, mental disorder was associated with 3.60 (95% CI 2.69-4.83) times higher odds of disability pension during the first post-event year compared with people without a mental disorder, whereas the corresponding odds ratio among stroke cases was 1.90 (95% CI 1.41-2.55). Comorbid diabetes was associated with 2.49 (95% CI 1.85-3.34) times higher odds of disability pension, while it was not associated with the risk of disability pension among people who had suffered a stroke. Among stroke cases, having undergone a medical procedure was associated with 2.13 (95% CI 1.33-3.42) times higher odds of disability pension in the first year after the event than among those who did not receive such procedure (Table 2.) These interactions, and absolute differences between IHD and stroke cases, are further illustrated in Figure 2, where we present percentages of those who ended up on disability pension adjusted for other predictor variables.

Sensitivity analysis: Disability pension in fifth post-event year

Supplementary Table 1 presents the results regarding the factors associated with the risk of disability pension in the fifth post-event year after an IHD or stroke event. The main effects corresponded to those in first post-event year, but effect modification by event type was observed more often, indicating larger differences between IHD and stroke regarding

disability pension in the fifth post-year. Interaction terms observed at first post-year remained statistically significant, but also several other interactions emerged. Those with less education, economically inactive, and who were born outside of Sweden were at a higher risk of disability pension, especially among the IHD cases.

DISCUSSION

In this population-based longitudinal cohort study of people of working ages in Sweden who had a new IHD or stroke event, we found that the incidence of disability pension was similar five years before the first IHD or stroke event. About 25% of the cohort were already on disability pension one year prior to the event, with significant overrepresentation of socioeconomically disadvantaged. This corresponds to previous studies which have reported pre-event disability pension prevalence of 22–29%.[3, 18-20] We showed that similar sociodemographic characteristics and pre-existing comorbid conditions were associated with pre-event and post-event disability pension.

People who had suffered a stroke had a substantially higher incidence of disability pension after the event (up to 50% during the five subsequent years) than people who had suffered an IHD event (up to 30%). Thus, although the incidence of an IHD event (18 480 cases in three years) was more common than the incidence of stroke (9750 cases in three years), the disability burden of stroke was greater than that of IHD.

Female sex, older age, lower education, economic inactivity, immigrant status, living in rural areas, and having comorbid conditions were all risk factors for disability pension after cardiovascular events, which corresponds to previous studies.[4, 5, 7, 9-12, 21]. The risk of disability pension after the event was higher among women than among men with IHD, but we observed no sex difference regarding stroke. Other research has reported significantly better long-term prognosis among women,[22] but no sex difference in mortality due to stroke.[23] Thus, the higher risk of disability pension after an IHD event among women may reflect women's higher probability of disability pension in general,[24] or may

be related to men's higher risk of cardiovascular mortality before disability pension is granted.

As comorbid conditions contributed to exit to disability pension, it is possible that part of these disability pensions were due to diagnoses other than cardiovascular diseases. However, as the incidence of disability pension increased markedly after the cardiovascular event, it is unlikely that comorbid conditions can explain all disability pensions. Having had medical procedure related to the event was associated with disability pension shortly after a stroke event. Medical procedure can be viewed as a proxy for the severity of the event. Thus, risk groups for disability pension shortly after a stroke are those who suffer a more severe event, which corresponds to previous results regarding return to work.[4, 5]

Although the relative difference in the risk of disability pension between those with and without comorbid mental disorder and diabetes was larger for IHD cases than for stroke cases, the highest absolute risk was found among those who had suffered a stroke and had mental disorder or diabetes. Mental disorders, particularly depression, associated with an IHD or stroke event might decrease work capacity by reducing functional capacity, and by preventing the patient from participating in physical rehabilitation and cognitive therapies, adhering to medical procedures, or making the necessary lifestyle changes needed to achieve work capacity after IHD or a stroke.[25] Diabetes has been associated with excess risk of death following myocardial infarction.[26]

In Sweden, people can be granted disability pension even without a history of sick leave. However, even if it is rather likely that the individual will not return to work after, e.g., a severe stroke, the patient or the relatives seldom apply for disability pension as the benefit is usually lower than that for sick leave. The main reason for applying for disability

pension immediately after the disability event is that one cannot get sickness absence benefits (not having had income from work or unemployment benefit). Apart from certain specific exceptions (e.g., ongoing treatment), one cannot be on sick leave for more than 365 consecutive days. Thus, people who were granted disability pension during the first post-event year were possibly in a poorer labour market position, which prevented them from applying for sickness absence benefits. This corresponds to our findings, since economic inactivity was the strongest predictor of disability pension in the first post-event year regardless of event type. Other indicators of poorer labour market position, such as low education and birth country other than Sweden, were also predictive of fast exit to disability pension.

