Journal of Psychosomatic Research 82 (2016) 41–47

Contents lists available at ScienceDirect

Journal of Psychosomatic Research

Health- and work-related predictors of work disability among employees with a cardiometabolic disease — A cohort study

Jenni Ervasti [a,*], Mika Kivimäki [a,b,c], Jaana Pentti [a], Paula Salo [a,d], Tuula Oksanen [a], Jussi Vahtera [a,e], Marianna Virtanen [a]

[a] Finnish Institute of Occupational Health, Helsinki, Finland
[b] Department of Epidemiology and Public Health, University College London, UK
[c] Clinicum, Faculty of Medicine, University of Helsinki, Finland
[d] Department of Psychology, University of Turku, Finland
[e] Department of Public Health, University of Turku and Turku University Hospital, Turku, Finland

ARTICLE INFO

Article history:
Received 14 October 2015
Received in revised form 28 January 2016
Accepted 29 January 2016

Keywords:
Cerebrovascular disease
Diabetes
Heart disease
Stage 2 hypertension
Obesity
Psychological distress

ABSTRACT

Objective: The proportion of aging employees with cardiometabolic diseases, such as heart or cerebrovascular disease, diabetes and chronic hypertension is on the rise. We explored the extent to which health- and work-related factors were associated with the risk of disability pension among individuals with such cardiometabolic disease.
Methods: A cohort of 4798 employees with and 9716 employees without a cardiometabolic disease were followed up for 7 years (2005–2011) for disability pension. For these participants, register and survey data (from 2004) were linked to records on disability pensions. Cox proportional hazards modeling was used for estimating the hazard ratios (HR) with 95% confidence intervals (CI).
Results: Individuals with heart or cerebrovascular disease had 2.88-fold (95% CI = 2.50–3.31) higher risk of all-cause disability pension compared to employees with no cardiometabolic disease. Diabetes was associated with a 1.84-fold (95% CI = 1.52–2.23) and hypertension a 1.50-fold (95% CI = 1.31–1.72) increased risk of disability pension. Obesity in cases of diabetes and hypertension (15%) and psychological distress in cases of heart or cerebrovascular disease (9%) were the strongest contributing factors. All 12 health- and work-related risk factors investigated accounted for 24% of the excess work disability in hypertension, 28% in diabetes, and 11% in heart or cerebrovascular disease. Cause-specific analyses (disability pension due to mental, musculoskeletal and circulatory system diseases) yielded similar results.
Conclusions: In this study, modifiable risk factors, such as obesity and mental comorbidity, predicted permanent exit from the labor market due to disability in individuals with cardiometabolic disease.

1. Introduction

As employees are expected to extend their working careers, the proportion of aging employees with cardiometabolic diseases, such as heart or cerebrovascular disease, diabetes and chronic hypertension is likely to rise in the future. Although these diseases are important causes of work disability [1–4], having a cardiometabolic disease does not necessary lead to permanent exit from the labor market. However, factors that are associated with an increased risk of work disability in these patient groups are not well known.

Previous research suggests that smoking [5–9], high alcohol consumption [10,11], physical inactivity [8,9], high body mass index [12], and psychosocial factors at work [8,9,13–15] are associated with disability pension in working populations. It may therefore be justified to hypothesize that these health behaviors and work-related factors also contribute to work disability in those with a cardiometabolic disease. Similarly, comorbid physical diseases and psychological morbidity may be assumed to contribute to work disability in this group [16–18]. To date, however, few studies have directly tested these hypotheses.

To address these limitations, we sought to determine the extent to which non-cardiometabolic comorbidity, psychological distress, health behaviors, and work characteristics were associated with the risk of disability pension among individuals with heart disease, cerebrovascular disease, diabetes or chronic hypertension.

2. Methods

2.1. Study sample and design

This prospective cohort study is part of the Finnish Public Sector study of employees of 10 municipalities and 21 hospitals [19]. The study was approved by The Ethics Committee of the Hospital District

* Corresponding author at: Finnish Institute of Occupational Health, Topeliuksenkatu 41 a A, 00250 Helsinki, Finland.
E-mail address: jenni.ervasti@ttl.fi (J. Ervasti).

http://dx.doi.org/10.1016/j.jpsychores.2016.01.010
0022-3999/

of Helsinki. The eligible population comprised those who responded to a questionnaire survey in 2004 (n = 56,856). From these data, we sourced employees who were alive on 1 January 2005, were not on disability pension or old-age pension, and had heart disease, cerebrovascular disease, diabetes or chronic hypertension (n = 5415) in 2004. We also randomly selected a sex- and age-matched control group of employees who had none of the conditions at the baseline (n = 10,831). We excluded those with missing data on any of the predictor variables (n = 1732), resulting in a final analytic sample of 4798 cases with at least one of the cardiometabolic conditions and 9716 controls with none of these conditions.

