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FULL RESEARCH PAPER
CVD risk factors

Exposure to workplace sexual harassment and risk of cardiometabolic disease: a prospective cohort study of 88 904 Swedish men and women

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Aims Exposure to work-related sexual harassment may increase the risk for certain adverse behavioural and emotional outcomes but less is known about its association with somatic diseases such as cardiovascular disease (CVD) and type 2 diabetes. This study investigated the prospective association of work-related sexual harassment and risk of cardiometabolic diseases.

Methods and results This cohort study included 88 904 Swedish men and women in paid work who responded to questions on workplace sexual harassment in the Swedish Work Environment Survey (1995–2015) and were free from cardiometabolic diseases at baseline. Cardiometabolic diseases (CVD and type 2 diabetes) were identified from the National Patient Register and Causes of Death Register through linkage. Cox proportional hazard regression was used, adjusting for socio-demographic, work-related psychosocial, and physical exposure at baseline. Overall, 4.8% of the participants ($n = 4300$) reported exposure to workplace sexual harassment during the previous 12 months. After adjustment for sex, birth country, family situation, education, income, and work-related factors, workplace sexual harassment was associated with increased incidence of CVD [hazard ratio (HR) 1.25, 95% confidence interval 1.03–1.51] and type 2 diabetes (1.45, 1.21–1.73). The HR for CVD (1.57, 1.15–2.15) and type 2 diabetes (1.85, 1.39–2.46) was increased for sexual harassment from superior or fellow workers, and sexual harassment from others was associated with type 2 diabetes (1.39, 1.13–1.70). The HR for both CVD (1.31, 0.95–1.81) and type 2 diabetes (1.72, 1.30–2.28) was increased for frequent exposure.

Conclusion The results of this study support the hypothesis that workplace sexual harassment is prospectively associated with cardiometabolic diseases. Future research is warranted to understand causality and mechanisms behind these associations.

Lay summary We investigated if workers in Sweden who had experienced sexual harassment at work had a higher risk of developing cardiovascular disease and diabetes than workers who had not experienced sexual harassment at work.

- The experience of workplace sexual harassment was associated with an increased risk of both cardiovascular disease and diabetes. The risk was highest among those workers who had frequently experienced sexual harassment.
- Our results suggest that preventive measures directed towards elimination of sexual harassment may contribute to a reduction in cardiovascular disease and diabetes in the population.

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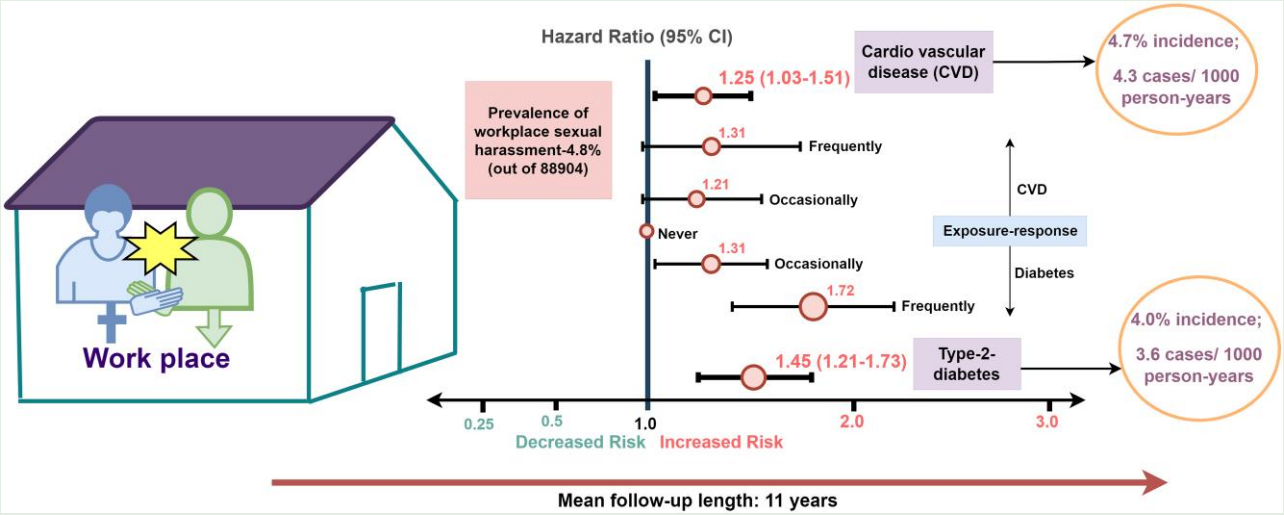
Graphical Abstract



Keywords Cardiometabolic diseases • CVD • Type 2 diabetes • Workplace negative behaviours • Sexual harassment • Longitudinal studies

Introduction

Cardiovascular disease (CVD) was the underlying cause of one-third of all deaths globally in 2019, i.e. an estimated 17.9 million deaths, making it the leading cause of death and a major public health problem globally.[1] Likewise, diabetes mellitus is among the leading causes of death and disability, and its prevalence is rising worldwide.[2] The number of individuals affected by diabetes is projected to increase to 1.3 billion by 2050,[2] especially among those aged 50 or above. Cardiovascular disease and diabetes have been found to share many lifestyle and environmental risk factors and biological mechanisms connected to the cardiovascular and metabolic system.[3] Especially people with diabetes are also more prone to develop CVD compared with those without diabetes.[4]

