



## Mediation of lifestyle-associated variables on the association between occupation and incident cardiovascular disease

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### ABSTRACT

The main aim was to examine the association between occupational groups and incident cardiovascular disease (CVD), and to which extent associations are mediated by lifestyle-associated variables (cardiorespiratory fitness, smoking, BMI, exercise, and diet). A total of 304,702 participants (mean age 42.5 yrs., 47% women), who performed a health profile assessment in Sweden between 1982 and 2019, were included in the analyses. CVD incidence was obtained from national registers. All participants were free from CVD prior to the health profile assessment. Occupational group was defined using the Swedish Standard Classification of Occupations and analyzed separately (13 different occupational groups) as well as after aggregation into four occupational groups (white-collar high-skilled, white-collar low-skilled, blue-collar high-skilled and blue-collar low-skilled). Cardiorespiratory fitness, BMI, exercise, smoking, and diet were included as mediators and analyzed separately in single models and simultaneously in one multiple mediation model. All mediation analyses were adjusted for sex, age, length of education and calendar time. White-collar high-skilled was set as reference in all analyses. Blue-collar and low-skilled occupation had a higher risk of incident CVD compared to the reference. Cardiorespiratory fitness, BMI, exercise, smoking, and diet mediated 48% to 54% of the associations between reference and the other aggregated occupational groups. In the single model, the strongest mediators were cardiorespiratory fitness, smoking and BMI. In conclusion, blue-collar and low-skilled occupations had a significantly higher risk for incident CVD compared to white-collar high-skilled workers, with the association mediated to a large extent by variation in lifestyle-associated variables.

### 1. Introduction

Between 2002 and 2015, low skilled occupations such as manufacturing labourers, motor-vehicle drivers and metal moulders experienced the highest risk of incident coronary heart disease in Sweden (Carlsson et al., 2021). Similar patterns are reported in other Western countries, with higher cardiovascular disease (CVD) risk score and a higher cardiovascular mortality in low-skilled and blue-collar occupations (Katikireddi et al., 2017; Marmot et al., 1984; Kelsall et al., 2018; Barnes et al., 2020; Vandersmissen et al., 2020). This may partly be attributed to work-related factors including psychosocial and physical work environment, stress and shift-work (Olsen and Kristensen, 1991; Kristensen, 1989; Kivimäki and Steptoe, 2018; Taouk et al., 2020),

but also to a variation in common lifestyle-associated factors closely linked to incident CVD risk (Väisänen et al., 2020; Ockene and Miller, 1997; Blair et al., 1996; Zhuo et al., 2021; Emerging Risk Factors Collaboration et al., 2011). However, while several studies exist on the contribution of lifestyle behaviors to socioeconomic inequalities and possible mediation effects on cardiometabolic disorders and mortality (Petrovic et al., 2018; Jiang and VanderWeele, 2015). Few larger studies have been able to include a broader set of lifestyle-factors to study the mediating effect on the association between multiple occupational groups and incident CVD. In a recent paper, lifestyle-associated risk factors such as cardiorespiratory fitness (CRF), BMI and smoking were shown to mediated a large part of the association between occupational group and severe COVID-19 risk (Ekblom-Bak et al., 2021). Similar

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knowledge regarding mediation by lifestyle-associated factors on the association between occupational group and CVD would provide important knowledge for the development of appropriate, targeted interventions.

The main aim was to examine the association between occupational groups and incident CVD, and to which extent associations are mediated by lifestyle-associated variables (CRF, BMI, smoking, exercise, and diet). A secondary aim was to calculate population attributable fractions (PAF) to estimate the percentage of incident CVD cases that could have been prevented if the exposure was eliminated.

## 2. Method

Data was retrieved from the Health Profile Institute database, which consists of data from health profile assessments (HPAs) performed in the Swedish working population since 1970. HPA is an interdisciplinary method consisting of a questionnaire regarding lifestyle and health experiences, measurements of anthropometrics and blood pressure, a submaximal cycle test for estimation of CRF, and a dialogue with a Health Profile Coach. Participation is offered to employees in a company or organization connected to occupational or health services and is free of charge for the participant. The HPA method has been developed and standardized by the HPI Health Profile Institute, which is also responsible for the database. Results from HPAs are available in the database from 1980. CVD incidence, education and complementing occupational codes were obtained from national registers (Patient register and Statistics Sweden). Ethics were granted by the ethics board at the Stockholm Ethics Review Board (Dnr 2015/1864–31/2 and 2016/9–32), and the study complied with the Declaration of Helsinki.

Data from HPAs performed between 1982 and 2020 were collected on December 1st, 2020, with a total of 420,339 HPAs available. After exclusion of participants younger than 18 or older than 75 years at baseline ( $n = 11$ ), with missing data on occupational group or any of the mediating or confounding variables ( $n = 111,835$ ), with incident CVD prior to the HPA ( $n = 2968$ ) or having an incident CVD event <2 years after the HPA ( $n = 812$ ), the resulting sample included 304,702 participants (mean age 42.5 years, range 18–75 years, 47% women) to be included in the analyses. Internal validity analyses were performed for a subset of variables for those included and those not included in the present paper (appendix table A.1). Differences were small but significant (all  $p < 0.001$ ); Participants included were more often women (46% vs. 44%), younger (42.6 vs. 43.9 years), less often daily smokers (9.8% vs. 12.0%), more often with high education (26.6% vs. 24.7%), and leaner (BMI 25.6 vs. 26.3). External validity analyses for the same cohort have been reported before (Väisänen et al., 2020).