Survey data were linked to records from national registers through the personal identity number that is unique to each resident of Finland. The Social Insurance Institution of Finland keeps records of sickness allowance, subsidized medication and other medication purchases for which data are collected from employees and pharmacies. The Finnish Centre for Pensions keeps records of all pensions in Finland. The Finnish Cancer Registry is an institute for epidemiological and statistical cancer research. We used data from:

(1) Drug Reimbursement Register: records of medical purchases coded according to the Anatomic Therapeutic Chemical (ATC) classification system [20].
(2) Special Refund Entitlement Register, which lists individuals with certain severe and chronic conditions who are entitled to a higher rate of reimbursement for medicines. To be eligible for special reimbursement, a patient's condition must meet explicit predefined criteria, and a written certificate is required from the treating physician. The application is reviewed by a physician from the Social Insurance Institution to determine whether the uniformly defined requirements have been met.
(3) Sickness Allowance Register records of sickness absence. This register includes all diagnosis-specific sickness absences lasting for 10 to 365 days, with beginning and ending dates. The main diagnosis assigned by the treating physician was coded according to the International Classification of Diseases, 10th Revision (ICD-10) [21].
(4) Finnish Centre for Pensions: Data on temporary, permanent, full-time, and part-time disability pensions, coded according to ICD-10.
(5) Hospital discharge records: Main and secondary diagnoses for causes of hospitalization according to ICD-10.
(6) Finnish Cancer Registry: Information on all cancer cases in Finland going back to 1953.

2.2. Measures

2.2.1. Heart or cerebrovascular disease, diabetes and chronic stage 2 hypertension

Heart or cerebrovascular disease was defined as having at least one of the following: Special reimbursement for cardiac failure or coronary artery disease; sickness absences or hospitalization with ICD-10 codes I20-I25, I46-I49, and I60-I69 from 2003 to 2004; or self-reported doctor-diagnosed cardiovascular disease (coronary thrombosis, angina pectoris or transient ischemic attack) in the 2004 survey. Indication of diabetes was based on having at least one of the following: Diabetes medication (ATC code A10) purchases (in 2003 to 2004), special reimbursement for diabetes in 2004 or self-reported doctor-diagnosed diabetes in the 2004 survey. Cases of chronic stage 2 hypertension were identified on the basis of entitlement for special reimbursement for chronic hypertension.

As cardiometabolic diseases co-occur [22–24], we allowed for comorbid chronic hypertension among those with heart disease, cerebrovascular disease or diabetes, and because diabetes is also a risk factor for future cardiovascular events [24–26], we also allowed for comorbid diabetes among those with heart or cerebrovascular disease. The chronic hypertension group included participants who had hypertension but neither heart disease, cerebrovascular disease nor diabetes. These groups were not overlapping, i.e. each individual was exclusively classified as either having heart- or cerebrovascular disease, diabetes, or hypertension.

2.2.2. Disability pension

Daily-based information on disability pension was obtained from the Finnish Centre for Pensions and linked to survey data. The cohort was followed up for disability pension for 7 years, from the beginning of 2005 to the end of 2011. As a study on the population of Sweden found that most of the excess work disability in people with diabetes compared to those without were due to mental and musculoskeletal disorders followed by disease of the circulatory system [4], we examined in sensitivity analyses, in addition to all-cause disability pension, the three most common causes of disability pension separately. Diagnosis-specific data was coded according to ICD-10; mental disorders included codes F00-F99; musculoskeletal, M00-M99; and diseases of the circulatory system, I00-I99.

2.2.3. Sociodemographic characteristics

Sociodemographic factors were measured at the beginning of the follow-up. Sex, age (continuous variable), and socioeconomic status (SES) based on occupational title (coded as upper-grade non-manual, lower-grade non-manual and manual) were retrieved from employers' registers.

2.2.4. Health factors

Comorbid non-cardiometabolic chronic diseases included asthma, rheumatoid arthritis, and cancer, and were derived from health records: information on cancer was from the Finnish Cancer Registry, and the rest of the diseases were from the Special Refund Entitlement Register. Psychological morbidity was measured by a psychological distress scale, the 12-item General Health Questionnaire (GHQ-12) [27]. In GHQ-12, respondents rate the extent to which they are affected by each of the 12 symptoms of distress (0 = not at all, 0 = as much as usual, 1 = slightly more than usual, 1 = much more than usual). As previously, participants with a rating of 1 in at least 4 items of the total measure were coded as cases of psychological distress.

2.2.5. Behavior-related risk factors

Health behaviors, including obesity, heavy alcohol use, smoking, and physical inactivity, were self-reported from the baseline survey. Body mass index (BMI = weight in kilograms divided by height in meters squared) was dichotomized as less than 30 (non-obese) and 30 or more (obese) [28]. Alcohol use was elicited by questions on weekly consumption. One drink was approximately equivalent to one unit or one glass of alcoholic drink or 10 g of alcohol. Alcohol use was dichotomized into no use or moderate use (a maximum of 14 units for women and 21 units for men) versus alcohol use greater than this [29]. Smoking was dichotomized into current smoker and non-smoker (including never smokers and ex-smokers) [30]. Participants were categorized as being physically inactive if they reported <2 metabolic equivalent task hours per day (approximately 30 min of walking) and active if more than this [31].

2.2.6. Work arrangements

Shift work, coded as day job, shift work without night shifts, shift work with night shifts, and other type of shift work, was retrieved from survey data, and type of job contract (permanent or temporary) at baseline was retrieved from employers' registers.