It has been acknowledged that a relatively large share of CVD deaths is attributable to occupational risk factors such as long working hours, probably increasing the risk for mortality and morbidity through psychosocial stress.[5] Other psychosocial work characteristics such as sexual harassment may also initiate stress reactions[6] and eventually lead to diseases such as CVD and diabetes.[7] Harassment is usually regarded as unacceptable or threat of unacceptable behaviour that aims at or results in harm.[8] Sexual harassment is usually regarded as unwanted or unwelcome verbal or non-verbal behaviour of sexual nature, which is experienced as intimidating, degrading, humiliating, hostile, or offensive by those exposed. If this phenomenon occurs at work or in circumstances related to work, it may be considered as workplace sexual harassment.[8,9] Workplace sexual harassment is a problem affecting all occupations, sectors, and countries around the globe. It is a widespread but under-reported phenomenon.[8] Since the Me Too movement,[10] reporting and prevalence of sexual harassment in the working population has received widespread attention. However, being a sensitive issue, the estimation of exact prevalence is challenging. There are huge discrepancies in the reported prevalence, with few reporting 1–20% and others reporting 30% among men and no less than 80% among women, which could be attributed to the measurement of harassment, the cultural context of victims, the representativeness of the sample, and the time frame of these different studies.[11,12] It is, however, clear that exposure is common in occupations with client contact,[13] often leading to an increased risk of job exit among the exposed. Previous studies have reported higher prevalence, for instance among women and workers of younger age and in occupations with an unequal sex ratio and industries such as restaurants and hotels and workplaces with large power differentials between men and women.[9,14]

Work-related exposures such as long working hours, job strain, and other adverse psychosocial working conditions and negative workplace behaviours, such as bullying and violence, have been associated with an increased risk of type 2 diabetes and CVD.[15–17] Previous studies have reported workplace sexual harassment as a risk factor of several chronic conditions and health outcomes[18–24] including high blood pressure, poor sleep, depression, anxiety, sickness absence, chronic drinking behaviour, obesity, and suicide and suicide attempts. However, despite a conceptual link between lifetime bullying and sexual violence with diabetes and CVD[16,25–28] and of workplace sexual harassment with cardiovascular health,[21] substantial gaps of evidence exist.[21,26] A recent systematic review and meta-analysis based on 830 579 adults reported greater risk of CVD among those with a history of lifetime sexual violence relative to those without a history[26]; however, the articles considering assessment of sexual harassment were limited. Many studies have also been based on lifetime sexual harassment, or adolescent sexual harassment, or harassment among those in specific occupational sectors or groups or convenience samples. Workplace sexual harassment has previously been connected to cardiovascular risk factors such as high blood pressure.[21,23] However, to the best of our knowledge, no population-based longitudinal studies on workplace sexual harassment and risk of CVD or type 2 diabetes have been reported yet. Further, there is lack of evidence on the association between sexual harassment and chronic conditions based on perpetrators of sexual violence. Therefore, we aimed to investigate the prospective association between workplace sexual harassment and risk of CVD and type 2 diabetes among 88 904 Swedish men and women in paid work.

Methods

Study population

The Swedish Work Environment Survey (SWES, 1995–2015), a biennial cross-sectional survey, building on the Labor Force Survey is the data

source of this study. These survey data were collected by simple random sampling from the sample of 10 000–15 000 people aged 16–74 years from the entire Swedish population, after stratification for sex, county, and citizenship. The sample was first interviewed by phone, and a representative subsample of individuals aged 16–64 years and in paid work were subsequently asked a range of questions related to their work as part of SWES using additional self-completion questionnaire.[22] In the initial interviews, non-participation in Labor Force Survey and SWES varied between 13% (1995) and 42% (2015), respectively, and was 23% and 53% for the subsequent phone interviews and work situation questionnaire, respectively. The SWES (1995–2015) collectively included 93 199 respondents to self-completion questionnaires. The final analytical sample included 88 904 participants after excluding persons with missing data on workplace sexual harassment and invalid data for the analyses on age at end of follow-up. The final analytical sample did not differ from the eligible sample. However, the excluded samples were slightly younger on average (42.5 vs. 43.2 years), consisting of a lower proportion of women (44 vs. 52%), a higher proportion with foreign origin (17 vs. 10%), and a higher proportion of singles (31 vs. 28%) than the analytical sample. Ethical approval was obtained from the Regional Research Ethics Board in Stockholm, Sweden. Participants received written information on the survey and response to the survey indicated informed consent.

Sexual harassment and covariates at baseline

After a brief definition of sexual harassment ('sexual harassment refers to undesirable advances or offensive references to what is generally associated with sexual relations'), the respondents were asked to respond to two questionnaire items about sexual harassment, which were used in this study: 'Are you subjected to sexual harassment in your workplace from (i) superiors or fellow workers and (ii) other people (e.g. patients, clients, passengers, students)?' The response format was a 7-point Likert-type scale ranging from not at all during the previous 12 months to every day. For the analysis, we categorized the respondents into 'exposed' if they reported that they were subjected to sexual harassment 'once or twice during the previous 12 months', 'sometimes during the last 3 months', 'a couple of days a month (1 day of 10)', 'one day a week (1 day of 5),' 'a couple of days a week (1 day of 2)', or 'every day'. We considered those reporting not being subjected to sexual harassment at all during the previous 12 months to be 'un-exposed'. We combined the responses on sexual harassment by superiors, by fellow workers, or from other people into one variable for the main analyses, indicating any exposure to workplace sexual harassment during the previous 12 months. For exposure–response analyses, we created a variable with three categories ('frequently', every day to sometimes during the last 3 months; 'occasionally', once or twice during the last 12 months; and 'never', not at all during the last 12 months, and the latter was used as the reference group).