### 2.1. Occupational groups

Occupational group was obtained from the HPA as Swedish Standard Classification of Occupations-codes (SSYK), which is similar to the International Standard of Occupation (Standard för svensk yrkesklassificering (SSYK), 2022; ISCO - International Standard Classification of Occupations, 2020). Internal missing of SSYK codes reported by the participant (22%) were replaced by SSYK codes from national register data reported by the employer. Each occupation was derived as a four-digit SSYK-code; the first digit defined the major group, the second digit defined the sub-major group, the third digit defined the minor group, and the fourth digit defined the unit group. In the present study, occupational groups were analyzed at major group level, with decimal number representing a subcategory of that major group level, as (1) managers; (2.1) science and engineering; (2.2) health care; (2.3) education; (2.4) other professionals; (3) associate professionals; (4) administrative and customer service; (5) service, care, and shop sales; (6) agriculture and forestry; (7) building and manufacturing; (8.1) mechanical manufacturing; (8.2) transport; and (9) elementary occupations. Furthermore, we used aggregated occupational groups for most

analyses, defined as white-collar high-skilled (occupational groups 1–3), white-collar low-skilled (occupational groups 4 and 5), blue-collar high-skilled (occupational group 6 and 7), and blue-collar low-skilled (occupational groups 8 and 9). More details on occupational grouping have been described earlier (Väisänen et al., 2020).

### 2.2. Mediators and confounders

Mediators used in the analyses were CRF - in relative terms to kg as mlO<sub>2</sub>/kg/min, and in relative terms to meters as mlO<sub>2</sub>/min/m<sup>2</sup> (called ml/min/kg and ml/min/m<sup>2</sup> respectively from here on) BMI, smoking, exercise and diet. Confounding variables included were sex, age, length of education as well as years between the HPA and the year 2020 from here on called calendar time.

CRF was assessed as estimated VO<sub>2</sub>max using the submaximal Åstrand cycle ergometer test (Åstrand, 1960). The Åstrand test has shown a low variation on group level in the mean difference between the estimated and directly measured VO<sub>2</sub>max (mean difference – 0.07 l/min 95% CI –0.21 to 0.06) (Bjorkman et al., 2016). Weight and height were measured to the nearest 0.5 kg and cm, respectively, and BMI was calculated as kg/m<sup>2</sup>. Data on smoking, exercise and diet were self-reported in the HPA. The question-and-answer choices were: *I smoke ... with the alternatives At least 20 cig/day, 11–19 cig/day, 1–10 cig/day, Occasionally, or Never; I exercise for the purpose of maintaining/improving my physical fitness, health and well-being ... with the alternatives Never, Sometimes, 1–2 times/week, 3–5 times/week, or At least 6 times/week; I consider my diet, regarding both meal frequency and nutritional content to be ... with the alternatives Very poor, Poor, Neither good or bad, Good, or Very Good.*

Sex was used as a categorical variable and age as a continuous variable. Length of education was derived from national registers and divided into the categories low ( $\leq 9$  years), middle (10–12 years) and high ( $\geq 13$  years).

### 2.3. Outcome variables

Participants were prospectively followed from performing their HPA until their first incident CVD, death or the end of the study period (2019–12–31). CVD classifications were made with International Classification of Diseases codes, ICD-10, earlier ICD-versions were converted before selection. ICD codes for ischemic heart disease (I21–I25), cardiac arrest (I46) and stroke (I60–I66) from patient register were used for classification of incident CVD.

### 2.4. Statistics

Right censored cox regression models were used to study the association between occupational groups and incident CVD risk with four gradually more adjusted models, in a) the 13 occupational groups and b) the four aggregated occupational groups. Model 1 was adjusted for age, sex and calendar time; Model 2 additionally for length of education; Model 3 for mediating variables (CRF, BMI, smoking, exercise and diet); and Model 4 for all variables in Model 1 to 3. CRF, BMI, exercise and diet were used as continuous variables while smoking was dichotomized into *more or <1 cigarette/day*. Schoenfeld's residuals were used to check proportional hazards.

Causal mediation analyses were used to evaluate potential mediation of each a priori selected mediator in the association between aggregated occupational group and incident CVD. Causal mediation analysis is based on a counterfactual framework (23). This method is more robust than other traditional approaches, for instance by protecting against mediator-outcome confounding affected by the exposure, exposure-mediator interaction, mediator-outcome confounding, and exposure-outcome confounding (Richiardi et al., 2013). From the casual mediation analysis, natural indirect effects, natural direct effects, and the total effect (from now on called indirect, direct, and total effects) were

obtained.

Further, a multiple mediation model was used, including all mediators as well as single mediation models for each mediator. White-collar high-skilled was used as reference group and modeled against the three other aggregated occupational groups, resulting in eight mediation models for each of the three occupational group comparisons. Each mediation model consisted of two models, a cox regression (direct effect between occupational group and outcome and the estimate between mediator and outcome) and either a logistic regression when it was a binary mediator or a linear regression model when it was a continuous variable (estimate between occupational group and mediator). CRF was analyzed as ml/min/kg in the single mediator model, and as ml/min/m<sup>2</sup> in the multiple mediator model to avoid inflated standard errors from multicollinearity between BMI and CRF as ml/min/kg ( $r = 0.50$ ). All mediation models were adjusted for a common set of confounders: sex, age, length of education and calendar time. Confidence intervals for the indirect effects were based on 1000 bootstrap samples with replacement. Sensitivity analyses including the exposure-mediator interaction were performed for all models, with no statistically significant ( $p < 0.05$ ) interaction effects.