2.2.7. Psychosocial work environment

Psychosocial work environment factors were measured by a questionnaire survey in 2004. Job demands and job control were measured

by mean response scores: three job demand items (scale 1–5) and nine job control items (1–5), for which higher scores indicated greater control and greater demands. Job strain, as indicated by low control and high strain [32], was calculated as: 'job demands' − 'job control' resulting in values ranging from −4 to 4, where higher score indicated higher strain [13]. Efforts and rewards were measured by mean response scores using one effort item (1–5) and three reward items (1–5), in which higher scores indicated higher efforts and higher rewards [33]. Effort-reward imbalance (ERI) was calculated as: 'efforts'/'rewards' resulting in values ranging from 0.2 to 5.0, where a higher score indicated a greater imbalance. This 4-item measure of ERI is considered as a valid proxy for the original ERI-scale [34]. Social capital at work was measured by a previously validated 8-item measure [35]. The items (scale 1–5) indicated whether employees felt respected, valued and treated as equals at work. Higher scores indicated greater social capital. The question used to assess supervisor support was different in the survey among the municipal employees than that used among the hospital staff. In municipalities, the question was "My supervisor supports and encourages me" (scale 1–5, where 5 = totally disagree), whereas the hospital questionnaire elicited "satisfaction with support and guidance from supervisor" (scale 1–7, where 7 = totally unsatisfied). Participants were denoted as having low supervisor support if they reported values above 3 in the municipalities, or above 4 in the hospitals.

2.3. Statistical analysis

We used normal and log-binomial regression procedures to produce rate ratios (RR) and prevalence ratios (PR) and their 95% confidence intervals (CI) to estimate differences in baseline characteristics between those with and without cardiometabolic disease. The estimate was indicated by RR with continuous outcomes, and by PR with dichotomous outcomes. Since the controls were matched for sex and age, we did not test the differences for these characteristics.

We used Cox proportional hazard regression analysis to estimate hazard ratios (HR) and their 95% CI for disability pension. The participants were followed from the beginning of follow-up (1.1.2005) until disability pension, old-age pension, death, or the end of follow-up (31.12.2011), whichever came first. The contribution of health-, health behaviors-, and work-related factors was determined by calculating the percentage reduction in the parameter coefficient (Beta [B]) for the association between each cardiometabolic disease and disability pension after the serial inclusion of these covariates using the formula.

$$100 \times (B_{Base} - B_{Model\ X})/(B_{Base})$$

where 'Base' is the model adjusted for socio-demographic factors (age, sex, SES), and 'Model X' is the model introducing a new predictor variable(s).

3. Results

The characteristics of participants with heart or cerebrovascular disease (n = 1282), diabetes (n = 1037), hypertension (n = 2479), or none of these (n = 9716) are described in Table 1. Employees with heart or cerebrovascular disease had an adverse psychosocial work environment more often than employees who had no cardiometabolic disease. Employees with diabetes more often had a temporary job contract, and were more often smokers than those free of the conditions. Employees with chronic hypertension were more often risky alcohol users, and more often had a permanent job contract and adverse psychosocial work environment than those free of cardiometabolic conditions. Overall, participants having any of the cardiometabolic diseases had lower socioeconomic status; were more often obese; more often had a sedentary lifestyle, comorbid non-cardiometabolic conditions and psychological distress; and more often experienced an imbalance between efforts and rewards at work than those with no cardiometabolic disease. Individuals with heart or cerebrovascular disease suffered more psychological distress than those with diabetes or hypertension. Those with diabetes or hypertension were more often obese than those with heart or cerebrovascular disease.

The mean follow-up time for participants with heart or cerebrovascular disease was 5.1 years (SD = 2.3); for those with diabetes, 5.8 years (SD = 2.0); for those with hypertension, 5.6 years (SD = 2.1); and for those without any cardiometabolic disease, 5.9 years (SD = 1.9). Fig. 1 shows the unadjusted cumulative probability of disability pension for those with heart or cerebrovascular disease, diabetes, hypertension, and those without any of the conditions, suggesting that participants with heart or cerebrovascular disease most often ended up on disability pension. The cumulative probability of disability pension in the 7th year of follow-up was 24% for participants with heart or cerebrovascular disease, 14% for those with diabetes, 14% for those with hypertension, and 9% for those without cardiometabolic diseases.

Table 2 shows the contribution of health-, health behavior-, and work-related factors to the risk of disability pension. In the socio-demographics-adjusted model (i.e., the base model), the relative risk of disability pension among employees with heart or cerebrovascular disease was 2.88 times (95% CI 2.50–3.31) greater than that of those with no cardiometabolic disease. Adjustment for psychological distress attenuated the risk of disability pension among employees with heart or cerebrovascular disease by 9%. Adjustment for non-cardiometabolic diseases did not change the relative risk, and adjustment for health behaviors only made a small contribution (4%) to the relative risk of disability pension. Adjustment for work arrangements did not change the relative risk of disability pension among employees with heart or cerebrovascular disease. Adjustment for psychosocial work environment made a small (3%) contribution to the risk of disability pension. When adjusting for all health factors, health behaviors, work arrangements, and psychosocial work environment, the risk was attenuated by 11% compared to the base model.

For employees with diabetes, the socio-demographics-adjusted risk for disability pension was 1.84 times (95% CI 1.52–2.23) greater than that of those with no cardiometabolic diseases (Table 2). Adjustment for both psychological distress and other non-cardiometabolic conditions attenuated the risk for disability pension by 11%. Adjustment for smoking or alcohol use did not change the relative risk of disability pension among employees with diabetes, but adjustment for BMI attenuated this risk by 15%, and adjustment for physical activity by 5%. Adjustment for work arrangements did not change the relative risk of disability pension among employees with diabetes, and adjustment for job strain and ERI only made a small contribution (2%). When adjusting for all health factors, health behaviors, work arrangements, and psychosocial work environment, the risk was attenuated by 28% compared to that of the base model.