Covariates were sex, family situation, birth country, educational level, income, and work characteristics, as these factors have been found to be associated with workplace sexual harassment and risk factors for chronic diseases.[18,19,21,22] The source of information about sex, family situation, birth country, education, and income was the longitudinal integration database for health insurance and labour market studies (LISA). We used educational level as a categorical variable with three categories (≤9 years, 10–12 years, and ≥13 years). We categorized baseline family situation as single (living alone, divorced, separated, or widowed) without children, single with children, married or living with partner without children, or married or living with partner with children. Birth country was divided into 'Swedish' and 'Foreign'. Baseline work characteristics included job demands and control, measured by indices for demands and control based on four items each scored from 0 to 4. We also used an index for job support measured with two separate questions about support from superiors and fellow workers, scored from 1 to 4, and physical strain at work measured with question on frequency of physical strain, which was assessed on a scale from not at all to every day and divided into three categories, namely low (not at all or rarely the last 3 months), moderate (1 day per week or 2 days per month), and high (2 days per week or every day).

Cardiometabolic diseases at follow-up

We identified CVD and type 2 diabetes from the National Patient Register and Causes of Death Register through linkage based on the Swedish personal identification number. The patient register includes both inpatient and outpatient data. We followed the respondents from the year of response to SWES questionnaires to the year of either first registered CVD, type 2 diabetes and death from another cause, emigration, or end of follow-up (31 December 2015). We defined people with incident endpoint using versions eight, nine, and ten of the International Classification of Diseases, including ICD-10 codes I20.0, I20.1, I21–I25 (excluding unspecified angina) and ICD-8/9 410–414 for the diagnosis of coronary heart disease (CHD) and ICD-10 I60–I69, and ICD-8/9 430–438 for the diagnosis of cerebrovascular disease (CD). Total CVD included codes for either CHD or CD. Myocardial infarction (MI) was based on the main diagnosis of ICD-10 I21–22 or 410 in ICD-9 or ICD8 41 from the hospital registers and the main cause of death in acute coronary death of ICD-10 I20–25, or 410–414 in ICD-9, or ICD-8 410–414 from the death register. Likewise, ischaemic stroke was based on the main diagnosis of ICD-10 I63 or ICD-9 433–434 or ICD8 433–434 from hospital and death registers. Similarly, haemorrhagic stroke was based on the main diagnosis of codes ICD-10 I61 and I62 or ICD-9 431 or ICD8 431 from hospital and death registers. Likewise, we considered those registered with codes ICD-8/9 250 and ICD-10 E11 in the National Patient Register to be cases of type 2 diabetes.

Statistical analyses

We estimated the risk of cardiometabolic diseases by using Cox proportional hazard regression analyses. Assuming that the participants are entering the risk set at the age they entered the survey, we used age as the underlying time scale, which takes entry age and exit age into account. In this study, the entry age is the age at first response to SWES questionnaire, and exit age is the age of being censored (i.e. first registered cardiometabolic diseases, death from cardiometabolic disease, death from another cause, emigration, or age at end of follow-up). We tested the proportional hazard assumption for all Cox models by using log–log plots and testing the interactions of exposure with time (logarithmically transformed), and we found no significant deviations from proportionality (see Supplementary material online, *Table S1*). We fitted separate models assessing the associations of workplace sexual harassment with risk of CVD and risk of type 2 diabetes. All people with full information on exposure and outcome were included in the analyses. The main analyses were adjusted for sex, family situation, birth country, educational level, and income. In additional analyses, we adjusted for baseline work characteristics.

We checked for interaction between sex and sexual harassment by including an interaction term in the model and stratified the analyses by sex. Likewise, we presented the results separately for sexual harassment from superior or fellow workers and sexual harassment from other people than the fellow workers (e.g. patients, clients, passengers, and students).[21] Similar sets of results are also presented for CHD, any CD, MI, and stroke as separate outcomes. We also present exposure–response analyses for CVD and type 2 diabetes according to the frequency of exposure to workplace sexual harassment. We used SAS Statistical Software 9.4 for all analyses.

Patient and public involvement

No patients were involved in setting the research question or the outcome measures, nor were they involved in developing plans for recruitment, design, and implementation of the study. No patients were asked for advice on interpretation or writing up of results. However, part of the research and dissemination strategy at the Stress Research Institute is developed with patient and public involvement.

Results

Overall, 4.8% (4300/88 904) of the included study population reported workplace sexual harassment during the previous 12 months. The corresponding prevalence was 1.9% (815/42551) in men and 7.5% (3485/46353) in women. Those who were not exposed to workplace sexual harassment differed from the exposed group of the study population in terms of several baseline socio-economic and work-related characteristics (*Table 1*). There was a higher proportion of women,

Table 1 Distribution of socio-demographic factors and chronic diseases among participants of Swedish Work Environment Survey (1995–2015) according to exposure to workplace sexual harassment