Population attributable fraction (PAF) was calculated to estimate the percentage of incident CVD cases in our sample that could have been prevented if the exposure was eliminated. We recoded each previous continuous mediator into adverse binary variables (CRF <32 ml/min/kg (Blair, 1989), BMI  $\geq 30$  kg/m<sup>2</sup> (Weir and Jan, 2022), exercising less than once a week, considering the diet to be poor or very poor) to be used as exposures while adjusting for all previous mediators. BMI was removed in the CRF model to avoid multicollinearity. PAF was calculated for each binary exposure according to the equation:  $PAF = \{(HR - 1)/HR\} Pe$  (cases), where  $Pe$ (cases) is the prevalence of the exposure in participants with the lifestyle-associated factor (Rockhill et al., 1998) and HR being Hazard ratio. The 95% confidence interval calculated with the percentile method and 1000 bootstrap samples for each exposure from the original sample with replacement.

All data processing, analyses and graphics were made using R version 4.2 (R Core Team, 2022) with the packages tidyverse (Wickham, 2019) and CMAverse (Shi et al., 2021).

**Table 1**  
Baseline characteristics of study participants in relation to occupational groups.

	N	Women	Daily smoking	Physically demanding work	No regular exercise	Poor diet	Obesity (BMI $\geq 30$ kg/m <sup>2</sup> )	Low fitness (CRF < 32 ml/min/kg)
White-collar high-skilled								
1 managers	17,347	34%	5%	13%	28%	5%	11%	35%
2.1 science and engineering	22,575	28%	4%	7%	30%	5%	9%	26%
2.2 health care	10,520	64%	5%	25%	25%	3%	10%	35%
2.3 education	11,221	71%	5%	51%	27%	4%	10%	35%
2.4 other professionals	31,087	56%	6%	8%	29%	5%	9%	30%
3 associate professionals	71,619	50%	7%	24%	30%	5%	11%	34%
White-collar low-skilled								
4 admin and customer service	26,935	66%	13%	27%	32%	7%	13%	39%
5 service, care and shop sales	35,147	82%	16%	72%	32%	7%	17%	45%
Blue-collar high-skilled								
6 agriculture and forestry	2,741	29%	13%	79%	43%	8%	14%	37%
7 building and manufacturing	32,964	6%	13%	82%	45%	9%	16%	37%
Blue-collar low-skilled								
8 mechanical manufacturing	25,915	19%	15%	64%	43%	10%	18%	40%
8.3 transport	6,430	8%	15%	38%	48%	11%	24%	45%
9 elementary occupations	10,201	63%	20%	86%	38%	7%	18%	48%

### 3. Results

During a median follow up of 10 yrs (Q1-Q3 6 yrs–14 yrs), a total of 6,343 (2% of the study population) experienced a first-time incident CVD event. Of these, 71% occurred in men. In relation to occupational groups, 2.7% occurred in blue-collar occupational groups and 1.9% in white-collar occupational groups. The percentage of events by length of education was 4.6% for short, 2.1% for middle and 1.2% for long education (Table 1).

#### 3.1. Occupational groups and CVD-incidence

Fig. 1 describes the association between the 13 occupational groups and CVD incidence. Compared to reference (*Managers*), other white collar high skilled occupations had in general lower CVD incidence, with significantly lower HR for *other professionals* (includes occupations such as accountants, analysts, and HR-specialists). On the contrary, blue collar and low skilled occupations had in general higher risk, with *elementary occupations* having 50% (Model 1) to 22% (Model 4) higher risk compared to managers. Adjusting for lifestyle-associated variables had a more pronounced attenuation of the associations in blue-collar and low-skilled occupational groups compared to white-collar high-skilled occupational groups. Further we added interaction by sex and age groups for Model 4 which can be seen in appendix fig. A.1.

In analyses of the four aggregated occupational groups, blue-collar and low-skilled occupational groups had higher HR (range HR 1.09 to 1.38) for incident CVD compared to the reference group (white-collar high-skilled) in all models (Fig. 2).

A large part of the association between occupational group and CVD was mediated by differences in lifestyle-associated factors (Fig. 3 for directed acyclic graph, Fig. 4 and appendix table A.2 for estimates, appendix fig. A.2 for the mediating effect of physical workload). The range of point estimates for the indirect effect for blue-collar and low-skilled occupational groups compared to white-collar high-skilled occupational groups, were 1.04–1.07 for smoking, 1.03–1.05 for CRF (ml/min/kg), 1.02–1.04 for BMI, 1.01–1.01 for CRF (ml/min/m<sup>2</sup>), 1.00–1.02 for exercise and 1.01–1.01 for diet. For percentage mediated a similar pattern can be seen in Fig. 4.

