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Improving job strain might reduce inequalities in cardiovascular disease mortality in European men.

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Abstract

Unfavorable psychosocial working conditions can lead to cardiovascular disease (CVD) mortality. Lower-occupational groups typically experience unfavorable psychosocial working conditions as compared to higher-occupational groups. We investigate the extent to which CVD mortality inequalities might be reduced if psychosocial working conditions for manual workers are raised to the level experienced by non-manual workers (upward-leveling scenario). We also investigate what would occur if psychosocial working conditions among manual and non-manual workers are raised to better levels as observed in the 'ideal' region (best practice scenario).

Individual-level CVD mortality data from 12 European countries were obtained from the EURO-GBD-SE project (1998-2007). Psychosocial working conditions data (i.e. job strain) were extracted from the European Working Conditions Survey (2005) and rate ratios from literature reviews. Population attributable fractions (PAF) and two counterfactual scenarios (namely, upward-leveling scenario and best-practice scenario) were developed to examine employed male non-manual and manual workers.

Results appeared to show that CVD mortality might be reduced in men when unfavorable psychosocial working conditions are improved for manual workers (PAF = 7.7%, 95% CI: 6.5-10.0). The upward-leveling scenario seems to reduce CVD mortality inequalities for manual workers, by 13-74%. Best-practice scenario shows the largest reduction in CVD mortality in the Baltic region (87 deaths per 100,000 person years).

Findings suggest that rendering job strain in manual workers to the level experienced by non-manual workers might substantially reduce CVD mortality inequalities in European men.

KEYWORDS: mortality, EURO-GBD-SE, psychosocial working conditions, population attributable fractions, cardiovascular disease, CVD mortality, socioeconomic status, health inequality

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Introduction

The economic and social situation of individuals can influence personal health and is known to contribute to health inequalities (Marmot and Wilkinson 2006). Health inequalities are identified as being influenced by geographical location (Witvliet et al. 2012). Efforts have been made to close the widening health gaps between high and low-income people (WHO 2008). However, as of yet no single solution exists to adequately close the health inequality gap that exists around the world (Petticrew 2007).

Prior research shows that working conditions contribute to health inequalities (Marmot and Wilkinson 2006). Lower-occupational groups tend to experience extensive unfavorable working conditions at their jobs as compared to their higher-occupational counterparts. Higher mortality rates are also evident in lower-occupational groups (Eikemo et al. 2008a, Eikemo and Mackenbach 2012, Kunst, Groenhof and Mackenbach 1998, Kunst et al. 1998, Mackenbach et al. 2008). Unfavorable working conditions related to the psychosocial working environment (i.e. high job demands and low job control), are found to increase the risk of coronary heart disease (Dragano et al. 2017).

Cardiovascular disease (CVD) is one of the leading causes of death in high-income countries. It is also a growing concern in low-income countries (Grafts Aikins and Agyemang 2016). CVD mortality is linked to psychosocial factors at work (Backé et al. 2012, Kivimäki and Kawachi 2015). In most European countries CVD mortality is declining (Nichols et al. 2012). However, substantial inequalities in CVD mortality remain across Europe, and CVD is a major problem, in particular amongst lower-socioeconomic groups. Previous research indicates that higher socioeconomic status is associated with lower mortality rates, especially in the case of CVD mortality (Mackenbach et al. 2015, Marmot, Siegrist and Theorell 2006).

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Strategies to reduce health inequalities are outlined in the research literature (Whitehead 2007). However, , more evidence-based solutions are needed, especially concerning the role of unfavorable psychosocial working conditions.

Population attributable fractions (PAF) investigations are a useful statistical method that can be used to provide information concerning the extent to which health inequalities might potentially decrease if improvement is made in the selected situation (Eikemo and Mackenbach 2012). For example, in a prior PAF investigation on smoking, it was identified that inequalities in smoking-related mortality could be reduced by more than half for some types of death (Kulik et al. 2013). Another PAF investigation examined six risk factors, finding that for smoking economics played the greatest role in reducing inequality in mortality (Eikemo et al. 2014). A growing number of health investigations utilize the PAF method. However, it is a tool overwhelmingly used in economics research. Few socio-epidemiological investigations have taken advantage of this method (Galea, Riddle and Kaplan 2010). In this investigation we apply the PAF method. We developed two counterfactual scenarios. First, we provide an estimation (i.e. upward-leveling scenario) that shows the extent to which a reduction in CVD mortality inequalities might be achieved, if exposure to unfavorable psychosocial working conditions experienced by manual workers are the same as compared to non-manual workers. Second, we identify the 'ideal' European region with the smallest mortality inequalities that can be attributed to unfavorable psychosocial working conditions to determine the 'best practice scenario'. We then estimate the change in occupational group differences in CVD mortality if unfavorable psychosocial working conditions in all countries are at the level of the 'ideal' or 'best-practice' European region.