Socioeconomic background and comorbid conditions explained the risk of disability pension five years after the event to a greater extent among IHD than stroke cases. This is noteworthy, since poorer labour market position and not fulfilling the criteria for entitlement to sickness absence benefits cannot explain disability pension in the fifth post-event year. The often higher severity of stroke compared to IHD may explain this difference; after an IHD event, the probability of recovering to relatively good work capacity may be higher. However, the observed differences in this recovery seem to relate to socioeconomic characteristics and resources; the background factors may affect people's recovery and rehabilitation.[27] Stroke, often a more disabling cardiovascular event, may more totally reduce work capacity, and hence we found smaller individual differences. However, a socioeconomic gradient has also been observed in short- and long-term outcomes after a stroke.[28]

The major strength of this study was its large population-based cohort data with reliable register-based measures of high coverage and specificity,[29] and no loss to follow up. Compared to previous studies, we also had a longer follow-up – five years – both before

and after the event. We were able to include a large set of predictors of disability pension, including sociodemographic factors, comorbid conditions, and medical procedure.

The register data also have some limitations: we were only able to include information that was available in administrative registers. This meant that we had no information on quality and outcome of post-event care, individuals' health behaviours or workplace psychosocial factors, which are typically collected in surveys, and have previously been linked to disability pension in general populations.[30] However, a recent study among Finnish public sector employees demonstrated that the contribution of health behaviours and workplace psychosocial factors to the risk of disability pension was relatively small compared to the contribution of comorbidity, especially mental comorbidity.[7] Regarding post-event care, men were more likely to enrol in disease management program than women after coronary heart disease in Germany.[31] We also did not have direct measure of event severity, but used medical procedure as a proxy measure. In future studies, also recurrent events could be included. Finally, the high employment frequency in higher ages and among women in Sweden as well as the universal coverage with relatively high benefit levels might limit the generalizability of the results.[32]

In a recent study, disability pensioning five years after percutaneous coronary intervention or coronary artery bypass crafting was fairly common (15-35%) among young (≤50 years) IHD patients.[33] The fact that even after successful surgery and complete revascularization, these patients often ended up on disability pension lead the authors to speculate that disability pensioning may be partly explained by patients' and healthcare professionals' attitudes towards recovery and return to work.[33] In Sweden, at least one physician and often other health professionals, are involved in the assessments of the disease the patient has, the functional limitations the disease have led to, and to what extent those limitations actually might influence the work capacity of the patient and for how long. These

assessments are sent to the Social Insurance Agency, where an officer evaluates and decides whether the patient (=claimant) fulfills the criteria for being granted disability pension or not, and if so, to what extent (part- or full-time). However, other type of studies are warranted to shed light on these processes, and perhaps this explorative study can inspire such studies.

Conclusions

Our results quantify and emphasize the burden of IHD and stroke to the labour market, and can help occupational and other healthcare professionals to identify vulnerable groups at risk for permanent exclusion from labour market after such an event. While IHD event was more common, stroke caused more permanent work disability. As regards IHD, non-medical risk factors contributed to the risk of disability pension, whereas medical factors contributed to the risk of disability pension after stroke. This knowledge may be beneficial when planning interventions to prevent permanent work disability after either event.

Contributors: JE, MV, TL, EMR, and KA contributed to conception and design. JE analysed the data and drafted the manuscript. All authors contributed either to analysis, interpretation or acquisition of the data, and critically revised the manuscript. All gave final approval and agree to be accountable for all aspects ensuring integrity and accuracy.

Funding: This study was supported by the Swedish Research Council for Health, Working Life and Welfare. JE, MV, and TL were supported by the Academy of Finland (projects 258598, 292824, 287488). The funding organizations had no role in the study design, data collection, analysis, interpretation of the data, writing the report, or in the decision to submit the paper.

Competing interest: None declared.

Ethics approval: Ethical approval was obtained from the Regional Ethical Review Board, Stockholm, Sweden.

Data sharing statement: No additional data available.