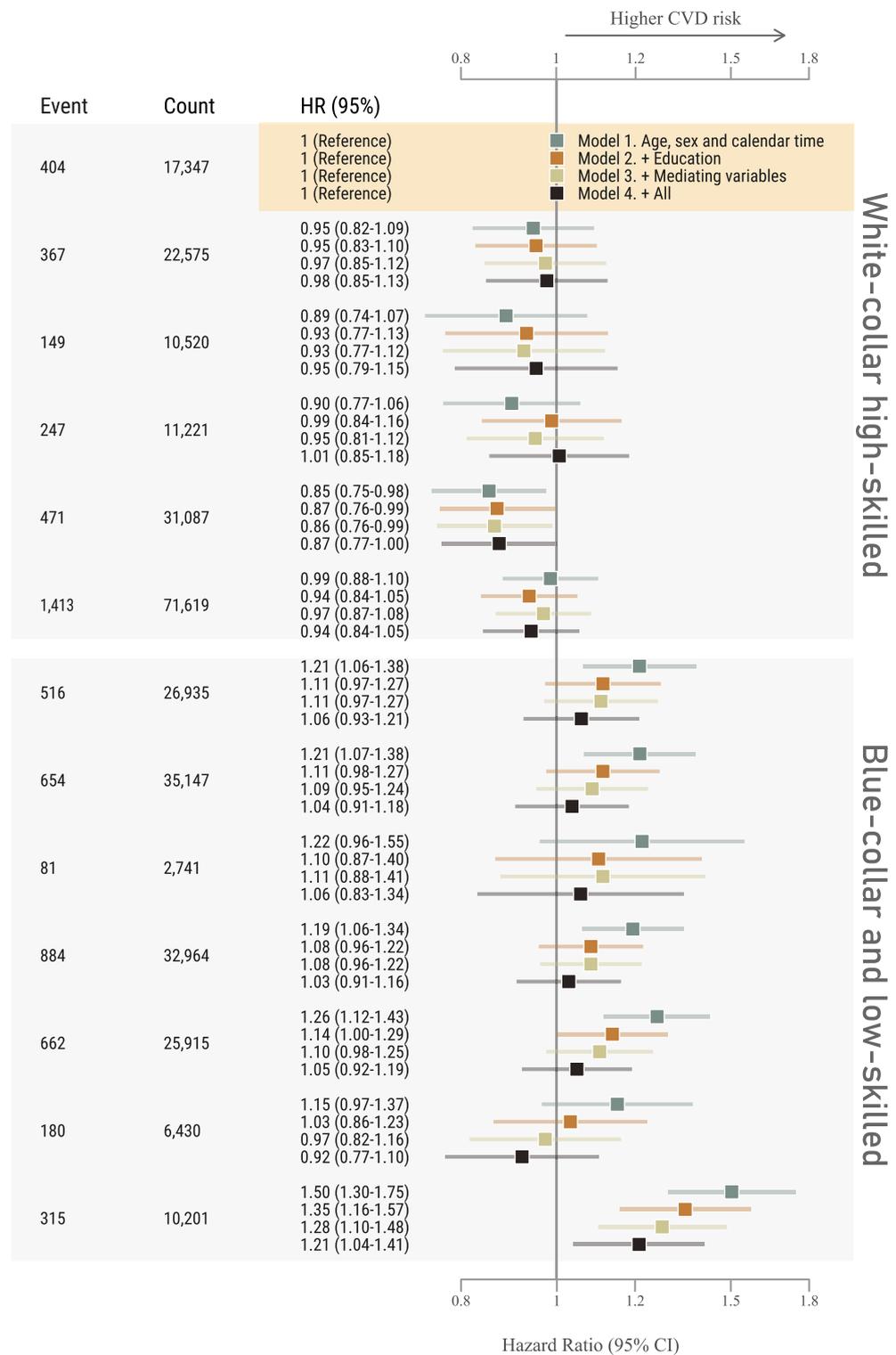


Fig. 1. Hazard ratios (HR) with 95% confidence intervals (CIs) for the association between 13 occupational groups and incident CVD.

### 3.2. Population attributable fractions

The largest theoretical prevention of incident CVD (as PAF estimations) in the total study population was seen for low CRF (range 6.8% to 9.0%), with no significant differences between occupational groups (Fig. 5). PAF for daily smoking and obesity displayed the largest differences between occupational groups; 8.0% vs 2.8% and 5.1% vs 2.8% comparing blue-collar low-skilled and white-collar high-skilled

occupational groups. PAF for no regular exercise and poor diet were small and non-significant.

### 4. Discussion

Main findings in this large study of men and women from the Swedish working population were that low-skilled and blue-collar occupations had in general a significantly higher risk for incident CVD