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Data and Methods

To carry out a PAF investigation data are needed from multiple sources. First, we obtained individual-level CVD mortality data by occupational group from Toch-Marquardt et al. (2014). Causes of death were coded according to the International Classification of Diseases (ICD)-10 and comprised all cardiovascular diseases (CVD, I00-I99). Toch-Marquardt et al. (2014) analyzed longitudinal data (with the exception of Madrid, Spain which contained cross-sectional linked data) and were originally part of the EURO-GBD-SE project (Eikemo and Mackenbach 2012). To the best of our knowledge, this is the only study with a large number of populations that measures occupational group and uses mortality data derived from mortality registries. The EURO-GBD-SE data were collected and harmonized from population censuses and mortality registries from 12 European countries, from the years 1998-2007 (Table 1). The Euro-GBD-SE mortality data contained information on sex, age (in five year age groups from 30-85+) and occupational group. Our study populations derived from the European countries: Austria, Denmark, England and Wales, Finland, France, Italy (represented by the city Turin and three cities in Tuscany (Florence, Leghorn and Prato)), Lithuania, The Netherlands, Scotland, Spain (represented by the Basque Country and the region of Madrid), Sweden and Switzerland. These countries were grouped into four European sub-regions: North, West, South and Baltic. We used traditional geographic sub-groupings of Europe based on country location to define the sub-regions. A European average was constructed by pooling all analyzed countries into one group. To be certain that we had background and mortality information in its entirety, we restricted our analysis to men aged 30 to 59 who were employed. The mortality data source contained no information on occupational group for economically inactive men in most countries, thus this group was excluded. To account for lack of occupational information for economically inactive men a

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correction algorithm was applied separately for each population in the original data (for further details on the procedure see Toch-Marquardt et al. (2014)). Women had more than 30% missing on occupational group for most countries in the EURO-GBD-SE mortality data source and were excluded. In three populations in the original study (Denmark, Sweden and Switzerland) data were available for age at baseline only, this was accounted for using an adjustment method developed by Östergren, Menvielle and Lundberg (2011). For number of person-years of follow up within our sample please refer to Table 1.

Second, we obtained data on unfavorable psychosocial working conditions from the 2005 European Working Conditions Survey (EWCS) (Table 2). We used the survey year 2005 since this version was the closest match with EURO-GBD-SE mortality data. This cross-sectional comparative survey is conducted every five years by the European Foundation for the Improvement of Living and Working Conditions and is freely available online (Eurofound 2012). Respondents are sampled from the employed working population. Multistage, stratified random sampling methods were used and questionnaires were completed face-to-face (Eurofound 2012). Response rates for the EWCS are shown in Table 2. For more information on the data and survey development please refer to the EWCS website. The EWCS data contains information on entire countries, whereas EURO-GBD-SE mortality registry data contains information on countries, regions and cities. These regions and cities (see Table 1) were substituted with entire countries in the EWCS data. This left a sample size of 3,926 men. Given the small number of observations in the EWCS, we completed an overall analysis examining Europe in its entirety as well as a European sub-region analysis.

Occupational groups were created from the EWCS data source by utilizing the same classification used in the Euro-GBD-SE study, namely the Erikson-Goldthorpe (EGP) classification scheme (Erikson and Goldthorpe 1992), developed for international comparisons and previously used in studies on occupational inequalities in mortality (Kunst, Groenhof and Mackenbach 1998, Mackenbach et al. 2003, Toch-Marquardt et al. 2014). Thus, occupational groups were dichotomized to: (i) non-manual workers (e.g. professionals, managers, clerical, service, sales workers) and (ii) manual workers (e.g. manual supervisors, technicians, skilled and unskilled workers).

