European Agency for Safety and Health at Work

DISCUSSION PAPER

THE LINKS BETWEEN EXPOSURE TO WORK-RELATED PSYCHOSOCIAL RISK FACTORS AND CARDIOVASCULAR DISEASE

While, in general, work is good for health and the working population is on average healthier than those outside the labour market, there are adverse psychosocial factors at workplaces that can, through stress mechanisms, negatively affect the cardiovascular system. Follow-up studies of working populations have linked several psychosocial factors, including high job demands, low job control, imbalance of effort and rewards, long working hours, bullying and violent situations at work, organisational injustice and job insecurity, particularly when prolonged, to increased risk of cardiovascular disease.

1. Cardiovascular disease

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels and include coronary heart disease, cerebrovascular disease, rheumatic heart disease and other conditions (WHO, 2022).

CVDs are costly in terms of healthcare costs and lost productivity from premature death and stroke and they remain the leading cause of global disease burden, a burden that continues to rise (Roth et al., 2020). CVD was estimated in 2003 to cost €169 billion annually in the EU, with healthcare accounting for 62% of the costs (Leal et al., 2006).

Since the population at risk for CVD represents a significant portion of the workforce, it is important not only that work does not increase the risk of CVD, but also that the workplace provides an opportunity to promote cardiovascular health.

This article explores the link between CVD and work-related psychosocial risks, and the implications for workplace health promotion.

2. What is stress?

We become stressed when we are under excessive pressure and perceive that we do not have sufficient physical and mental resources to cope with all the demands on us. These resources could be not having enough time to do all the work required or not having the support we need to deal with an emotionally challenging job. Although stress is not an illness, if someone is under stress for a long time it may make them ill. This could take the form of mental health problems, such as burnout or depression. It has also been linked to physical illnesses. (EU-OSHA, 2018).

Symptoms of stress include:

Physical symptoms of stress: • Heart beating fast (palpitations) • Dry mouth • Headaches, odd pains, feeling dizzy or sick • Tiredness or trouble sleeping • Sudden weight loss or gain • Frequent bad temper and lack of patience.

Emotional signs of stress: • Upset • Feeling scared, anxious, panicked or worried often • Easily angry or tearful • Feeling alone or hopeless • Feeling numb and uninterested in life.

3. How is stress linked with CVD?

Our body's acute stress response when facing a challenging, frightening, worrying or anger-provoking situation causes several physiological reactions. Our autonomic nervous system, which covers nearly all organs in the human body, activates within seconds after exposure to a stressor. The released hormones increase heart rate and decrease heart rate variability, optimise blood flow to muscles and increase body temperature. This stress response can involve initial simultaneous activation of both the sympathetic and parasympathetic systems,[1] followed by parasympathetic nervous system withdrawal to sustain stress-evoked elevated heart rate (EU-OSHA, 2009; Kivimäki & Steptoe, 2018; Sara et al., 2022).

The hypothalamus-pituitary-adrenal (HPA) axis[2] activates within minutes after exposure to a stressor, releasing hormones into blood circulation and increasing blood glucose levels. In combination with the autonomic nervous system, the HPA axis response increases activity in blood circulation (Kivimäki & Steptoe, 2018).

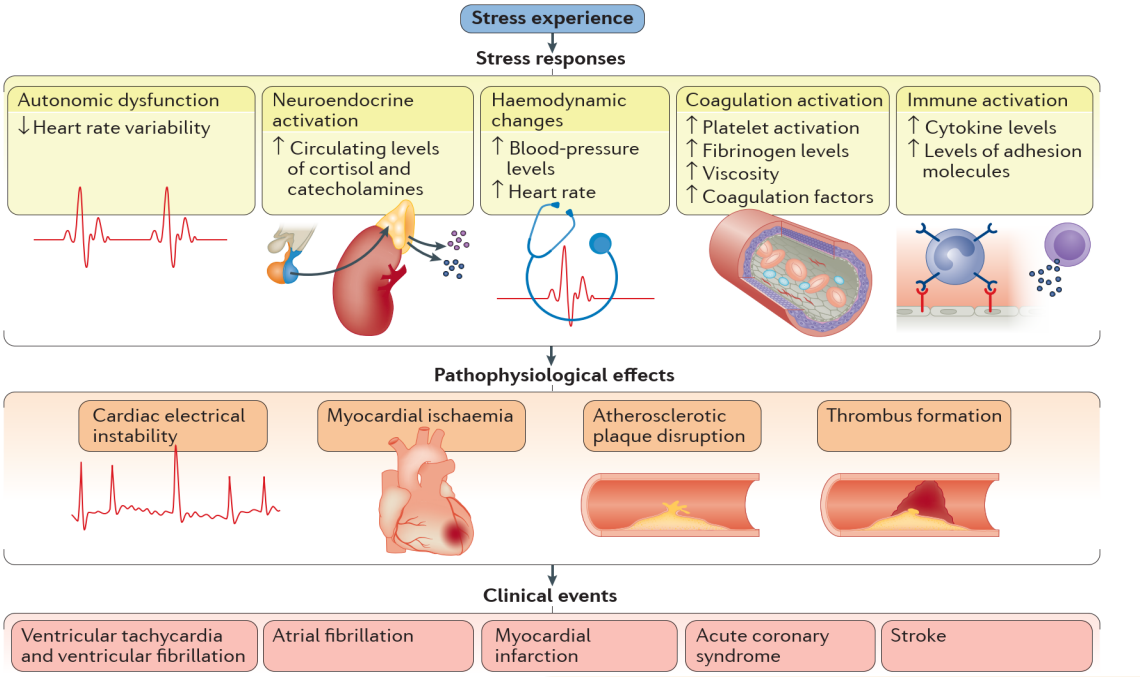
The physiological systems activated by stress help to maintain homeostasis[3] and protect and restore the body. However, research has linked excessive stress exposure with indicators of adverse glycaemic control, deterioration of immune function, and accelerated accumulation of age-associated molecular and cellular damage (where a person's biological profile is reflective of being older than expected based on their chronological age) (Kivimäki et al., 2022). Excessive stress may adversely affect the cardiovascular system by accelerating adverse cardiovascular processes, including atherosclerosis,[4] and by contributing to triggering a cardiovascular event. Whereas the progression of atherosclerosis is likely to involve repeated or prolonged exposure to stress, stress-related triggering of events among people with an already high atherosclerotic burden[5] might also be a consequence of an acute stress response (Kivimäki & Steptoe, 2018).