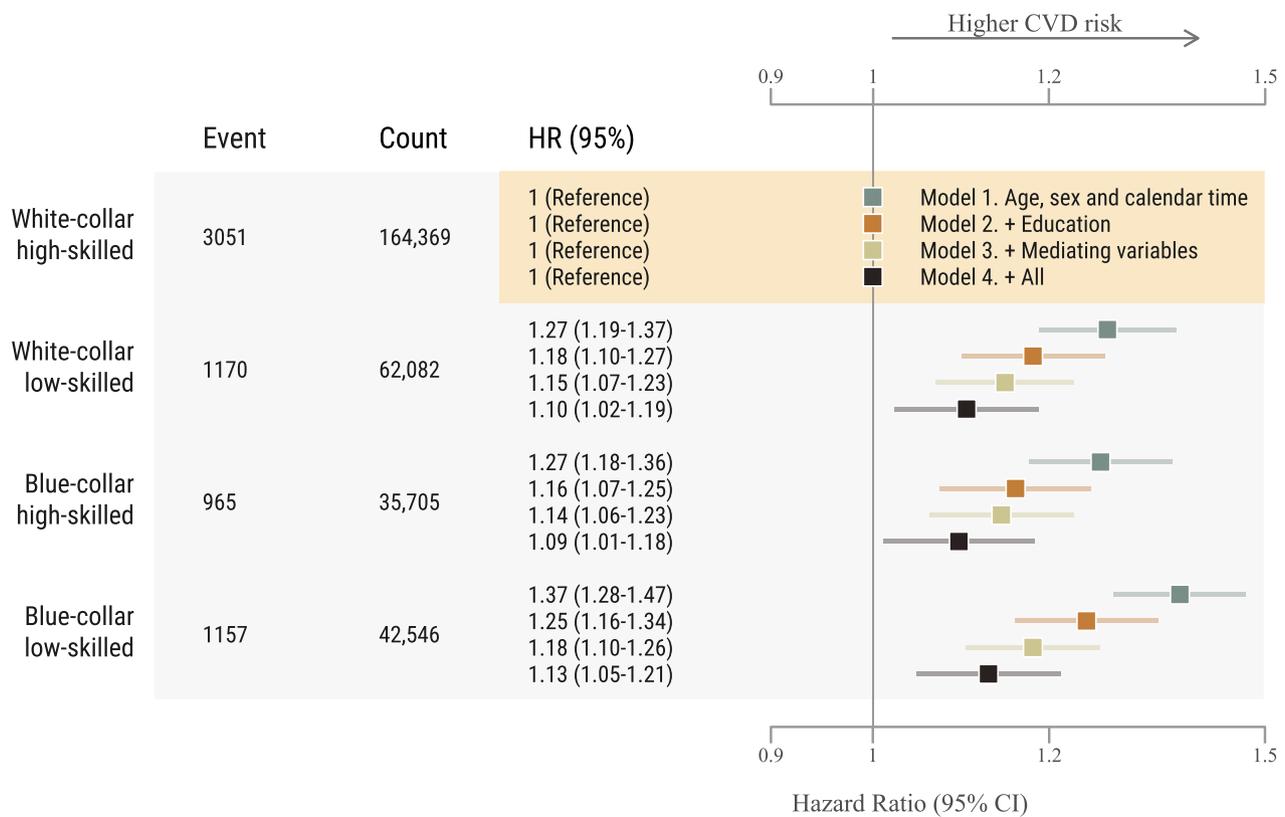


Fig. 2. Hazard ratios (HR) with 95% confidence intervals (CIs) for the association between the four aggregated occupational groups and incident CVD.

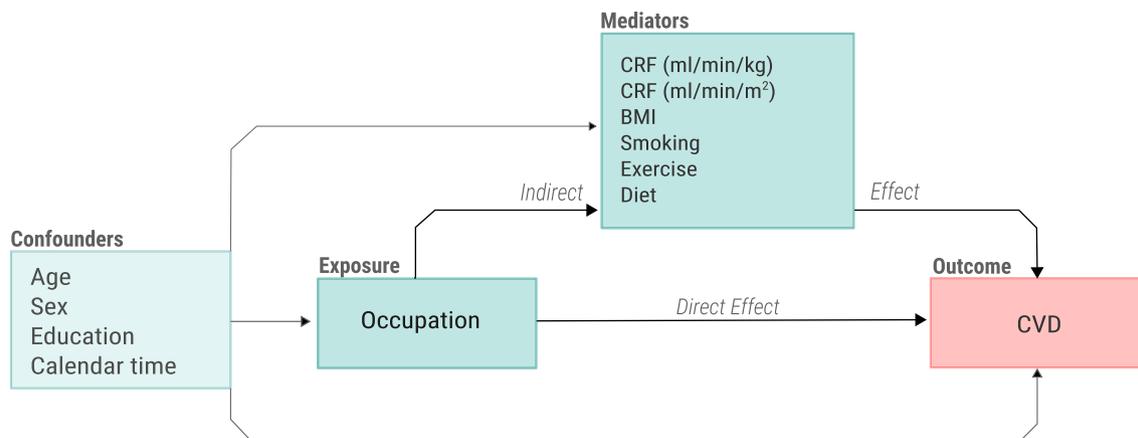


Fig. 3. Directed acyclic graph showing the examined effects in the mediation models. Mediators were analyzed in a single as well as in a multiple mediation model. The multiple mediation model included CRF as ml/min/m<sup>2</sup>. In all models, four backdoor paths were closed with the variables sex, age, education and calendar time.

compared to white-collar high-skilled, with elementary occupations displaying the highest risk. Mediation analyses revealed that a large part of the association between occupational group and incident CVD risk could be explained by variance in CRF (ml/min/kg) (20%–22% mediated), smoking (27%–36%), and BMI (11%–17%). PAF calculations indicated that removal of low CRF would theoretically prevent the largest proportion of CVD incident cases in the total population. However, to reduce the difference in CVD incidence seen between occupational groups, removal of daily smoking and obesity would provide the largest effect.

Difference in incident CVD risk was most pronounced between white-collar high-skilled vs blue-collar and low skilled occupations. This is similar to studies from New Zealand/Australia, which have reported

higher CVD risk score and higher risk of incident CVD in blue-collar low-skilled occupational groups (manufacturing, mining, retail trade, “transport, postal and warehousing, wholesale trading”) compared to white-collar occupational groups (Kelsall et al., 2018; Barnes et al., 2020). Also in studies from western countries, the highest mortality rates were shown in typical blue-collar occupations such as factory workers, cleaners, and construction workers (Carlsson et al., 2021; Katikireddi et al., 2017; Vandersmissen et al., 2020). Individuals in these blue-collar occupations have been shown to have higher prevalence of overweight, smoking, and low physical fitness (Carlsson et al., 2020). On the contrary, in Japan there seems to be an inverse relation between occupational class and coronary heart disease, where those in white-collar high-skilled occupations (managers and professionals) are at