Table 1 about here

To obtain prevalence rates for unfavorable working conditions 'job strain' was operationalized using the Karasek and Theorell (1990) model, which classifies job strain as a mixture of 'job demands' and 'job control.' According to the classification used by Parent-Thirion et al. (2007), two questions from the EWCS were used to construct job demands: (i) 'Does your job involve working at very high speed?' and (ii) 'Does your job involve working to tight deadlines?'. Respondents' answer choices were: 1. 'All of the time', 2. 'Almost all of the time', 3. 'Around ¾ of the time' 4. 'Around half of the time', 5. 'Around ¼ of the time', 6. 'Almost never', 7. 'Never', 8. 'Don't know' and 9. 'Refusal'. Job control was constructed by using answers to five questions: The first three were: 'Are you able to choose or change your- (i) 'order of tasks', (ii) 'methods of work', (iii) 'speed or rate of work?' Respondents answer choices were: 1. 'Yes', 2. 'No', 3. 'Don't Know' 4. 'Refusal'. The last two were: (iv) 'You have influence over the choice of your working partners.' and (v) 'You can take your break when you wish.' Respondents answer choices were: 1. 'Almost always', 2. 'Often', 3. 'Sometimes', 4. 'Rarely', 5. 'Almost never', 6. 'Don't know' and 7. 'Refusal'. We derived the four-item job strain variable using the aforementioned questions "1 High, 2 Passive, 3 Active, 4 Low job strain". The median scores were used to calculate the four types of job strain. As such, if a respondent scored *above* the median on job demands and *below* the median on job control, he was considered as having high job strain. A respondent had passive job strain if he scored *below* the median on job control and

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job demand. Active job strain included men who scored *above* the median on job control and job demands. All men scoring *below* the median on job demand and *above* the median on job control were considered as having low job strain.

To assess the impact of a modified distribution of the exposure job strain on inequalities in CVD mortality by occupational group we use the PAF method. PAF is defined as the fraction of deaths that would have been avoided if the prevalence of job strain had been lower in the unfavorable population group (Murray et al. 2003, Steenland and Armstrong 2006), and is measured as follows:

Formula 1
$$PAF = \frac{\sum_{i=1}^{n} P_i RR_i - \sum_{i=1}^{n} P_i^{'} RR_i}{\sum_{i=1}^{n} P_i RR_i},$$

With n being the number of exposure categories, P_i the proportion of population currently in the ith exposure category, P'_i the proportion of population in the ith exposure category in the counterfactual (alternative) scenario and RR_i the relative mortality risk for the ith exposure category. PAF is used in a more generalized sense, not only taking into account elimination of a risk factor, but modification of the risk factor, which is otherwise described as Population Impact Fraction (Eikemo and Mackenbach 2012).

To compute the PAF the following three-step procedure was followed. First, population specific age-standardized mortality rates (ASMR), computed per 100,000 person-years of exposure and directly standardized with the European standard population (Ahmad et al. 2001) and CVD mortality rate ratios (RR) by occupational group, adjusted for age and estimated with Poisson regression were taken from Toch-Marquardt et al. (2014). Second, population specific job strain prevalence by occupational group data were calculated using the EWCS. Third, job strain specific

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mortality rate ratios (RRs) were extracted from a review conducted by Kivimäki et al. (2006). This study is the only investigation where RRs calculated solely for men could be distinguished. In addition, since all studies were not calculated solely for men, we could not use the pooled RR. RRs of all the studies included in the review are shown in the Appendix Table 5. From the studies in the review, we selected RRs derived from Johnson and Hall (1988) since it distinguished between men and women and used approximately the same CVD mortality definition that we applied. The RRs from Johnson were statistically significant, while others shown in the review were not. The other RRs in the study that were also statistically significant showed even higher values. A sensitivity analysis was conducted. It included all of the studies from the review and was used to compare the results using different RRs (see Appendix Figure 1). Sensitivity analysis showed that PAF values derived from Johnson and Hall (1988) are moderate, with some RRs from the respective studies being above and below. Utilizing the RRs from Johnson and Hall is a conservative approach that will lead to moderately higher PAF values. Since the review does not provide RRs for the fourfold job strain variable, we set active or passive job strain as having the same effect on CVD mortality as having low job strain (see Appendix A Table 5). Mortality rates, RRs and prevalence were calculated using the statistical package STATA 14. Confidence intervals (CI) for the PAFs were calculated with bootstrapping using the statistical package R (Efron and Tibshirani 1993).

We calculated two counterfactual scenarios, including the upward-leveling scenario and best practice scenario. The upward leveling scenario measured population specific CVD mortality reduction if manual workers had the same job strain prevalence as compared to non-manual workers. The best practice scenario measured the reduction of CVD mortality inequalities if all populations had the same job strain distribution as compared to the population with the lowest inequalities in job strain.

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PAF was used to calculate ASMR. This technique provides estimates of the extent of observed mortality after applying counterfactual scenarios. Absolute inequalities were expressed as age-standardized mortality rate differences, before and after the implementation of the counterfactual scenarios, between manual and non-manual workers. Further, we calculated the percentage reduction in mortality inequalities as follows:

Formula 2: $$\left(1-\frac{(MRR_{scenario}^{low}-1)}{(MRR_{original}^{low}-1)}\right)*100$$

where $MRR_{original}^{manual}$ is the original mortality rate ratio of manual workers and $MRR_{scenario}^{manual}$ is the mortality rate ratio of manual workers after implementing the counterfactual scenarios.