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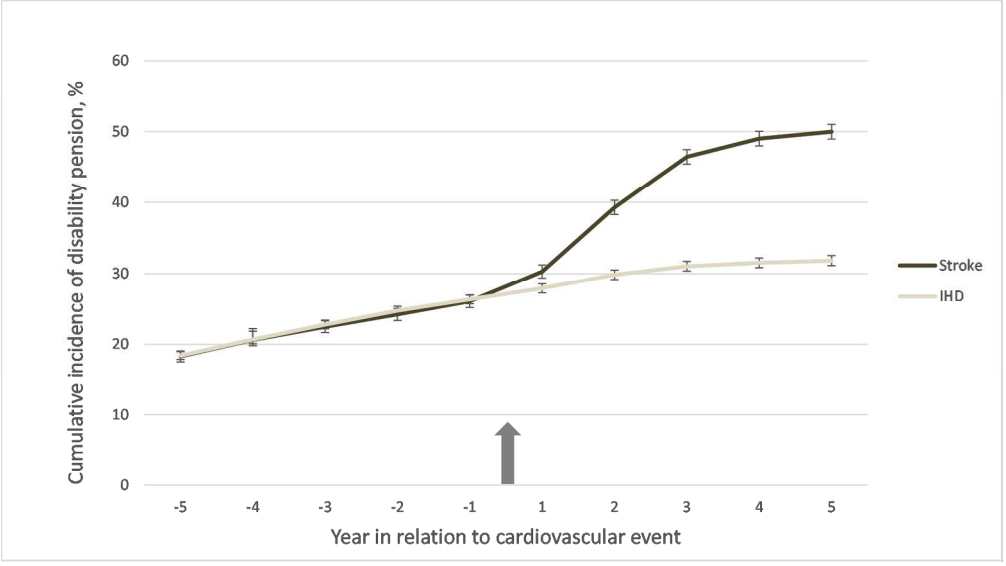
Figure legends:

Figure 1. Cumulative incidence of disability pension 5 years before and 5 years after cardiovascular event, unadjusted. The arrow indicates the event. IHD=ischemic heart disease.

Figure 2. Adjusted percentage of people suffering an IHD or stroke event ending up on disability pension during first post-event year. Exponentiated least square means (×100) adjusted for sex, age, education, economic inactivity, family situation, birth country, type of living area, mental disorder, diabetes, cancer, and medical procedure. Error bars indicate 95% confidence intervals. IHD=ischemic heart disease.



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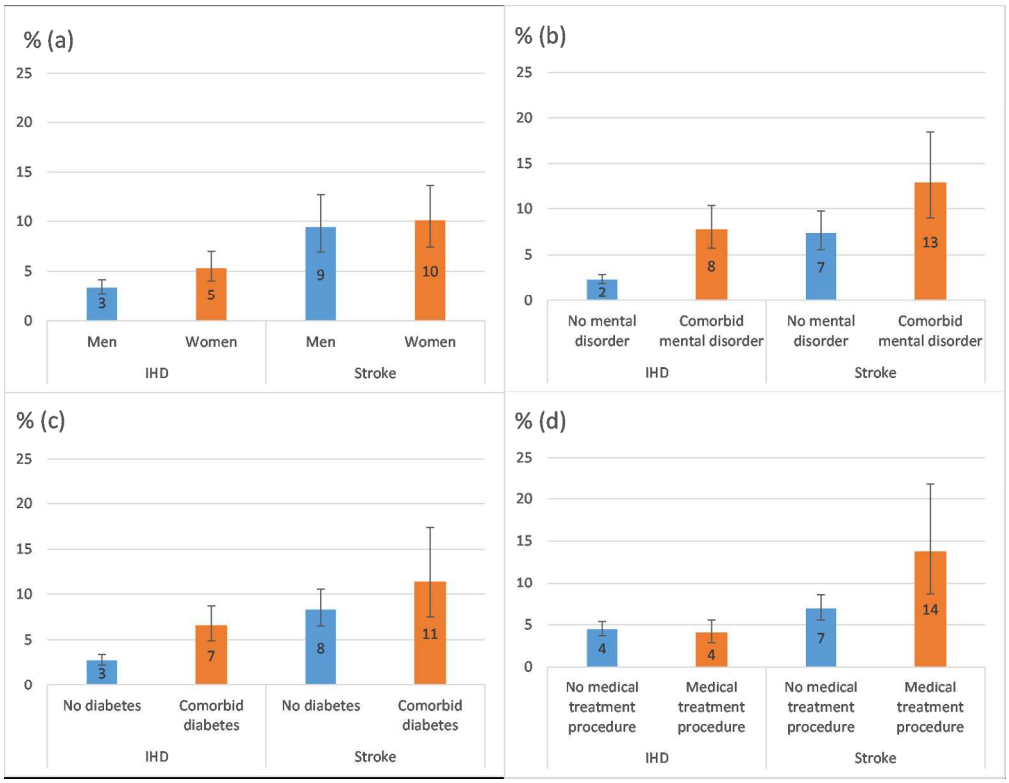