Characteristics	Total (*n*, 88 904)		Un-exposed (*n*, 84 604)		Exposed (*n*, 4300)		*P*-value[a]
	n	(%)	*n*	%	*n*	%	
Sex							<0.0001
Male	42 551	48	41 736	49	815	19	
Female	46 353	52	42 868	51	3485	81	
Mean (SD) age in years	43.2 (11.9)		43.6 (11.8)		37.3 (11.5)		<0.0001
Birth country							
Sweden	80 050	90	76 262	90	3788	88	<0.0001
Foreign	8854	10	8342	10	512	12	
Family situation							<0.0001
Married/living with partner with children	41 376	46	39 612	47	1764	41	
Married/living with partner without children	16 180	18	15 777	19	403	9	
Single/divorced/separated/widowed with children	6786	8	6287	7	499	12	
Single/divorced/separated/widowed without children	24 550	28	22 917	27	1633	38	
Mean (SD) income from work, SEK	2 525 894 (1 582 097)		2 547 288 (1 597 219)		2 104 916 (1 170 9372)		<0.0001
Education (*n* = 88 341)							<0.0001
Primary and lower secondary	12 657	14	12 294	15	363	8	
Upper secondary	42 644	48	40 446	48	2198	52	
University	33 040	38	31 335	37	1705	40	
Mean (SD) job demands, scale 0–4	1.7 (1.3)		1.7 (1.3)		2.1 (1.3)		<0.0001
Mean (SD) job control, scale 0–4	2.5 (1.3)		2.6 (1.3)		1.9 (1.3)		<0.0001
Mean (SD) job support, scale 1–4	1.6 (0.9)		1.6 (0.9)		1.7 (0.9)		<0.0001
Physical strain at work (*n* = 88 199)							<0.0001
Low (not at all, rarely the last 3 months)	54 498	62	52 404	63	2094	49	
Moderate (1 day/week or 2 days/month)	13 663	15	12 824	15	839	20	
High (2 days/week or every day)	20 038	23	18 701	22	1337	31	
CVD							<0.0001
No	84 686	95	80 497	95	4189	97	
Yes	4218	5	4107	5	111	3	
Type 2 diabetes							0.0002
No	85 280	96	81 108	96	4172	97	
Yes	3624	4	3496	4	128	3	

CVD, cardiovascular disease; SD, standard deviation.
[a]*P*-value for hypothesis testing that one group is different from other based on chi-square test for categorical and analysis of variance for continuous characteristics of the study population.

single/divorced/separated, people with foreign background, people with high job demands, and low controls among exposed than among un-exposed. Moreover, the population exposed to workplace sexual harassment were relatively younger than the un-exposed population. A higher proportion of exposed had university education, but the majority had low income from their work and had no supervisory duties. Of all study population born outside Sweden, 5.8% were exposed to workplace sexual harassment (512/8854), which was slightly higher than in the total study population born in Sweden (4.7%, 3788/80050).

Workplace sexual harassment and risk of CVD and type 2 diabetes

We followed the study population for a total of 989 512 person-years (mean follow-up 11 years, standard deviation 6 years). In total, 4218 (4.7%) persons had been diagnosed with CVD during the follow-up (rate: 4.3 cases per 1000 person-years), 111 (2.6%) among those exposed to any workplace sexual harassment, and 4107 (4.9%) among those un-exposed. A total of 3624 (4%) persons were diagnosed with type 2 diabetes during the follow-up (rate: 3.6 cases per 1000 person-years), 3% among exposed, and 4% among un-exposed study population. In total, 2784 (3.1%) person had been diagnosed with CHD (2.8 cases per 1000 person-years), 1935 (2.2%) were diagnosed with CD (1.9 cases per 1000 person-years), 1776 (2.0%) were diagnosed with MI (1.8 cases per 1000 person-years), and 1488 (1.7%) were diagnosed with stroke (1.5 cases per 1000 person-years) during the follow-up (*Table 1*; Supplementary material online, *Tables S1* and *S2*).

In the Cox regression analysis (*Figure 1*), the hazard ratio (HR) for CVD was 1.27 (95% confidence interval 1.05–1.54) for any workplace sexual harassment in the sex-adjusted model. Neither adjustment for birth country, family situation, education, and income nor additional adjustment for work-related factors (job demands, job control, job support, and physical strain) substantially changed the HRs (1.26, 1.04–1.53, 1.25, and 1.03–1.51, respectively). Excess risk estimates