In a second sensitivity analysis, we analyzed country differences by examining men in each country separately (see Appendix B). The results of these country-specific analyses show a number of unstable confidence intervals, but the general pattern is similar to what is observed in the overall and regional analysis.

Table 2 about here

Results

Table 2 shows descriptive characteristics from the EWCS. The average age of the respondents is 43.6 years (SD = 8.3 years). The European sub-region with the highest number of non-manual workers is Northern (61.8%) followed by Western Europe (58.6%). Country-specific results show that the largest proportion of non-manual workers are in the Netherlands (69.5%), Sweden (69.4%) and Denmark (68.0%). Manual workers living in the West (39.7%) and in the Southern Europe (38%) report

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the highest level of job strain. Country-specific results show that job strain is most pronounced for people living in Italy (38.4%), France (34.5%) and The Netherlands (32.4%).

Table 3 about here

PAF estimates are depicted in Table 3. Results for the upward-leveling counterfactual scenario show that if job strain among manual workers is experienced to the same degree as among non-manual workers then the largest number of saved deaths from CVD would be in the Baltic region (PAF = 12.6%, 95% confidence interval (CI): 4.7-19.8). Western Europe has a large number of saved deaths attributed to CVD (PAF = 8.8%, 95%CI: 7.0-12.2). The smallest number of CVD deaths appears in manual workers living in Southern and Northern Europe. (PAF = 6.3%, 95%CI: 2.9-9.9 and PAF=6.9%, 95%CI 2.8-10.6, respectively). Pooled results for Europe show that manual workers living in Europe might have a significant reduction in CVD mortality if job strain would be at the same level as observed among non-manual workers.

Table 4 shows the (i) potential, (ii) relative and (iii) absolute reductions in CVD mortality for both scenarios. The upward-leveling scenario shows a reduction in CVD mortality for all sub-regions. Northern Europe reduced by 13%. The highest reduction appears in the Baltic and Southern European region (27% and 26% reduction respectively). Europe in its entirety appears to reduce the number of CVD-related deaths by 18%. The potential reduction of absolute inequalities varies in all regions, ranging from 11% in Southern Europe to 74% in the Baltic region.

Table 4 about here

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For the best practice scenario, the Northern European region is selected as the reference group. PAF is smallest in the Southern European region. However, the PAF is not significant for Italy. We selected the Northern European region as the best practice scenario region because Denmark is the best practice scenario country in the country-specific analysis (see Appendix B) and shows significant PAF estimates. The Northern European region has potentially better working conditions as compared to Southern Europe (Esping-Andersen 1991). This means that in our regional analysis occupational inequalities in CVD mortality is lowered to the average level of Denmark, Finland and Sweden (the Northern European region).

Changing occupational group inequalities to the level of Northern Europe results in the largest relative reduction being observed in Southern Europe (29%). A 14% decrease is identified in Western Europe for the people living in the Baltics a 15% decrease is observed. The overall results for Europe show a 16% relative decrease in CVD mortality. Results of the absolute reduction in CVD mortality inequalities appear to show that as compared to the best-practice group, Southern Europe has the lowest reduction of CVD-related deaths (10 deaths per 100,000 person years) followed by Western Europe. The largest reduction in absolute mortality is observed in the Baltic region, with 87 CVD-related deaths per 100,000 person years. Results for Europe in its entirety appear to be a reduction in 27 CVD-related deaths per 100,000 person years.

Discussion

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European regions appear to show a reduction in CVD mortality if the exposure to unfavorable psychosocial working conditions (i.e. job strain) are rendered the same within manual and non-manual occupations. The largest proportion of CVD-related deaths could be avoided in people living in Southern Europe and in the Baltic region if the distribution of unfavorable psychosocial working conditions between non-manual and manual workers are raised to the level of non-manual workers. A reduction in CVD mortality is expected if the level of unfavorable psychosocial working conditions is raised to that of Northern Europe.

This study is an exploratory first-step in the utilization of the PAF method to study unfavorable psychosocial working conditions as measured by job strain. As within all PAF investigations interpretation of findings should be done with caution. To carry out a PAF investigation a number of assumptions must be made related to causality, absence of confounding during exposure and time (Robins and Greenland 1989, Rockhill, Newman and Weinberg 1998). A noteworthy strength of this investigation is that it is the first to provide information using counterfactual scenarios on what could potentially occur to CVD mortality rates if unfavorable psychosocial working conditions are improved. Second, most research on this subject matter is single-country or examines occupational group inequalities in health by describing variations by education or income (Eikemo et al. 2008a, 2008b). We build on previous investigations by using a comparative approach. We are also one of the few PAF investigations to include confidence intervals for the PAF estimates, which allows for us to gauge the uncertainty of PAF estimates (Natarajan 2007).