For those with chronic hypertension, the sociodemographics-adjusted risk for disability pension was 1.50 (95% CI 1.31–1.72) times greater than that of those with no cardiometabolic disease. Adjustment for both psychological distress and comorbid non-cardiometabolic diseases attenuated the risk for disability pension by 7%. Adjustment for BMI attenuated this risk by 15%, and adjustment for physical activity by 5%. Adjustment for work arrangements did not change the relative risk of disability pension among employees with hypertension. Adjustment for job strain attenuated the risk of disability pension by 5%; and adjustment for ERI, social capital and supervisor support by 2% each. When adjusting for all health factors, health behaviors, work arrangements, and mental and physical workload, the risk was attenuated by 24% compared to that of the base model. (Table 2.)

3.1. Diagnosis-specific disability pension

The diagnosis-specific analyses are presented in Supplementary Tables 1–3. Compared to the reference group without cardiometabolic

Table 1
Characteristics of participants at baseline in 2004 (n = 14,514) and differences in health- and work-related factors compared to those with no cardiometabolic disease.

Characteristic	Without cardiometabolic condition n = 9716		Chronic hypertension n = 2479		Diabetes n = 1037		Heart or cerebrovascular disease n = 1282	
	Frequency/mean (SD)	RR/PR[a] (95% CI)	Frequency/mean (SD)	RR/PR[a] (95% CI)	Frequency/mean (SD)	RR/PR[a] (95% CI)	Frequency/mean (SD)	RR/PR[a] (95% CI)
Age, years	50.8 (7.7)		51.9 (6.6)		47.9 (9.6)		52.1 (7.4)	
Sex								
Men	2545 (26)		607 (24)		276 (27)		375 (29)	
Women	7171 (74)		1872 (76)		761 (73)		907 (71)	
SES[b]		1.00		1.16 (1.13–1.20)		1.11 (1.06–1.16)		1.16 (1.12–1.21)
Upper non-manual	3259 (34)		559 (23)		280 (27)		329 (26)	
Lower non-manual	4638 (48)		1352 (55)		525 (51)		619 (48)	
Manual	1819 (19)		568 (23)		232 (22)		334 (26)	
Other chronic conditions								
No	9081 (93)		2254 (91)		947 (91)		1175 (92)	
Yes	635 (7)	1.00	225 (9)	1.39 (1.20–1.61)	90 (9)	1.33 (1.08–1.64)	107 (8)	1.28 (1.05–1.55)
Psychological distress								
No	7435 (77)		1864 (75)		743 (72)		809 (63)	
Yes	2281 (23)	1.00	615 (25)	1.07 (0.98–1.14)	294 (28)	1.21 (1.09–1.34)	473 (37)	1.57 (1.45–1.70)
Smoking								
No	8097 (83)		2091 (84)		838 (81)		1068 (83)	
Yes	1619 (17)	1.00	388 (16)	0.94 (0.85–1.04)	199 (19)	1.15 (1.01–1.31)	214 (17)	1.00 (0.88–1.14)
Risky alcohol use								
No	8706 (90)		2174 (88)		921 (89)		1157 (90)	
Yes	1010 (10)	1.00	305 (12)	1.18 (1.05–1.33)	116 (11)	1.08 (0.90–1.29)	125 (10)	0.94 (0.79–1.12)
Obesity								
No	8547 (88)		1781 (72)		664 (64)		1037 (81)	
Yes	1169 (12)	1.00	698 (28)	2.34 (2.15–2.54)	373 (36)	2.99 (2.71–3.30)	245 (19)	1.59 (1.40–1.80)
Physical activity								
Active	7384 (76)		1686 (68)		671 (65)		852 (66)	
Sedentary	2332 (24)	1.00	793 (32)	1.33 (1.25–1.43)	366 (35)	1.47 (1.34–1.61)	430 (34)	1.40 (1.28–1.52)
Shift work								
Day job	6662 (69)		1718 (69)		724 (70)		892 (70)	
Shift work	3054 (31)	1.00	761 (31)	0.98 (0.91–1.04)	313 (30)	0.96 (0.87–1.06)	390 (30)	0.97 (0.89–1.06)
Job contract								
Permanent	8887 (93)		2305 (94)		924 (90)		1188 (94)	
Temporary	698 (7)	1.00	137 (6)	0.77 (0.65–0.92)	100 (10)	1.34 (1.10–1.64)	74 (6)	0.81 (0.64–1.02)
Job strain	−0.48 (1.09)	1.00	−0.37 (1.11)	1.12 (1.06–1.17)	−0.44 (1.12)	1.04 (0.97–1.12)	−0.31 (1.16)	1.19 (1.11–1.27)
ERI	1.54 (0.54)	1.00	1.58 (0.57)	1.04 (1.02–1.07)	1.60 (0.62)	1.06 (1.02–1.10)	1.60 (0.62)	1.06 (1.03–1.10)
Social capital	3.62 (0.75)		3.56 (0.76)	0.94 (0.91–0.98)	3.59 (0.79)	0.97 (0.92–1.02)	3.50 (0.81)	0.89 (0.85–0.93)
Supervisor support								
No	1776 (18)	1.00	497 (20)	1.10 (1.00–1.20)	203 (20)	1.07 (0.94–1.22)	286 (22)	1.22 (1.09–1.36)
Yes	7940 (82)		1982 (80)		834 (80)		996 (78)	