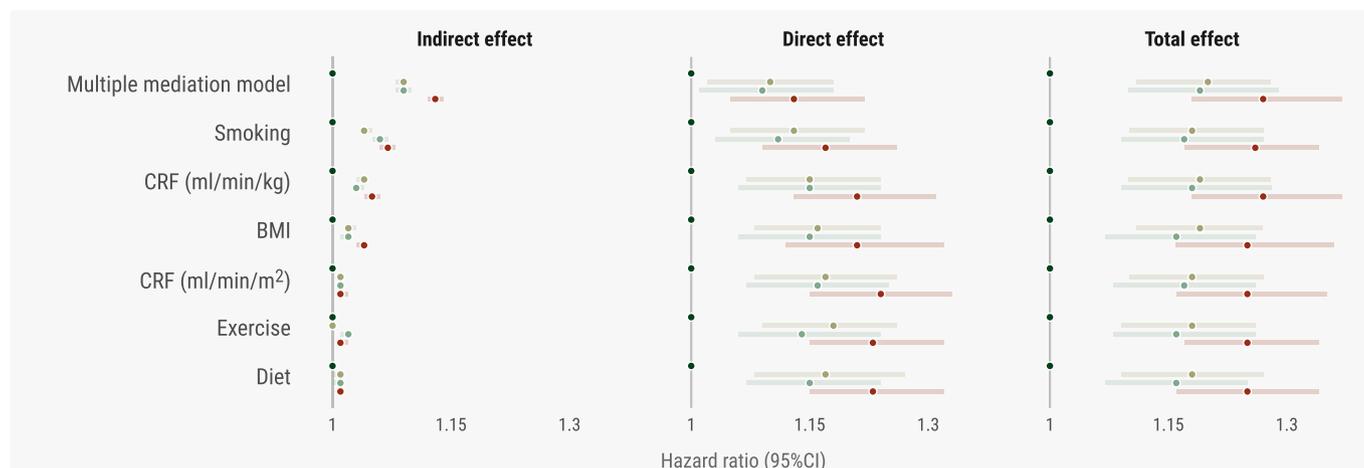
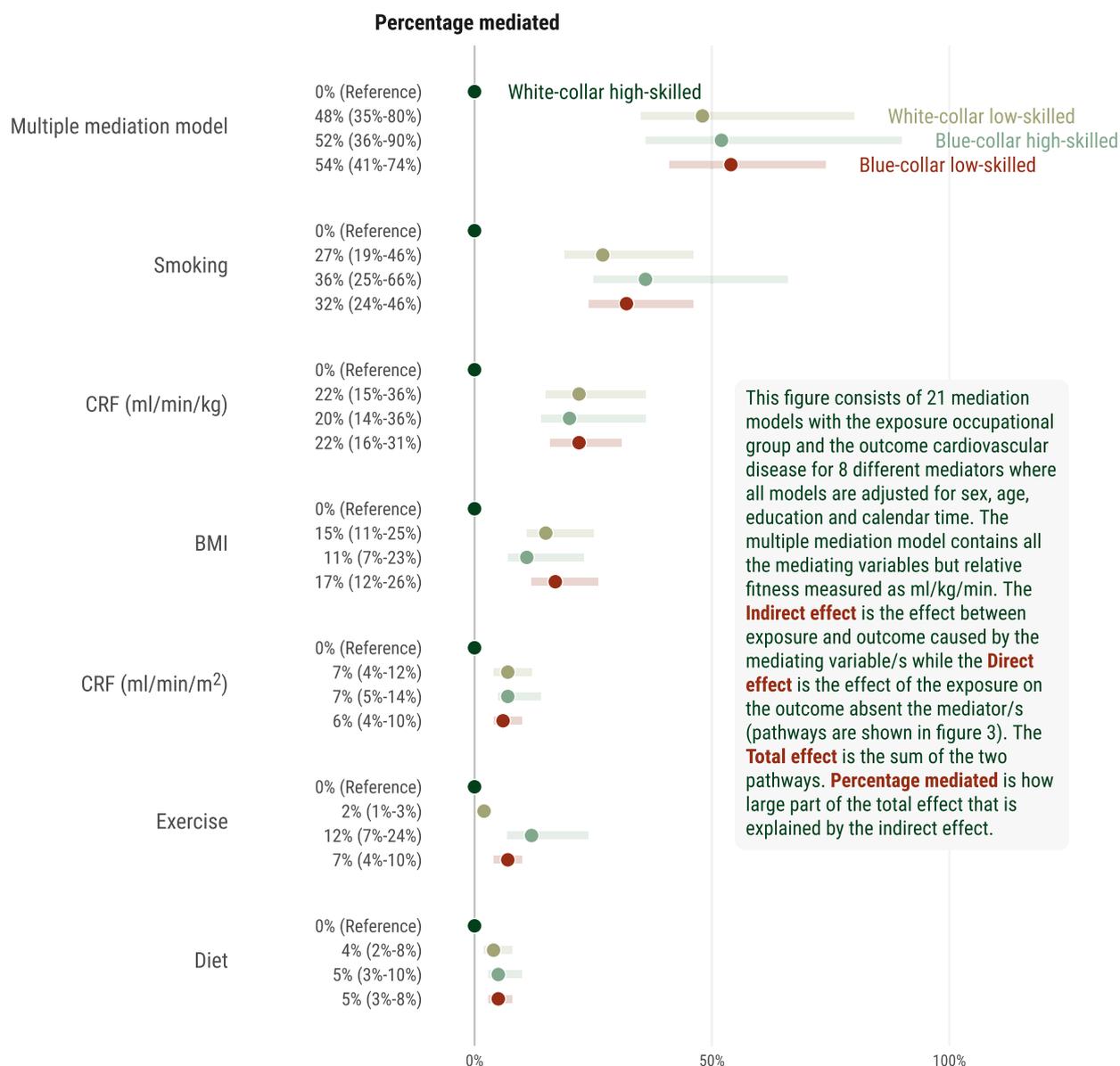


Fig. 4. Mediation analyses with percentage mediated, indirect, direct and total effect of smoking, CRF (ml/min/kg), BMI, CRF (ml/min/m<sup>2</sup>), exercise, and diet.