Another strength is that unlike in a conventional regression, we pool data from several different sources, which gives a hypothetical overview of how the current situation could be improved. However, this advantage is also a limitation, given that introducing data from different

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data sources can make estimates more susceptible to bias. This may lead to an over or underestimation of conclusions. Nevertheless, since we calculated CVD mortality and job strain from a meta-analysis, we expect potential bias to be limited.

A shortcoming of this study is that we limited our study population to employed men. Excluding economically inactive men might lead to a biased downward estimation of mortality rates, since inactive persons generally have a higher mortality rate as compared to the employed, and the proportion of economically inactive people is typically higher in manual classes (Blossfeld, Mills and Bernardi 2006). Furthermore, in three countries (Denmark, Sweden, and Switzerland) data were available for age at baseline only. In these populations, CVD mortality rates can be biased upward, since the numbers of CVD-related deaths are attributed to a younger age group (and not in the age group they occurred in). This bias increases with follow-up time. Even though we applied an adjustment method to increase the accuracy of our mortality estimates, the extent that this has influenced our results is unknown. Further, the average response rate for the EWCS is low (47%). The EWCS is essential to our analysis and despite not having more information on these figures to draw firm conclusions concerning the extent to which our results might be influenced by selective non-response, the EWCS is deemed valid and reliable and has undergone rigorous quality assurance measures (Eurofound 2012). We also acknowledge that the classification of workers into manual and non-manual is not ideal. Given that it does not make a distinction between the variability between groups (e.g. unskilled workers vs. skilled workers). However, data restrictions forced us to narrow the classifications. The same is true for utilizing only one measure of unfavorable psychosocial working conditions. Future, research would benefit by using a more detailed classification of occupational group and a larger variety of measures for unfavorable working conditions as data estimating RRs become available.

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In this investigation we focus on one social determinant of health (i.e. working conditions). The nature of the PAF analysis and the need to gather data from multiple data sources makes it difficult to investigate all factors that might contribute to reducing occupational inequalities in mortality. For example, alcohol use is an important factor that contributes to health inequality that we are not able to measure in the current investigation, because of limited data in the literature. This is an inherent limitation to PAF investigations. This limitation however does not minimize the importance of lifestyle factors for health. A recent study identified that working conditions might be of great importance when it comes to occupational group inequalities in mortality (Hämmig, Gutzwiller and Kawachi 2014). Therefore, the current investigation is a first step in filling the gap in our knowledge concerning the extent to which CVD mortality could be reduced.

This exploratory PAF investigation shows differences across European regions in reduction of CVD mortality inequalities. Previous research identifies that inequalities in health due to unfavorable psychosocial working conditions are a major concern for lower-occupational groups, with higher-occupational groups usually managing best (Eikemo et al. 2008c, Eikemo and Mackenbach 2012, Kunst, Groenhof and Mackenbach 1998, Kunst et al. 1998, Marmot et al. 1999, Marmot et al. 1991). Unfavorable psychosocial working conditions are also known to impact mental health (WHO 2014). Although previous health studies are not directly comparable to the current study, our findings appear to confirm the negative impact of unfavorable psychosocial working conditions on CVD mortality. This is especially evident for men employed in lower-occupational jobs. Our findings suggest that all regions might benefit if unfavorable psychosocial working conditions are improved.

The Baltic region, which included Lithuania, appeared to have the highest potential reduction in CVD mortality. We observed regional differences in the numbers of lives saved. Regional

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differences in health across Europe have been identified in previous investigations (Rajaratnam et al. 2010, Toch-Marquardt et al. 2014, Witvliet et al. 2012), and follow an East-West gradient, with people in the Baltic region, Central and Eastern Europe typically reporting higher levels of morbidity and mortality (Mladovsky et al. 2009, Witvliet et al. 2013). The largest quantity of saved deaths being observed in the Baltic region as compared to the rest of Europe is a promising result. The long-standing problematic political and economic situation of the Baltic region has contributed to a significant increase in poor health and high mortality rates, especially within men (Carlson 2004, Velkova, Wolleswinkel-van den Bosch and Mackenbach 1997, Watson 1995). Although overconsumption of alcohol is a known catalyst to the high mortality rates in the Baltic region (Nolte, McKee and Gilmore 2005), our results appear to show that improving psychosocial working conditions might have a considerable impact on CVD mortality in the Baltic region.