Figure 2. Adjusted percentage of people suffering an IHD or stroke event ending up on disability pension during first post-event year. Exponentiated least square means (×100) adjusted for sex, age, education, economic inactivity, family situation, birth country, type of living area, mental disorder, diabetes, cancer, and medical procedure. Error bars indicate 95% confidence intervals. IHD=ischemic heart disease.

Supplementary Table 1. Predictors of disability pension in five year follow-up after cardiovascular (ischemic heart disease or stroke) event. In case of significant interaction ($p<0.05$), analyses are stratified by event type.

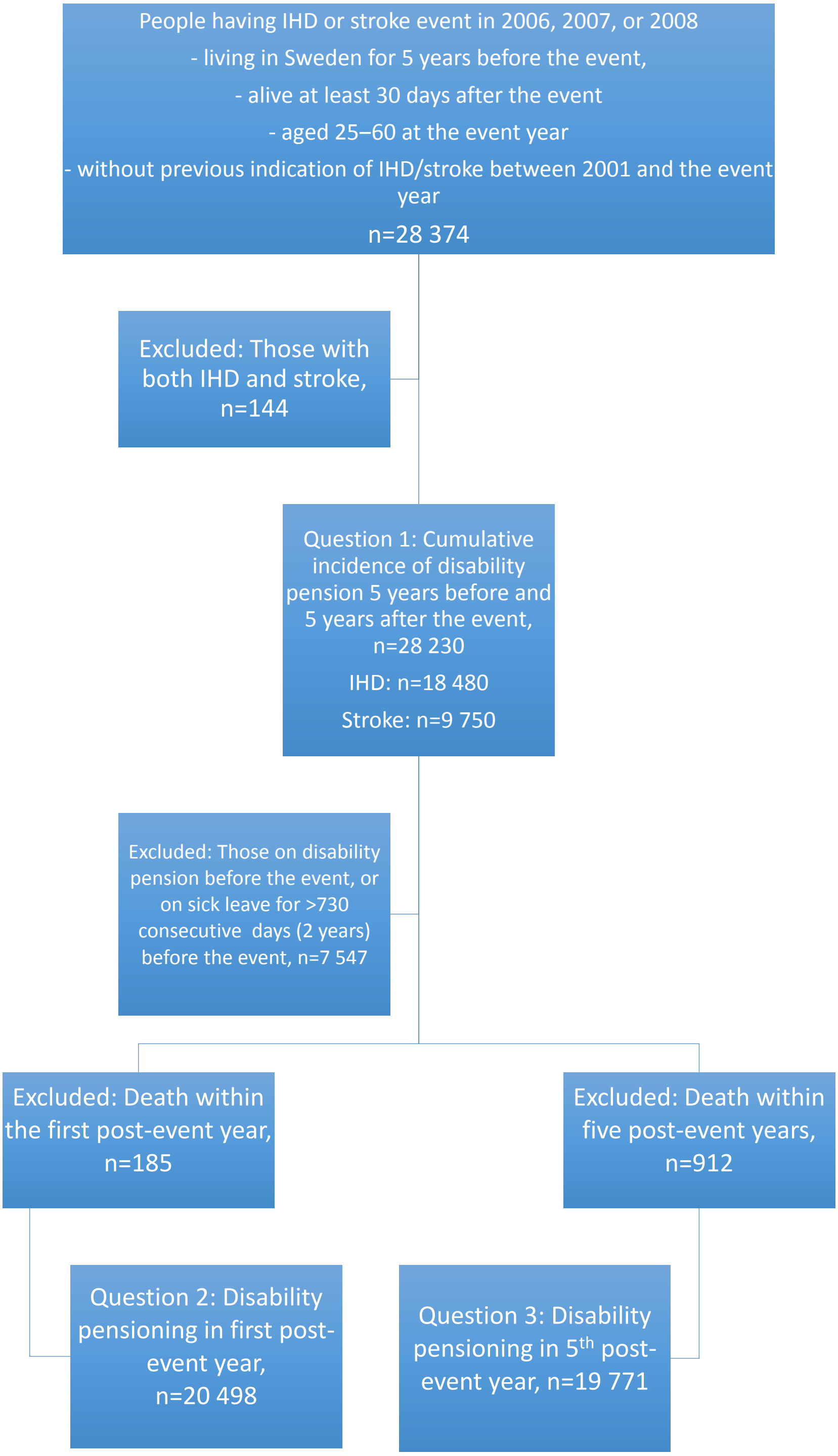
		IHD or stroke				P for interaction with event type (IHD/stroke)	IHD		Stroke	
		Crude RR	**95% CI**	**RR***	**95% CI**		**RR†**	**95% CI**	**RR†**	**95% CI**
Age:	≤50 years	1 (=Ref.)		1 (=Ref.)		0.99				
	>50 years	1.23	1.14-1.32	1.45	1.35-1.57					
Sex:	Men	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
	Women	1.77	1.65-1.90	1.45	1.35-1.55		1.81	1.60-2.04	1.29	1.10-1.40
Education:	High	1 (=Ref.)		1 (=Ref.)		0.013	1 (=Ref.)		1 (=Ref.)	
	Intermediate	1.11	1.02-1.21	1.11	1.02-1.21		1.07	0.92-1.25	1.13	1.02-1.26
	Low	1.30	1.19-1.43	1.29	1.17-1.42		1.46	1.24-1.71	1.20	1.07-1.36
Economically:	Active	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
	Inactive	1.54	1.41-1.68	1.35	1.23-1.48		1.78	1.54-2.05	1.16	1.03-1.30
Family	Married/cohab.	1 (=Ref.)		1 (=Ref.)		0.19				
	Single, no childr.	1.19	1.11-1.27	1.11	1.03-1.19					
	Single, childr.	1.22	1.07-1.39	1.04	0.91-1.19					
Birth country:	Sweden	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	