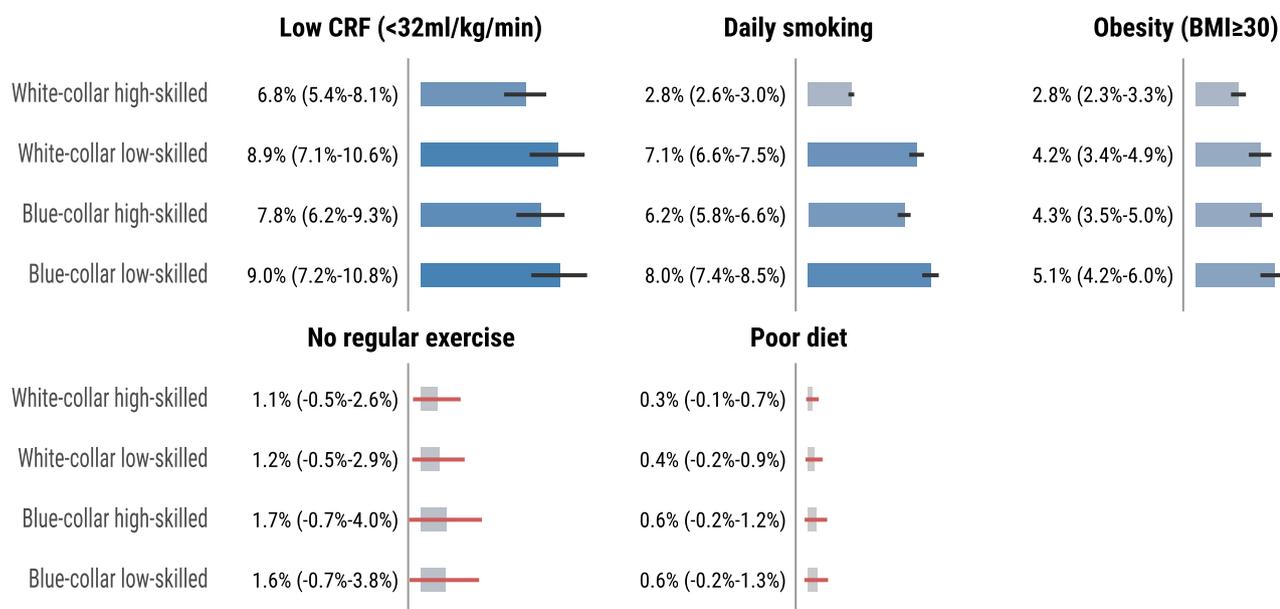


Fig. 5. Population attributable fraction (PAF) for low CRF, daily smoking, obesity, no regular exercise and poor diet for incident CVD. Each outcome variable is adjusted for the other predictor variables, except in the models with CRF and BMI as outcomes where they are not adjusted for each other.

higher risk (Zaitsu et al., 2019). This implies that the association between occupation and health may vary between cultures and countries, and that comparisons should be interpreted with caution.

The present mediation analyses showed that CRF, smoking and BMI to a large part mediated the association seen between occupational group and incident CVD risk. These results are partly in line with a previous systematic review including 30 studies world-wide, which calculated the mediated effect of different lifestyle-associated factors on the association between occupation and cardiovascular outcomes (Petrovic et al., 2018). In that study, the median combined effect of smoking, physical activity, alcohol consumption and dietary patterns was 26% (min: -7%; max: 73%, data from 11 studies), with smoking being the strongest independent contributor (15%, min: -13%; max: 36%, data from 7 studies). These are somewhat lower mediation effects than seen in the present study. One explanation may be that studies from different regions were included, and that studies conducted in North America and Northern Europe had larger contributions from lifestyle-associated factors than studies conducted in Central/Southern Europe. Another explanation may be the use of only aggregated data (not individual level data) in the systematic review, which only enabled the use of the difference method to calculate mediation (in comparison to the present study which used the additive hazard model). This method includes the limitation that the outcome studied should be relatively rare, which could have an effect on the percentages mediated in comparison to the present study (VanderWeele, 2013).

An important aspect was the difference in mediation effect by different measures of CRF. While there was a large mediating effect of CRF in relative terms by kg (as ml/min/kg), the mediating effect of CRF in relative terms by m (ml/min/m<sup>2</sup>) was smaller. One possible explanation is the inclusion of weight in the relative CRF measure, making the contribution of weight apparent in the association to CVD risk on a population level. We have previously compared the predictive power of CRF scaled to different body size measurements in relation to CVD incidence and all-cause mortality (Eriksson et al., 2021), indicating a stronger predictive power of CRF scaled to kg or waist circumference than to height squared. Together with the increased prevalence of both obesity and low CRF in the study population (Hemmingsson et al., 2021), this further highlights the importance to target obesity and low CRF in future health interventions.