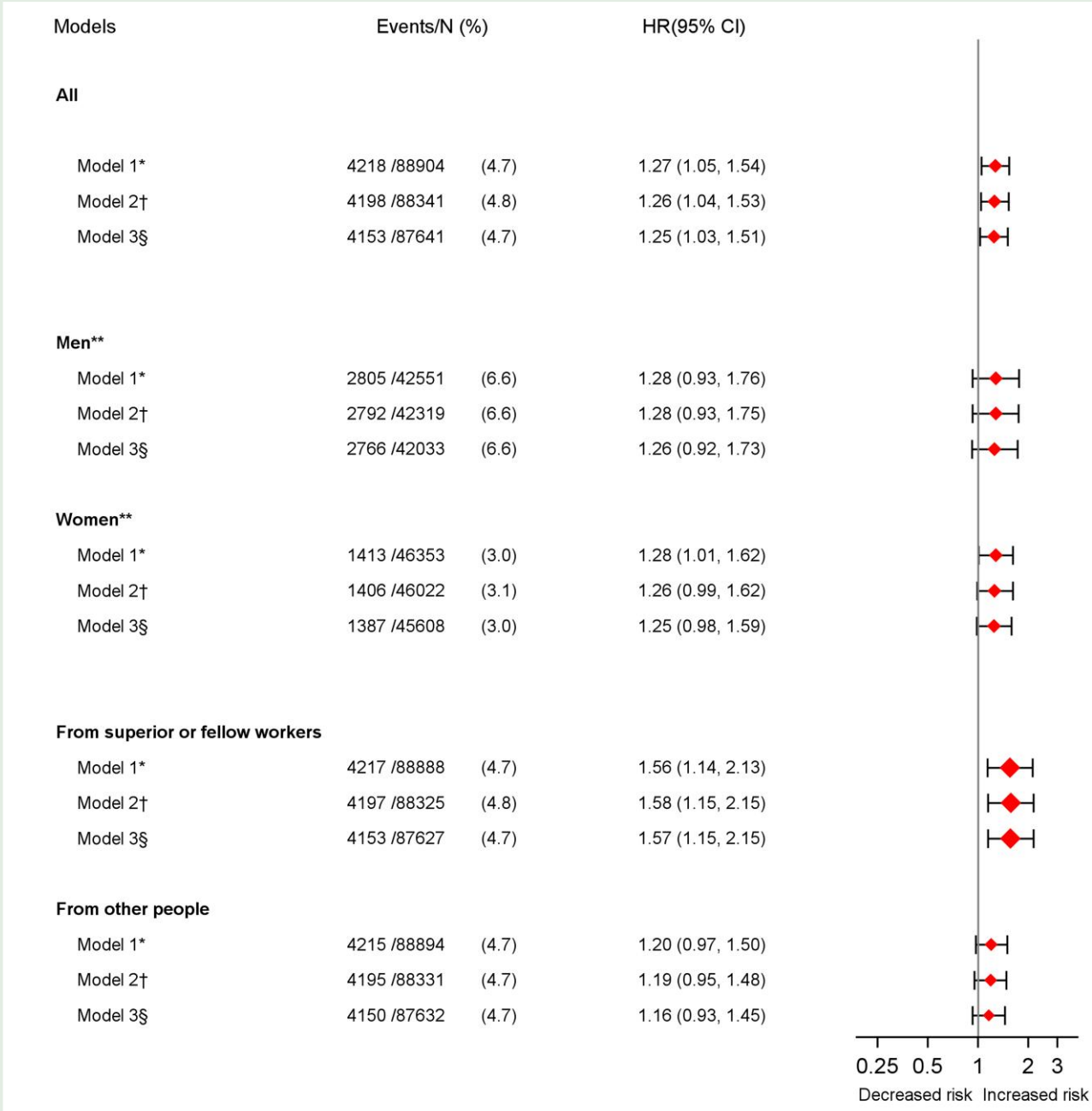


Figure 1 Results from Cox regression analyses on workplace sexual harassment stratified by sex and presented separately for sexual harassment from superiors/fellow workers and others, presented as hazard ratios and 95% confidence intervals with and without adjustment for cardiovascular disease. CI, confidence interval; HR, hazard ratio.

were detected in both men and women, although most risk estimates were not statistically significantly increased in stratified analyses, and there was no statistically significant interaction between workplace sexual harassment and sex for CVD.

In total, 1.5% reported being exposed by superiors or fellow workers, and 3.8% were exposed by other people, which include patients, clients, passengers, and students. Excess risk of CVD was detected for the exposure to sexual harassment from both superiors and fellow workers (1.57, 1.15–2.15), while the risk estimate for exposure from other people was weaker and not statistically significant (1.16, 0.93–1.45) in the fully adjusted model.

The results from Cox regression were similar for type 2 diabetes (1.51 and 1.26–1.80 in the sex-adjusted model), with a HR of 1.45 (1.21–1.73) in the fully adjusted model (*Figure 2*). Excess risk estimates