Findings for the upward-leveling scenario show a difference between relative and absolute percentages for all regions (except Southern Europe). This suggests that rendering unfavorable psychosocial working conditions of manual workers to what is observed in non-manual workers within the respective region might make a substantial contribution in reducing CVD mortality in most regions. This finding supports prior research that shows belonging to a higher-occupational group might be a health protective factor from the negative health effects associated to unfavorable psychosocial working conditions (Elo 2009).

The best-practice scenario findings are not much different to the upward-leveling scenario. This suggests that improving unfavorable psychosocial working conditions will have a similar outcome as changing working conditions to reflect Northern Europe. Achieving the same distribution of psychosocial working conditions between occupational groups, akin to what is observed in Northern

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Europe, might lead to a reduction in inequalities in CVD mortality in other regions. For the Baltic region, it seems that the best-practice scenario might make an even larger impact, rather than the upward-leveling scenario.

Socioeconomic inequalities in CVD mortality are a public health concern. We observed that there is a potential to reduce socioeconomic inequalities in CVD mortality, if psychosocial working conditions are improved in manual workers. Identifying realistic steps that countries can take to improve manual workers health is important. Research shows that stress management interventions at work improve stress at work (Limm et al. 2011). Time-flexible work policies also seem to be beneficial for working conditions (Halpern 2005). Having job resources is known to reduce job strain (Bakker, Demerouti and Euwema 2005). Actual intervention advice and policy recommendations are outside the scope of this study. The goal of the PAF investigation is to highlight what a country could aspire to achieve if a psychosocial working conditions are improved. The methods countries should take to make improvements (albeit via labour policies, corporate actions or other factors) is the next step in future research. What seems evident is that if the aim is to reduce CVD mortality inequalities, then employers and governments should be concerned with improving psychosocial working conditions..

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Appendix A: Sensitivity analysis using the different RRs from Kivimäki et al. 2006.

Table 5 about here

Figure 1 about here

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Appendix B: By country analysis.

Table 6 about here

Table 7 about here

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Table 1: Characteristics of the EURO-GBD-SE mortality data for employed men aged 30-59

Population	Type of dataset	Period	Geographic coverage	Demographic coverage	Person-years of follow-up	Number of CVD deaths	Proportion of manual workers (%)
				NORTH			
Denmark	longitudinal	2001-2005	National	whole population	5,708,058	3410	30.9
Finland	longitudinal	2001-2007	National	20% of Finns are excluded (at random)	5,742,810	5065	39.5
Sweden	longitudinal	2001-2006	National	whole population	11,000,000	5436	40.1
				WEST			
Austria	longitudinal	2001-2002	National	whole population	1,747,710	971	48.2
England & Wales	longitudinal	2001-2006	National	1% of the population	516,971	312	48.2
France	longitudinal	1999-2005	National	1% of the population (born outside France mainland excluded)	579,691	214	48.1
Netherlands	longitudinal	1998-2003/ 2003-2007	National	from labour force survey	708,457	340	54.3
Scotland	longitudinal	2001-2006	National	whole population		133	45.9
Switzerland	longitudinal	2001-2005	National	Non-Swiss nationals excluded	6,091,605	2450	57.1
				SOUTH			
Italy (Turin)	longitudinal	2001-2006	Urban	whole population	784,020	347	44.9
Italy (Tuscany)	longitudinal	2001-2005	Florence, Leghorn, Prato	whole population	473,682	151	63.2
Spain (Basque)	longitudinal	2001-2006	Regional	whole population	2,359,033	1141	38.9
Spain (Madrid)	cross-sectional, linked	2001-2003	Regional	whole population	1,902,232	685	61.6
				BALTIC			
Lithuania	longitudinal	2001-2005	National	whole population	3,149,964	3338	15.7

Note: Information in this table extracted from the EURO-GBD-SE project mortality data.

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Table 2: Characteristics of the EWCS (2005) data, men, age 30-59.

Population	Sample size	Response rate (%)	Proportion of non-manual workers (%)	Prevalence of job strain (%)* High	
				Non-manual workers	Manual workers
NORTH					
Denmark	318	42	68.0	21.5	27.7
Finland	337	35	48.0	27.1	35.7
Sweden	418	47	69.4	20.8	30.9
WEST					
Austria	363	61	50.8	19.8	40.8
England & Wales	341	34	58.6	27.1	36.7
France	379	58	47.6	25.6	42.6
Netherlands	402	28	69.5	27.1	44.4
Scotland	341	34	58.6	27.1	36.7
Switzerland	435	32	66.3	24.4	37.0
SOUTH					
Italy (Turin)	322	49	61.9	35.2	43.6
Italy (Tuscany)	322	49	61.9	35.2	43.6
Spain (Basque)	340	66	54.8	20.0	32.4
Spain (Madrid)	340	66	54.8	20.0	32.4
BALTIC					
Lithuania	271	64	31	14.3	32.1

Note: * Data were weighted using the cross-national weight.