SES: socioeconomic status; ERI: effort-reward imbalance.
[a] RR: rate ratio, was used for continuous outcomes; PR: prevalence ratio, was used for binary outcomes.
[b] SES was treated as continuous outcome.

diseases, those with heart or cerebrovascular disease had a greater risk of disability pension due to mental disorders (HR = 2.69, 95% CI 1.97–3.68). The corresponding hazard ratio was 1.44 (95% CI = 1.07–1.93) for employees with chronic hypertension. Employees with diabetes were at no higher risk of disability pension due to mental disorders than the reference group. Obesity in hypertension cases (14%) and psychological distress in heart or cerebrovascular disease (20%) were the strongest contributing factors to the excess risk of work disability due to mental disorders. Adverse work-related psychosocial factors, especially job strain (6% in hypertension and 3% in heart or cerebrovascular disease) and imbalance of efforts and rewards (6% in hypertension and 4% in heart or cerebrovascular disease) contributed slightly to the excess risk of work disability due to mental disorders. All in all, the risk factors investigated accounted for 19% of the excess risk of work disability due to mental disorders in hypertension cases, and 22% in heart or cerebrovascular disease (Supplementary Table 1).

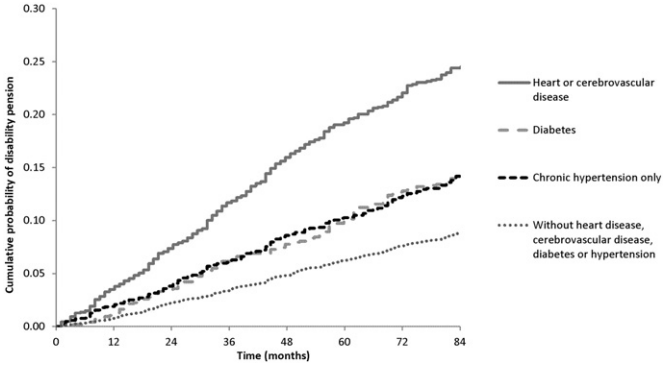

Fig. 1. Cumulative probability of all-cause disability pension from beginning of follow-up for people with heart or cerebrovascular disease, diabetes, or chronic hypertension only and without the cardiometabolic diseases (unadjusted).

The results were also rather similar with regard to disability pensions due to musculoskeletal disorders (Supplementary Table 2). Compared to the reference group with no cardiometabolic disease, those with heart or cerebrovascular disease were at the highest risk of disability pension due to musculoskeletal disorders (HR = 2.19, 95% CI 1.78–2.71). The corresponding hazard ratio was 1.62 (95% CI 1.22–2.14) for

Table 2
All-cause disability pension according to cardiometabolic disease following adjustment for potential explanatory and mediating factors.

	Without cardiometabolic condition	Chronic hypertension		% Attenuation[a]	Diabetes		% Attenuation[a]	Heart or cerebrovascular disease		% Attenuation[a]
N of events/N of participants	738/9716 (8%)	306/2479 (12%)			124/1037 (12%)			271/1282 (21%)		
	HR	HR	95% CI		HR	95% CI		HR	95% CI	
Age- sex-, SES-adjusted model (base model)	1.00	1.50	1.31–1.72		1.84	1.52–2.23		2.88	2.50–3.31	
Other chronic condition	1.00	1.48	1.29–1.69	2	1.79	1.48–2.17	5	2.86	2.48–3.28	1
Psychological distress	1.00	1.49	1.30–1.70	2	1.78	1.47–2.16	5	2.61	2.26–3.00	9
All health variables[b]	1.00	1.46	1.28–1.67	7	1.72	1.42–2.09	11	2.60	2.26–3.00	9
Smoking	1.00	1.51	1.32–1.73	0	1.84	1.52–2.23	0	2.90	2.52–3.33	0
Alcohol use	1.00	1.50	1.31–1.71	2	1.84	1.52–2.23	0	2.88	2.50–3.31	0
BMI	1.00	1.42	1.24–1.63	15	1.69	1.39–2.05	15	2.80	2.43–3.22	3
Physical activity	1.00	1.47	1.29–1.68	5	1.79	1.47–2.16	5	2.81	2.44–3.23	3
All health behaviors[c]	1.00	1.41	1.23–1.62	15	1.66	1.37–2.01	16	2.79	2.42–3.21	4
Shift work	1.00	1.51	1.32–1.72	0	1.85	1.53–2.24	0	2.89	2.52–3.33	0
Contract type	1.00	1.50	1.31–1.72	0	1.85	1.52–2.24	0	2.89	2.51–3.32	0
All work arrangements	1.00	1.51	1.32–1.73	0	1.85	1.53–2.25	0	2.90	2.52–3.34	0
All variables 1[d]	1.00	1.38	1.21–1.59	22	1.57	1.29–1.91	26	2.57	2.23–2.97	10
Job strain	1.00	1.48	1.29–1.69	5	1.82	1.51–2.21	2	2.82	2.45–3.24	2
Effort-reward imbalance	1.00	1.49	1.30–1.70	2	1.82	1.50–2.20	2	2.83	2.47–3.26	2
Workplace social capital	1.00	1.49	1.31–1.71	2	1.84	1.52–2.23	0	2.85	2.48–3.27	1
Supervisor support	1.00	1.50	1.31–1.71	2	1.84	1.52–2.23	0	2.87	2.49–3.29	1
All work psychosocial[e]	1.00	1.47	1.29–1.68	5	1.81	1.49–2.19	3	2.80	2.44–3.22	3
All variables 2[f]	1.00	1.37	1.19–1.57	24	1.56	1.28–1.89	28	2.57	2.23–2.96	11