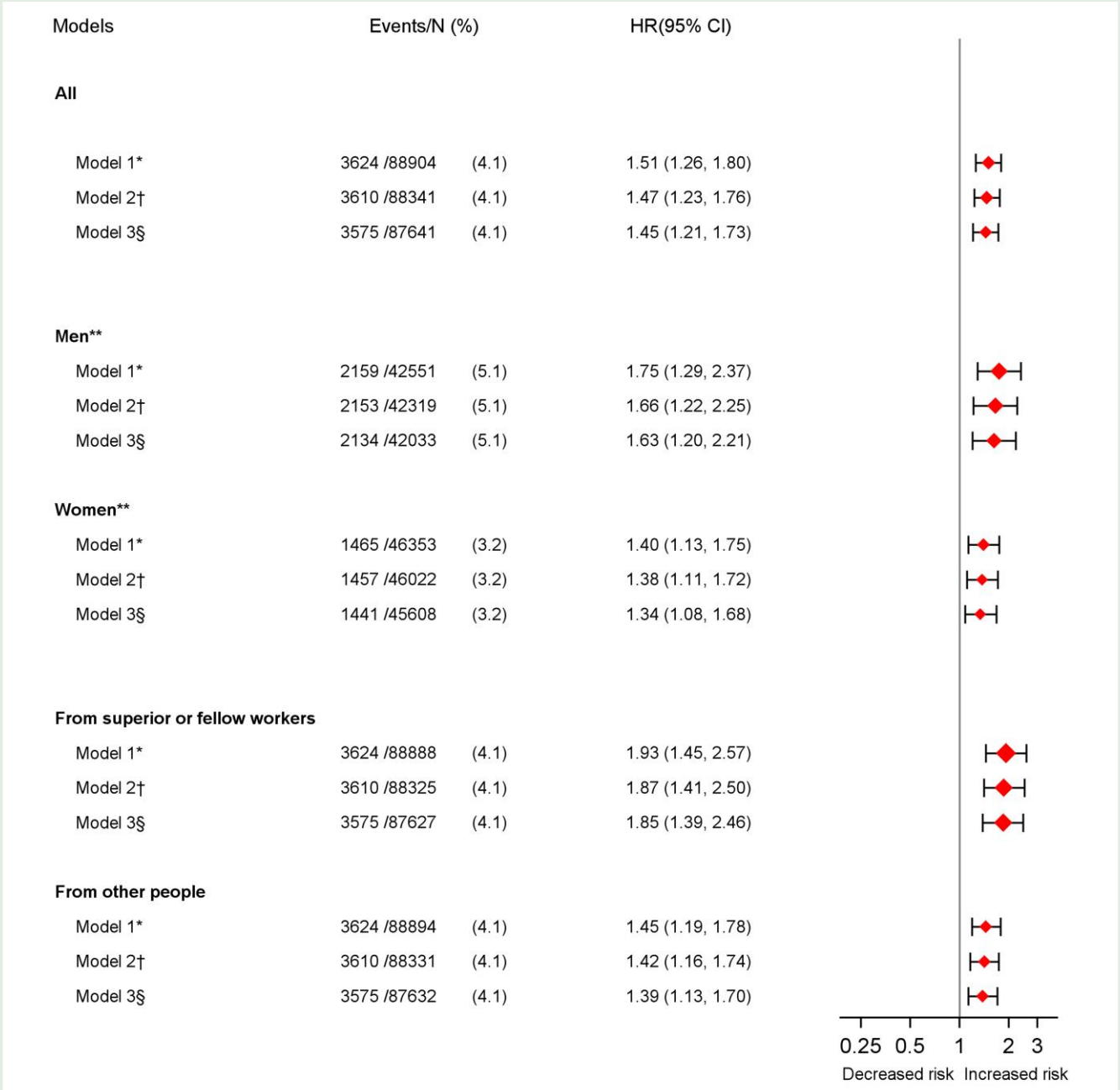


Figure 2 Results from Cox regression analyses on workplace sexual harassment stratified by sex and presented separately for sexual harassment from superiors/fellow workers and others, presented as hazard ratios and 95% confidence intervals with and without adjustment for covariates for type 2 diabetes. CI, confidence interval; HR, hazard ratio.

were detected for both sexes (1.63 and 1.20–2.21 for men and 1.34 and 1.08–1.68 for women in the fully adjusted model), and there was no statistically significant interaction between workplace sexual harassment and sex. An excess risk of type 2 diabetes was also indicated for both exposure to sexual harassment from both superiors and fellow workers (1.85, 1.39–2.46) and from other people (1.39, 1.13–1.70) in the fully adjusted model.

An exposure–response relationship according to the frequency of exposure to workplace sexual harassment was present for both CVD ($P_{trend} < 0.0001$) and diabetes ($P_{trend} = 0.001$) (*Figure 3*). The exposure–response analysis based on frequency of exposure to workplace sexual harassment showed that the risk of CVD was slightly higher among those who were frequently exposed (1.31, 0.95–1.54) than those who were occasionally exposed (1.21, 0.96–1.54) to