Other studies have examined the mediating effect of lifestyle-

associated variables on the association between educational level and CVD incidence. In Spanish adults, smoking, BMI and physical activity mediated the association between education and incident CVD, with BMI as the main mediator accounting for 6.9% of the variation (Dégano et al., 2017). Moreover, in a sample of Dutch adults, the relation between education and incident CVD were mediated by smoking (27.3%), obesity (10.2%), and physical inactivity (6.3%) (Kershaw et al., 2013). Mediation by BMI and smoking were slightly larger in the present study, while the proportion mediated by physical activity were similar as in the Spanish and Dutch sample. The current study and previous findings (Petrovic et al., 2018) indicate that occupation might have a stronger association to lifestyle-associated variables than education. A conclusion from the systematic review above was that factors such as job stress, job strain and lack of control are likely to affect high-rewarding unhealthy behaviors such as smoking, alcohol drinking, and overeating, which in turn affects the risk of health outcomes (Petrovic et al., 2018).

Although 48% to 54% of the association between occupational groups and incident CVD were explained with five lifestyle-associated factors in the present study, a large part remains unexplained. Some of the unexplained variance could be due to for example genetics, work environment and psychosocial factors (Kristensen, 1989; Taouk et al., 2020; McDade et al., 2019; Erola et al., 2022; Mayer et al., 2007). A mediator that may have an effect on different lifestyle-associated factors is job stress, which has been shown to be higher in low-skilled compared to high-skilled occupations (Rigó et al., 2021). Stress is associated with incident CVD both directly through increased neurobiological activity that affects the cardiovascular system negatively and indirectly through an adverse effect on life-style related variables such as BMI and smoking (Barrington et al., 2012; Stubbs et al., 2017; Osborne et al., 2020). Whereas a high BMI is often related to a low CRF (ml/min/kg) on a population level. Prolonged stress is therefore a potential mediator in the association between occupational group, lifestyle-associated factors and incident CVD that needs to be explored in future studies.

PAF was used to estimate an absolute theoretical toll of incident CVD risk on a sample of the Swedish workforce while adjusting for other lifestyle-associated factors using our sample data as reference. PAF was greatest for low CRF across all the four aggregated occupational groups, while daily smoking and obesity showed larger contribution to incident cases among blue-collar low-skilled workers. This indicates that daily smoking and obesity are the most important factors to target when

minimizing occupational health inequality, whereas improvements in fitness will have the largest overall effect. Moreover, while physical activity has been attributed to large positive health effects (Myers, 2003), reporting no regular exercise in the present study was associated with low and non-significant PAF after adjustment for other lifestyle-associated variables.

#### 4.1. Strengths and limitations

A strength of this study was the large and heterogenous sample with participants from different occupational groups from the general Swedish working population. There is an association between poor socioeconomic conditions in early life and cardiovascular health in adulthood (Winpenney et al., 2021). We included education that has a clearer relation to CVD than occupational group as a confounder to remove some of the effects of early adulthood when examining the effect of occupation (Havranek et al., 2015). There are also some limitations including misclassification by occupational group, making the differences in estimates and uncertainty spans smaller or larger. Further, occupation was only assessed at baseline, possibly diluting the effect of belonging to a certain occupation as time in an occupation and change of occupation during follow-up is unknown. We lack data on other variables that could confound the relationship between occupation and CVD incidence, such as psychosocial factors and blood pressure. The exposure was not randomized introducing possible bias. However, this was partly addressed through examining exposure-mediator interactions – assessing if inequality in CVD incidence between occupations was the same irrespective of the level of the mediator and whether occupational group moderated the mediated effects. Finally, the present cohort is relatively young, which explains why we only had 2% incident CVD cases. This, in turn, is the cause of our broad occupational group definitions because it is related to the precision through which we can answer our research questions. Our study sample is from a high-income country and the results may not be generalizable to populations in low-income countries or in countries with different work cultures.

## 5. Conclusion

Blue-collar and low-skilled occupational groups experienced higher risk of incident CVD compared to white-collar high-skilled occupations. These associations were largely mediated by lifestyle-associated variables (ranked in order of importance): CRF, smoking and BMI. Using PAF estimation, low CRF was an important factor for CVD incidence in all occupational groups, whereas daily smoking and obesity were more prominently contributing to CVD incidence risk in blue-collar low-skilled occupational groups. These high-risk and vulnerable occupational groups need initiatives for maintenance and improvement of CRF. Instead of, solely putting this responsibility on the individual to perform additional exercise in leisure time, worksite and community interventions should be implemented, where a shift in their occupational physical activity is one possible contribution.

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## Data statement

Data belongs to the HPI Health Profile Institute. Any data-inquiries are referred to them.

## CRedit authorship contribution statement

**Daniel Väisänen:** Conceptualization, Data curation, Methodology, Formal analysis, Visualization, Writing – original draft, Writing – review & editing. **Lena Kallings:** Conceptualization, Writing – review & editing. **Gunnar Andersson:** Conceptualization, Writing – review & editing. **Peter Wallin:** Conceptualization, Writing – review & editing. **Erik Hemmingsson:** Conceptualization, Writing – review & editing. **Andreas Stenling:** Conceptualization, Methodology, Writing – review & editing. **Elin Ekblom-Bak:** Funding acquisition, Conceptualization, Writing – review & editing.

## Declaration of Competing Interest

Gunnar Andersson and Peter Wallin are employed at HPI Health Profile Institute.

## Data availability

The authors do not have permission to share data.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ypmed.2022.107411>.

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