[a] Attenuation percentage (Model X vs Base model): $100 \times (B_{Base} - B_{Model\ X}) / (B_{Base})$.
[b] Adjusted for age, sex, SES, other chronic condition, and psychological distress.
[c] Adjusted for age, sex, SES, smoking, alcohol use, body mass index (BMI), and physical activity.
[d] Adjusted for age, sex, SES, other chronic condition, psychological distress, smoking, alcohol use, BMI, physical activity, shift work, and job contract.
[e] Adjusted for age, sex, SES, job strain, effort-reward imbalance, and supervisor support.
[f] Adjusted as 'All variables 1', and additionally for job strain, effort-reward imbalance, workplace social capital and supervisor support.

employees with diabetes, and 1.45 (95% CI = 1.21–1.75) for employees with chronic hypertension. Obesity in cases of hypertension (14%) and in cases of diabetes (19%), and psychological distress in heart or cerebrovascular disease (10%) were again the strongest contributing factors to the excess risk of work disability due to musculoskeletal disorders. Adverse psychosocial factors, especially job strain (5% in hypertension, 2% in diabetes, and 3% in heart or cerebrovascular disease), contributed slightly to the excess risk of work disability due to musculoskeletal disorders. All risk factors investigated accounted for 27% of the excess work disability due to musculoskeletal disorders in hypertension cases, 38% in diabetes cases, and 11% in cases of heart or cerebrovascular disease.

Compared to the reference group with no cardiometabolic disease, those with heart or cerebrovascular disease were at the highest risk of disability pension due to a disease of the circulatory system (HR = 15.8, 95% CI 10.2–24.6). The corresponding hazard ratio was 4.80 (95% CI 2.50–9.22) for employees with diabetes, and 3.49 (95% CI = 2.07–5.88) for employees with chronic hypertension. The risk factors included in this study contributed very little to the excess risk of disability pension due to diseases of the circulatory system among those with a cardiometabolic condition compared to that among those without: 1% in hypertension cases, 3% in diabetes cases, and 1% in cases of heart or cerebrovascular disease (Supplementary Table 3).

4. Discussion

In this 7-year follow-up study, the risk of all-cause disability pension was nearly threefold among employees with heart or cerebrovascular disease, almost twofold among those with diabetes, and 1.5-fold among those with chronic hypertension, compared to the age- and sex-matched group without these cardiometabolic diseases. Among employees with diabetes or chronic hypertension, behavior-related factors, particularly obesity, partly explained the excess risk of work disability while in relation to heart or cerebrovascular disease, psychological distress was a significant contributing factor to the excess risk.

Employees with heart or cerebrovascular disease had the highest prevalence of psychological distress, an indicator of low mental well-being [40]. Psychological distress was the most significant predictor of disability pension—especially disability pension due to mental disorders—among employees with heart or cerebrovascular disease, which suggests that mental well-being may be an important factor for maintaining the working capacity of employees with heart or cerebrovascular disease.

In this study, work arrangements, i.e., shift work or type of job contract, played only a negligible part in the association between cardiometabolic diseases and disability pension. This may be partly due to increased selection out from shift work among employees with chronic conditions [36], although studies analyzing this "healthy shift worker" effect have produced inconsistent results [36,37]. In agreement with our findings and supporting the healthy worker effect in certain groups, a previous study found that among older temporary workers (who had more cardiometabolic diseases than their younger counterparts), the rate of disability pension was low, whereas permanent workers with high rates of sickness absence were at a significantly increased risk of disability pension [38].

The contribution of psychosocial work environment to excess work disability among individuals with a cardiometabolic disease was relatively small, ranging from 3% to 6%. Individuals with heart disease, cerebrovascular disease or hypertension, rather than those with diabetes, perceived their psychosocial work environment in a more adverse manner than those with none of the cardiometabolic diseases. This corresponds to findings in previous studies [39]. Those with diabetes perceived the imbalance of efforts and rewards at work less favorably than those with no cardiometabolic disease, but the importance of effort-reward imbalance or job strain was relatively modest in terms of excess risk for disability pension. At least one earlier study has found an association between job strain and an increased risk of work disability among employees with diabetes [18].

The strengths of this study include its prospective design with a long follow-up, and objective register-based work disability pension information. We were also able to study a wide range of variables that

possibly contribute to disability pension. However, the data on psychological distress, health behaviors and psychosocial work environment were self-reported, thus the responses may have been subject to reporting bias influenced by health status, i.e., cardiometabolic disease. The fact that those with heart disease, cerebrovascular disease or hypertension perceived their work as having more adverse psychosocial elements than those without these conditions, may have resulted in an overestimation of the contribution of psychosocial work environment to the prognosis of working capacity in these disease groups.

In this study, it was not possible to determine the exact onset of cardiometabolic diseases or the temporal order between health- and work-related factors and cardiometabolic diseases. While we expected that the effect of cardiometabolic diseases on disability pension was mediated through health- and work-related factors, cardiometabolic diseases may equally well be a consequence of poor health behavior or adverse work-related factors. In this case, they would precede cardiometabolic diseases, and operate as explanatory factors of these conditions. The onset of a cardiometabolic disease may also change one's health behavior or perceptions of the work environment. It is also possible that participants with hypertension but no other cardiometabolic condition at baseline, developed one during the follow-up. Future studies are needed to examine in greater detail the associations between health- and work-related factors, the onset of cardiometabolic diseases, and subsequent work disability. Finally, we may also have missed some work characteristics relevant to the working capacity of employees with cardiometabolic diseases, including long working hours, hazardous exposures, and workplace bullying or harassment.