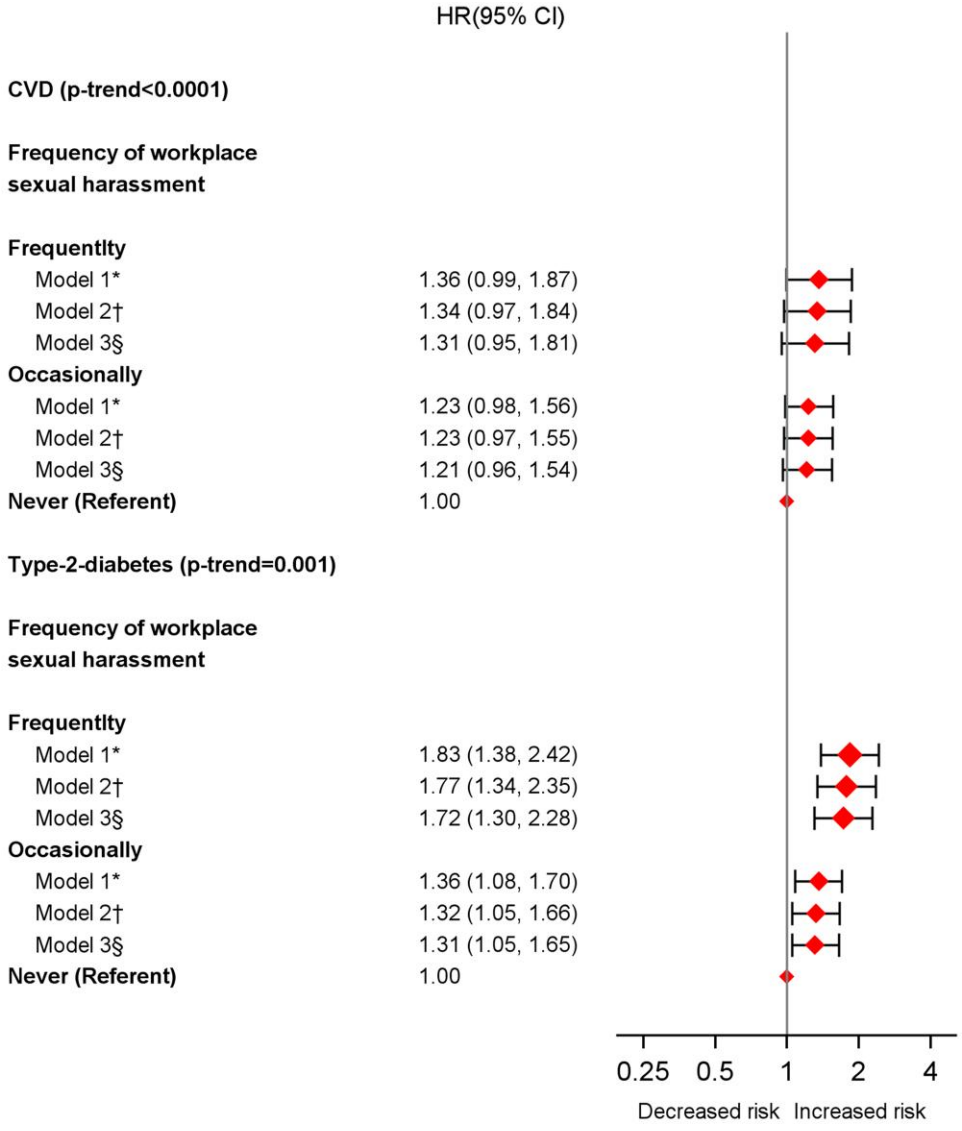


Figure 3 Results from Cox regression analyses on the frequency of workplace sexual harassment presented as hazard ratios and 95% confidence intervals with and without adjustment for covariates for cardiovascular disease and type 2 diabetes. CI, confidence interval; CVD, cardiovascular disease; HR, hazard ratio.

workplace sexual harassment. The risk of type 2 diabetes was also higher among frequently exposed (1.72, 1.30–2.28) than those who were occasionally exposed (1.31, 1.05–1.65).

The results from Cox regression for CHD (1.26, 0.99–1.91) and CD (1.31, 1.00–1.70) were borderline statistically significant in the sex-adjusted model but attenuated when fully adjusted, and the risk estimates for MI (1.29, 0.95–1.75) and stroke (1.11, 0.80–1.55) were not significant throughout (see Supplementary material online, *Figure S1*). In addition, we did not note any statistically significant excess risk estimates in sex-stratified analyses for women and men for CHD, CD, MI, and stroke (see Supplementary material online, *Figure S2*). However, we observed a moderately higher HR for CHD development (1.68, 1.15–2.46) and a two-fold higher HR for MI development (2.04, 1.33–3.15) among those exposed to workplace sexual harassment from superiors or fellow workers, in the fully adjusted model (see Supplementary material online, *Figure S3*). The estimates for other exposure–outcome associations were not statistically significantly increased.

Discussion

This population-based cohort study of Swedish paid workers aged 16–64 years showed an association between workplace sexual harassment and cardiometabolic diseases.

Our study finding on higher risk of CVD and diabetes[16,17,26–29] among those exposed to workplace sexual harassment is in line with findings from previous studies on exposure to sexual harassment in general or sexual abuse during childhood or inter-personal violence or lifetime abuse. Four of the previous studies were either systematic review or meta-analysis,[16,17,26,27] and another study was based on lifetime abuse.[29] The results from a systematic review by Suglia *et al.*[27] indicated high risk of CVD among the victims of child abuse; however, the authors did not find a tangible risk of CVD outcomes among the victims of adulthood violence exposure. This conclusion relied mostly on cross-sectional studies included in their study, and the authors asked for further research based on violence exposure across the life course. Our findings on higher risk of CVD among those exposed to workplace sexual harassment corroborate the findings reported by another recently conducted systematic review.[26] However, the exposure variable used in our study was any workplace sexual harassment compared with any sexual violence used in the previous systematic review. A multicohort meta-analytical study using four different studies carried out in Nordic countries reported a higher diabetes risk among those exposed to violence or threat of violence,[16] which is in line with our findings of an association between any workplace sexual harassment and type 2 diabetes. Those who experienced workplace violence had a significantly higher risk of CVD as compared with the un-exposed group in a study of working men and women from Sweden and Denmark by Xu *et al.* Given the similarity in the nature of the exposure variable, our study findings are in line with that of the previous study.[17] Moreover, previous studies have also reported an association between workplace sexual harassment and behavioural risk such as alcohol mis-use,[18,30] depressive symptoms,[20] post-traumatic stress disorder (PTSD),[6,19] and hypertension,[21,23] which may in turn aggravate the risk of CVD and diabetes through physical dysregulation. However, to the best of our knowledge, this is the first study to investigate the association of workplace sexual harassment and cardiometabolic disease using a prospective cohort of a large population-based sample.

In line with the study by Xu *et al.*,[16] we also found an exposure–response association with CVD and diabetes that strengthens the probability of a causal association. With regard to biological plausibility, it has been found that sexual harassment may induce reactions such as helplessness and fearfulness that often lead to increased risk of distress and PTSD.[31] Previous studies have also reported an association of workplace sexual harassment with an increased risk of distress and PTSD.[6,19] The cumulative burden of chronic stress reactions and stress symptoms and life events could result in physiological dysregulation, also referred to as allostatic load,[7] which is a potential pathway to manifestation of chronic diseases,[32] especially related to metabolic[33] and inflammatory system.[34] Such physiological dysregulation may include obesity, an increase in metabolic risk factors, cardiovascular risk factors, and inflammatory response, which may in turn increase the risk for diseases such as diabetes and CVD.[35] Psychosocial stressors may also trigger diseases such as CVD among individuals already at high risk for disease, for instance by accelerating the atherosclerotic process among people with an already high atherosclerotic plaque burden.[33]

The prevalence of any workplace sexual harassment is high among women,[13] which was also true in our sample, and the risk for cardiometabolic disorders may differ according to sex due to sex hormones and sex-specific molecular mechanism that has an influence on cardiac energy metabolism.[36] We, therefore, conducted sex-specific analyses. However, the lack of significant interaction between sex and workplace sexual harassment in the analyses of CVD and type 2 diabetes risk suggest that there were no obvious differences in associations by sex. We further analysed sexual harassment separately for harassment from superiors/fellow workers and others (clients, patients, etc.) and found that sexual harassment from superiors or fellow workers was most clearly associated with CVD and type 2 diabetes. Similarly, a previous prospective study on Danish workers reported sexual harassment from superiors and colleagues as a stronger predictor of depressive symptoms as compared with harassment from other customers or clients.[20] Sexual harassment from superiors or fellow workers may be more difficult to cope with than harassment from others such as patients, especially from superiors who are in a power situation[9] and since it may more frequently entail sexual coercion. Exposure from superiors or fellow workers may also be more frequently occurring and thereby have more severe consequences. However, few studies have to date looked at different types of workplace sexual harassment, which is why more knowledge is needed.