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Table 3: Population Attributable Fraction (PAF in %) of CVD mortality of manual workers, with 95% Confidence Interval, upward levelling scenario for men aged 30-59.

Population	PAF	CI (95%)
North	6.9	(2.8, 10.6)
West	8.8	(7.0, 12.2)
South	6.3	(2.9, 9.9)
Baltic	12.6	(4.7, 19.8)
Europe	7.7	(6.5, 10.0)

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Table 4: Original Mortality rate ratios (MRR), original rate difference (RD) (per 100,000 person years), new mortality rate ratios (MRR), and potential relative (in %) and absolute reductions (per 100,000 person years) in CVD mortality, between manual and non-manual workers, by scenario, men, age 30-59.

Population	Original MRR	Original RD	Upward levelling scenario			Best practice scenario		
			New MRR	% red.	Abs. red.	New MRR	% red.	Abs. red.
North	2.18	50	2.03	13	43	Best practice		
West	2.00	43	1.82	18	35	1.86	14	37
South	1.32	14	1.24	26	11	1.23	29	10
Baltic	1.90	101	1.66	27	74	1.77	15	87
Europe	1.75	33	1.61	18	27	1.63	16	27

Note: Reference group for best practice scenario is the North. No reference group needed for upward-levelling scenario.

Table 5: Job strain specific RRs as showed in Kivimäki et al. 2006

Job Strain	Low strain	Active	Passive	High strain	
Studies	RR	RR	RR	RR	CI
Johnson 1988	1	1	1	1.92	(1.15-3.21)
Reed 1989	1	1	1	0.94	(0.65-1.36)
Alterman 1994	1	1	1	1.48	(0.98-2.24)
Bacquer 2005	1	1	1	1.35	(0.73-2.49)
Uchiyama 2005	1	1	1	1.75	(0.49-6.27)
Netterström 2006	1	1	1	2.4	(1.01-5.68)
Kivimäki 2002	1	1	1	2.2	(1.16-4.17)
Kuper 2002	1	1	1	1.57	(1.26-1.96)

Note: Study in bold was used in the main analysis.

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Table 6: Population Attributable Fraction (PAF in %) of CVD mortality of manual workers, with 95% Confidence Interval, upward levelling scenario for men aged 30-59, by countries.

Population	PAF	CI (95%)
	NORTH	
Denmark	4.5	(-3.2, 11.6)
Finland	6.0	(-0.9, 12.8)
Sweden	7.2	(0.8, 13.2)
	WEST	
Austria	14.1	(7.4, 19.8)
England & Wales	6.6	(-1.1, 13.5)
France	11.2	(5.1, 16.9)
Netherlands	11.3	(4.5, 17.4)
Scotland	6.6	(-0.3, 13.8)
Switzerland	8.7	(2.2, 14.6)
	SOUTH	
Italy (Turin)	5.5	(-2.0, 12.9)
Italy (Tuscany)	5.5	(-1.4, 12.6)
Spain (Basque)	8.8	(1.8, 14.8)
Spain (Madrid)	8.8	(1.8, 14.8)
	BALTIC	
Lithuania	12.6	(5.3, 19.7)

Table 7: Original Mortality rate ratios (MRR), original rate difference (RD) (per 100,000 person years), new mortality rate ratios (MRR), and potential relative (in %) and absolute reductions (per 100,000 person years) in CVD mortality, between manual and non-manual workers, by scenario, men, age 30-59, by country.

Population	Original MRR	Original RD	Upward levelling scenario			Best practice scenario		
			New MRR	% red.	Abs. red.	New MRR	% red.	Abs. red.
			NORTH					
Denmark	1.96	37	1.87	9	33		Best practice	
Finland	2.16	73	2.03	11	65	2.07	8	67
Sweden	1.77	29	1.65	17	24	1.69	10	26
			WEST					
Austria	1.51	31	1.29	42	18	1.44	13	27
England & Wales	2.12	55	1.98	13	48	2.02	9	51
France	2.15	40	1.91	21	31	2.05	8	36
Netherlands	2.08	48	1.84	22	38	1.98	9	44
Scotland	1.96	40	1.83	14	35	1.87	9	36
Switzerland	1.77	28	1.62	20	22	1.69	10	25
			SOUTH					
Italy (Turin)	1.32	15	1.24	23	12	1.26	19	12
Italy (Tuscany)	1.26	9	1.19	27	7	1.2	22	7
Spain (Basque)	1.52	24	1.39	25	18	1.46	13	21
Spain (Madrid)	1.14	7	1.04	73	2	1.09	37	4
			BALTIC					
Lithuania	1.9	101	1.66	27	74	1.81	10	92

Note: Reference group for best practice scenario is Denmark. No reference group needed for upward-levelling scenario.