Overall, health behaviors and work-related factors were more strongly associated with the risk of disability pension among individuals with diabetes or chronic hypertension than among those with heart or cerebrovascular disease. This implies that these modifiable factors may provide useful specific targets to improve working capacity of employees with diabetes or hypertension, a suggestion consistent with the current clinical guidelines of treating diabetes and hypertension [41,42]. For employees with heart or cerebrovascular disease, psychological comorbidity appeared to be a major contributing factor to the risk of disability pension. Also this finding is in agreement with current clinical guidelines as they emphasize the importance of monitoring and treating depression among patients with cardiovascular disease [43].

Acknowledgments

J Ervasti and M Virtanen received funding from the Academy of Finland (#292824, #258598). Mika Kivimäki is supported by the NordForsk (the Nordic Programme on Health and Welfare), and J Vahtera received funding from the Era-Age2 grant (Academy of Finland #264944).

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jpsychores.2016.01.010.

References

[1] M. Kark, F. Rasmussen, High systolic blood pressure increases the risk of obtaining a disability pension because of cardiovascular disease: a cohort study of 903 174 Swedish men, Eur. J. Cardiovasc. Prev. Rehabil. 16 (2009) 597–602.
[2] L. Jespersen, S.Z. Abildstrøm, A. Hvelplund, et al., Symptoms of angina pectoris increase the probability of disability pension and premature exit from the workforce even in the absence of obstructive coronary artery disease, Eur. Heart J. 34 (2013) 3294–3303.
[3] J. Ervasti, M. Virtanen, J. Pentti, et al., Work disability before and after diabetes diagnosis: a nationwide population-based register study in Sweden, Am. J. Public Health 105 (2015) e22–e29.
[4] M. Virtanen, J. Ervasti, E. Mittendorfer-Rutz, et al., Trends of diagnosis-specific work disability after newly diagnosed diabetes: a four-year nationwide prospective cohort study, Diabetes Care (2015 Aug 6) pii: dc150247 [Epub ahead of print].
[5] L.L.N. Husemoen, M. Osler, N.S. Godtfredsen, et al., Smoking and subsequent risk of early retirement due to permanent disability, Eur. J. Pub. Health 14 (2004) 86–92.
[6] H. Claessen, V. Arndt, C. Drath, et al., Smoking habits and occupational disability: a cohort study of 14 483 construction workers, Occup. Environ. Med. 67 (2010) 84–90.
[7] K. Koskenvuo, U. Broms, T. Korhonen, et al., Smoking strongly predicts disability retirement due to COPD: the Finnish Twin Cohort Study, Eur. Respir. J. 37 (2011) 26–31.
[8] S. Krokstad, R. Johnsen, S. Westin, Social determinants of disability pension: a 10-year follow-up of 62 000 in a Norwegian county population, Int. J. Epidemiol. 31 (2002) 1183–1191.
[9] S.J. Robroek, A. Rongen, C.H. Arts, et al., Educational inequalities in exit from paid employment among Dutch workers: the influence of health, lifestyle and work, PLoS ONE 10 (2015), e0134867.
[10] N.-O. Månsson, L. Råstam, K.-F. Eriksson, et al., Alcohol consumption and disability pension among middle-aged men, Ann. Epidemiol. 9 (1999) 341–348.
[11] M. Upmark, J. Möller, A. Romelsjö, Longitudinal, population-based study of self-reported alcohol habits, high levels of sickness absence, and disability pensions, J. Epidemiol. Communit. Health 53 (1999) 223–229.
[12] N. Karnehed, F. Rasmussen, M. Kark, Obesity in young adulthood and later disability pension: a population-based cohort study of 366,929 Swedish men, Scand. J. Public Health. 35 (2007) 48–54.
[13] S. Laine, D. Gimeno, M. Virtanen, et al., Job strain as a predictor of disability pension: the Finnish Public Sector Study, J. Epidemiol. Community Health 63 (2009) 24–30.
[14] M. Stattin, B. Järvholm, Occupation, work environment, and disability pension: a prospective study of construction workers, Scand. J. Public Health 33 (2005) 84–90.
[15] K.B. Christensen, H. Feveile, M. Labriola, T. Lund, The impact of psychosocial work environment factors on the risk of disability pension in Denmark, Eur. J. Pub. Health 18 (2008) 235–237.
[16] N. Schmitz, J. Wang, A. Lesage, A. Malla, I. Strychar, Psychological distress and short-term disability in people with diabetes: results from the Canadian Community Health Survey, J. Psychosom. Res. 65 (2008) 165–172.
[17] M. Von Korff, W. Katon, E.H.B. Lin, et al., Potentially modifiable factors associated with disability among people with diabetes, Psychosom. Med. 67 (2005) 233–240.
[18] J. Ervasti, M. Kivimäki, R. Dray-Spira, et al., Psychosocial factors associated with work disability in men and women with diabetes: a pooled analysis of three occupational cohort studies, Diab Med. (2015 Jun 2)http://dx.doi.org/10.1111/dme.12821 [Epub ahead of print].
[19] M. Kivimäki, M. Hamer, D.G. Batty, et al., Antidepressant medication use, weight gain, and risk of type 2 diabetes: a population-based study, Diabetes Care 33 (2010) 2611–2616.
[20] World Health Organization. Anatomical Therapeutic Chemical Code Index. (Available at: http://www.whocc.no/atc_ddd_index/. Accessed May 25, 2015).
[21] International Classification of Diseases, 10th Revision, World Health Organization, Geneva, Switzerland, 1992.
[22] The Global Burden of Metabolic Risk Factors for Chronic Disease Collaboration, Cardiovascular disease, chronic kidney disease, and diabetes mortality burden of cardiometabolic risk factors from 1980 to 2010: a comparative risk assessment, Lancet Diabetes Endocrinol. 2 (2014) 634–647.
[23] A.V. Chobanian, G.L. Bakris, H.R. Black, et al., Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, Hypertension 42 (2003) 1206–1252.
[24] C.J. Caspersen, G.D. Thomas, L.A. Boseman, et al., Aging, diabetes, and the public health system in the United States, Am. J. Public Health 102 (2012) 1482–1497.
[25] S.A.E. Peters, R.R. Huxley, M. Woodward, Diabetes as a risk factor for incident coronary heart disease in in women compared with men: a systematic review and meta-analysis of 64 cohorts including 858,507 individuals and 28,203 coronary events, Diabetologia 57 (2014) 1542–1551.
[26] B.B. Yeap, K.A. McCaul, L. Flicker, et al., Diabetes, myocardial infarction and stroke are distinct and duration-dependent predictors of subsequent cardiovascular event and all-cause mortality in older men, J. Clin. Endocrinol. Metab. 100 (2015) 1038–1047.
[27] D.P. Goldberg, R. Gater, N. Sartorius, et al., The validity of the two versions of the GHQ in the WHO study of mental illness in general health care, Psychol. Med. 27 (1997) 191–197.
[28] J.I. Halonen, M. Kivimäki, J. Pentti, et al., Green and blue areas as predictors of overweight and obesity in an 8-year follow-up study, Obesity (Silver Spring) 22 (2014) 1910–1917.
[29] K. Heikkilä, S.T. Nyberg, E.I. Fransson, et al., Job strain and alcohol intake: a collaborative meta-analysis of individual-participant data from 140 000 men and women, PLoS ONE 7 (2012), e40101.
[30] K. Heikkilä, S.T. Nyberg, E.I. Fransson, et al., Job strain and tobacco smoking: an individual-participant data meta-analysis of 166 130 adults in 15 European studies, PLoS ONE 7 (2012), e3563.
[31] E.I. Fransson, K. Heikkilä, S.T. Nyberg, et al., Job strain as a risk factor for leisure-time physical inactivity: an individual-participant meta-analysis of up to 170 000 men and women. The IPD-Work consortium, Am. J. Epidemiol. 176 (2012) 1078–1989.
[32] R. Karasek, T. Theorell, Healthy Work: Stress, Productivity, and the Reconstruction of Working Life, Basic Books, New York, NY, 1990.
[33] M. Kivimäki, J. Vahtera, M. Elovainio, et al., Effort-reward imbalance, procedural justice and relational justice as psychosocial predictors of health: complementary or redundant models? Occup. Environ. Med. 63 (2007) 659–665.
[34] J. Siegrist, N. Dragano, S.T. Nyberg, et al., Validating abbreviated measures of effort-reward imbalance at work in European cohort studies: the IPD-work consortium, Int. Arch. Occup. Environ. Health 87 (2014) 249–256.