	Other		1.15	1.06-1.26	1.20	1.10-1.31		1.49	1.30-1.70	1.04	0.92-1.17
Living area:	Large city		1 (=Ref.)		1 (=Ref.)		0.77				
	Medium-size		1.19	1.10-1.29	1.26	1.16-1.36					
	Small town		1.18	1.08-1.28	1.27	1.17-1.39					
Cancer:	Yes		1 (=Ref.)		1 (=Ref.)		0.065				
	No		1.47	1.20-1.79	1.32	1.08-1.61					
Mental disorder:		Yes	1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
		No	1.76	1.58-1.96	1.52	1.36-1.70		2.35	1.99-2.78	1.19	1.03-1.38
Diabetes:	Yes		1 (=Ref.)		1 (=Ref.)		<0.001	1 (=Ref.)		1 (=Ref.)	
	No		1.45	1.30-1.63	1.64	1.46-1.83		2.05	1.76-2.39	1.30	1.10-1.54
Procedure‡:	Yes		1 (=Ref.)		1 (=Ref.)		0.28				
	No		0.83	0.74-0.93	1.29	1.15-1.45					
Type of event:	IHD		1 (=Ref.)		1 (=Ref.)						
		Stroke	3.64	3.39-3.90	3.77	3.50-4.06					

* Multivariable model; all variables are entered simultaneously into the model

† Estimates are adjusted for all other variables

‡ Medical procedure =coronary artery bypass graft, percutaneous transluminal coronary angioplasty, other coronary distension procedure, or intravenous intracranial procedure



Supplementary Figure 1. Flow chart of study inclusion and exclusion criteria.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6-7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-8
Bias	9	Describe any efforts to address potential sources of bias	6,7
Study size	10	Explain how the study size was arrived at	Supplementary Fig 1.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and	9

		interactions	
		(*c*) Explain how missing data were addressed	no missing data
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	no loss to follow-up
		€ Describe any sensitivity analyses	9
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Supplementary Fig 1.
		(b) Give reasons for non-participation at each stage	Supplementary Fig 1.
		(c) Consider use of a flow diagram	Supplementary Fig 1.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	no missing data
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Supplementary Fig 1.
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	Table 1
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 2
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Figure 1, Figure 2
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Table 2, Supplementary Table 1.
Discussion			
Key results	18	Summarise key results with reference to study objectives	19-20
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22

Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	22
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.