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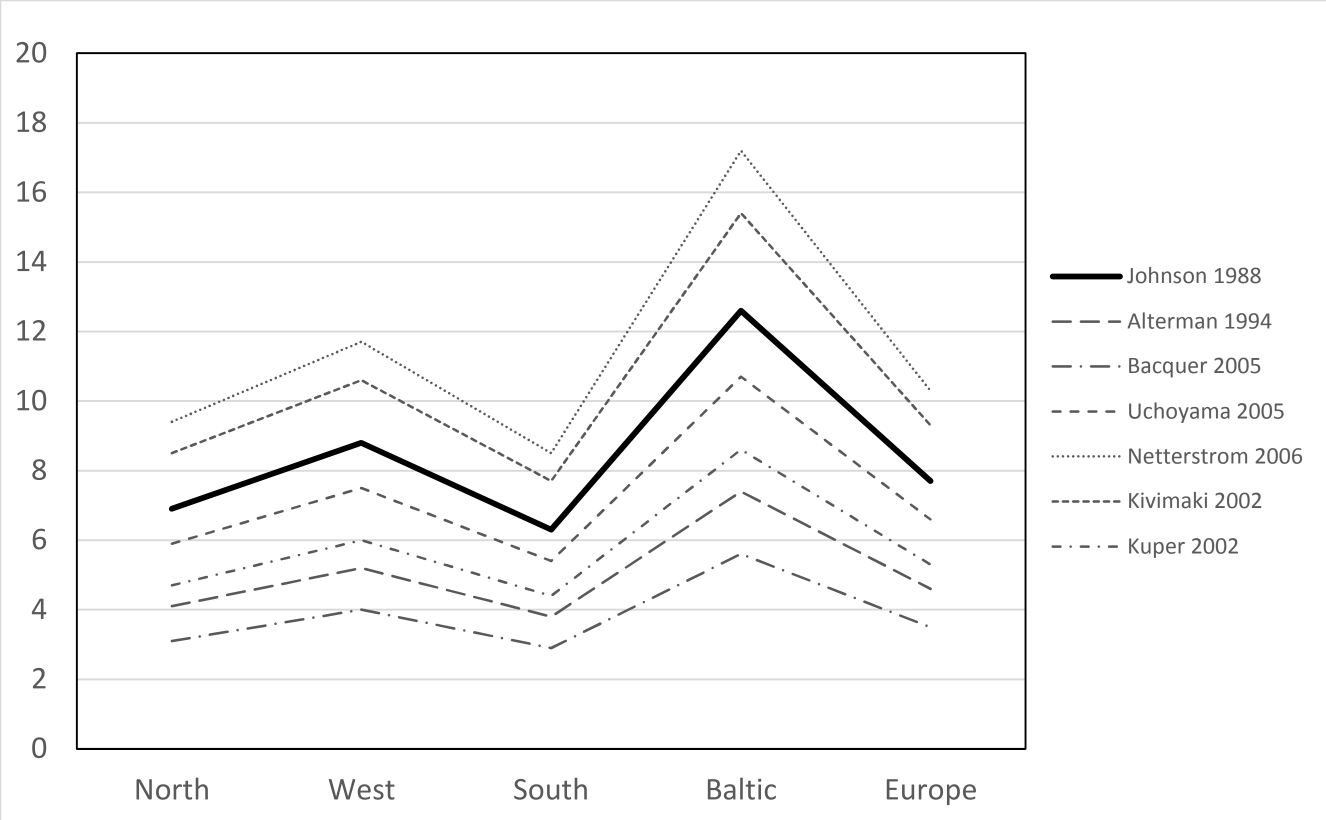

Figure 1: Population Attributable Fraction (PAF in %) of *CVD* mortality of manual workers, estimated using different RRs taken from Kivimäki et al. (2006), upward levelling scenario for men aged 30-59.

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Bullet Points

- Improving job strain might reduce CVD mortality inequality in men.
- Improving working conditions has large impact in Southern Europe and Baltic region.
- PAF analysis can estimate the CVD mortality burden of occupational group inequalities.

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