Strengths and limitations of the study

A large sample representative of Swedish workforce prospectively followed for several years is one of the major strengths of this study. Compared with other observational studies, prospective cohort studies deliver stronger evidence of an association. This contributes to fill the gap in the previous body of research as suggested by some of the latest systematic reviews projecting cardiovascular health effects of sexual harassment.[26,27,37]

There are some potential limitations of this study, and one of the major limitations is a risk that information on any sexual harassment at workplace is under-reported. As sexual harassment was self-reported and diseases were ascertained in the register objectively, the mis-classification of the exposure is very likely to be non-differential and independent, which may contribute to an under-estimation of associations. It is likely that the single-item self-reported measurement is not very sensitive in terms of capturing different types of sexually harassing behaviours. The methods with multiple items may better capture different behaviours that can constitute workplace sexual harassment compared with single-item strategies of assessing sexual harassment,[12,38] thus yielding higher prevalence.[39] The forms of workplace sexual harassment could vary from inappropriate verbal remarks to very severe physical acts such as rape. There is a probability that respondents only consider severe forms of sexual harassments when responding to explicit inquiries about sexual harassment,[11] which might be one of the relevant explanations for robust associations between any workplace sexual harassment and cardiometabolic diseases found in our study. Nonetheless, the assessment of workplace sexual harassment was based on the frequency, which we believe could serve as an indicator of severity of harassment. It is possible that part of our sample was too young for CVD development, and the follow-up time was too short. An earlier review on psychosocial work characteristics noted more pronounced associations with heart disease among younger age groups and an increased risk only among studies with a long follow-up (10 years or more).[40] However, in our previous work on workplace violence/bullying, the risk of CVD appeared to be higher among those 50 years of age or older, and the results did not differ according to the length of follow-up.[16,17] Socio-economic characteristics and work-related physical and psychosocial exposures were used to adjust for potential confounding, as suggested in previous literatures.[18,19,21] These factors partly explained the associations between any workplace sexual harassment and CVD as well as type 2 diabetes, but the associations persisted with adjustment for these factors. However, some unmeasured work exposures such as sitting and standing at work are other possible factors that could be considered as potential covariates in future studies. Exposure to these factors vary according to the type of work, and more importantly, the risk of heart disease has been found to differ among occupations that required lengthy sitting and lengthy standing.[41] We believe that the adjustment for job control, job demands, and physical strain at work partly satisfies the requirement of adjustment with sitting and standing at work. Yet, we are aware of the potential for a slight over-estimation due to the lack of other factors such as shift work and other hazardous nature of employment. Thus, residual confounding as an explanation for the present findings cannot

be excluded. Furthermore, due to the unavailability of information, we were also unable to account for smoking and risky alcohol consumption that may act as potential confounders for the association between workplace sexual harassment and CVD. However, sexual harassment is likely to be associated with stress responses that could lead to smoking and alcohol abuse, which may in turn be associated with cardiometabolic disease; therefore, factors such as smoking and risky alcohol consumption may be seen as mediators rather than confounders. Also, the estimates of prevalence and risk in our study might have been affected by the decreased response rate in SWES, which impacts the generalizability of the results of our study. We have seen an increase in attrition in SWES over time, majority of the non-responders being young people with low income and low education levels and immigrants. Nonetheless, we had a long follow-up and pragmatically no loss to follow-up that we regarded as another major strength of our study.

This study supports prospective association between workplace sexual harassment and increased risk of cardiometabolic diseases. If the observed associations were causal, then our findings indicate that prevention of sexual harassment at workplace through interventions targeted towards social environment and behaviours might contribute to decreased burden of type 2 diabetes as well as CVD. Given the importance of this association from the public health point of view, future research is warranted to clarify the causality and mechanisms behind these associations considering the severity of sexual harassment at workplace.

Supplementary material

Supplementary material is available at *European Journal of Preventive Cardiology*.

Author contributions

Concept and design: L.L.M.H., P.K.C., and H.W. Acquisition of data: L.L.M.H., I.E.H.M., R.R., T.X., H.W., M.K., and A.N. Analysis of data: P.K.C. Interpretation of data: P.K.C., L.L.M.H., I.E.H.M., R.R., T.X., H.W., M.K., and A.N. Drafted the manuscript: P.K.C. Critical revision of the manuscript for important intellectual content: P.K.C., L.L.M.H., I.E.H.M., R.R., T.X., H.W., M.K., and A.N. Obtained funding: L.L.M.H., H.W., I.E.H.M., T.X., R.R., M.K., and A.N. Agreed to be accountable for all aspects of work and given final approval of the submission: P.K.C., L.L.M.H., I.E.H.M., R.R., T.X., H.W., M.K., and A.N.

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Conflict of interest: none declared.

Data availability

SWES data are not publicly available due to legislative and ethical restrictions but can be requested for research directly from Statistics Sweden, while linked health records can be requested from the Swedish National Board of Health and Welfare.

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