[35] A. Kouvonen, M. Kivimäki, J. Vahtera, et al., Psychometric evaluation of a short measure of social capital at work, BMC Public Health 6 (2006) 251.
[36] S. Puttonen, M. Härmä, C. Hublin, Shift work and cardiovascular disease — pathways from circadian stress to morbidity, Scan. J. Work Environ. Health 36 (2010) 96–108.
[37] M. Yong, C. Germann, S. Lang, et al., Primary selection into shift work and change of cardiovascular risk profile, Scand. J. Work Environ. Health 41 (2015) 259–267.
[38] M. Virtanen, M. Kivimäki, J. Vahtera, et al., Sickness absence as a risk factor for job termination, unemployment, and disability pension among temporary and permanent employees, Occup. Environ. Med. 63 (2006) 212–217.
[39] J. Li, M.F. Dollard, A. Loerbroks, et al., Cardiovascular disease is associated with the perception of worsening psychosocial work characteristics, Int. J. Cardiol. 186 (2015) 149–151.
[40] J. Head, S.A. Stansfeld, K.P. Ebmeier, et al., Use of self-administered instruments to assess psychiatric disorders in older people: validity of the General Health Questionnaire, the Center for Epidemiologic Studies Depression Scale and the self-completion version of the revised Clinical Interview Schedule, Psychol. Med. 43 (2013) 2649–2656.
[41] American Diabetes Association, Standards of medical care in diabetes, Diabetes Care 38 (2015) S1–S94.
[42] The Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC), 2013 ESH/ESC guidelines for the management of arterial hypertension, J. Hypertension 31 (2013) 1281–1357.
[43] F. Seligman, C.B. Nemeroff, The interface of depression and cardiovascular disease: therapeutic implications, Ann. N. Y. Acad. Sci. 1345 (2015) 25–35.