The mechanisms underlying the increased risk of developing CVD among individuals with stress can also be indirect, via adverse lifestyle or lifestyle changes that speed up atherosclerosis and metabolic dysregulation.[6] This means that stress can be associated with unhealthy habits, such as smoking, unhealthy diets – typically high in fat or sugar – drinking too much alcohol and not being physically active. Unhealthy habits, in turn, are related to the development of dyslipidaemia,[7] high blood pressure and type 2 diabetes. These health conditions increase the risk of CVD, such as ischaemic heart disease and stroke.[8] For example, a higher smoking frequency has been observed in smokers under stress, and meta-analyses show that individuals with extensive working hours are more likely to increase their alcohol use to levels that pose a health risk. Work-related stress is also associated with reduced leisure-time physical activity – a vicious circle (Kivimäki & Steptoe, 2018).

[1] The autonomic nervous system comprises two parts: 1) the sympathetic and 2) parasympathetic nervous systems. The sympathetic nervous system activates the fight or flight response during a threat or perceived danger, and the parasympathetic nervous system restores the body to a state of calm.
[2] A term used to represent the interaction between the hypothalamus, pituitary gland, and adrenal glands; it plays an important role in the body's response to stress.
[3] State of balance between the body's systems, required for survival and correct functioning.
[4] Atherosclerosis is a hardening of the arteries caused by gradual plaque build-up.
[5] High build-up of plaque deposits in the blood.
[6] Alterations in glucose utilisation and storage, insulin sensitivity and/or lipid metabolism.
[7] Dyslipidaemia is an abnormal amount of lipids (e.g. triglycerides, cholesterol and/or fat phospholipids) in the blood.
[8] Not enough blood flowing to the heart or brain due to a blockage or narrowing of an artery.

The conceptual model of pathways from stress to pathophysiological effects and CVD is depicted in Figure 1.

Figure 1. A conceptual model of pathways from stress to preclinical pathophysiological changes and clinical CVD



Source: Kivimäki, M., & Steptoe, A. (2018). Effects of stress on the development and progression of cardiovascular disease. *Nature Reviews Cardiology, 15*(4), 215-229.

Stress and cardiovascular disease

Stress affects our physiology causing changes in heart rate, blood circulation, and hormone levels and may trigger a cardiovascular event in people with pre-existing plaque buildup. The pathway can also be indirect through poorer lifestyle (excessive alcohol use, smoking, eating too much fat and sugar, or exercising too little) among those stressed out.

4. Current evidence linking work-related psychosocial stressors with cardiovascular events

Work-related factors that are considered to induce stress in many employees include high workload, poor work-life balance, lack of involvement in decisions affecting the worker, lack of autonomy and influence, lack of role clarity, poor communication in the workplace and lack of support from managers. Other factors include sexual harassment and bullying, and working with members of the public, including the risk of violence, and job insecurity (EU-OSHA, 2018).

4.1 Increased risk of heart disease and stroke

Job strain: The most widely examined work-related psychosocial stressor is job strain resulting from a combination of high job demands and low job control. A meta-analysis[9] suggests that job strain is associated with a 1.2 to 1.3 times higher risk of coronary heart disease by (95% confidence interval[10] range from 1.1 to 1.5) (Kivimäki et al., 2012).

[9] A meta-analysis is a statistical analysis that combines the results of multiple scientific studies. The scientific evidence is stronger if there are multiple studies with the same research question that can be combined with systematic reviews and meta-analyses than when only single studies exist.

[10] A confidence interval is the range of values we expect a 'true' estimate to fall between. A confidence interval is given within a certain level of confidence, here 95%. Confidence, in statistics, is another way to describe probability.

Effort-reward imbalance: Another widely studied stressor is the imbalance between the effort put into work and rewards received from work. According to a meta-analysis, the relative risk of coronary heart disease associated with effort-reward imbalance is 1.2-fold (range from 1.01 to 1.3) (Dragano et al., 2017).

Job stress and effort-reward imbalance combined: Employees with both stressors (job strain + effort-reward imbalance) have been found to have a 1.4 times higher risk of coronary heart disease (range from 1.1 to 1.8) (Dragano et al., 2017).

Long working hours: In individual-participant and literature-based meta-analyses, pooled estimates from multiple cohort studies suggest employees working long hours (≥55 hours/week) have 1.1 times higher risk of coronary heart disease (range from 1.02 to 1.3) and 1.3 times higher risk of stroke (range from 1.1 to 1.6) compared to those working standard hours (Kivimäki et al., 2015; Li et al., 2020).

4.2 Increased risk of mortality

The excess risk of CVD among employees with these risk factors for stress raises the question of whether they are also associated with an increased risk of cardiovascular mortality, or mortality due to any cause.

Job strain: In pooled analysis of individual-participant data from seven European cohort studies, job strain was associated with relative and absolute increases in mortality in men with cardiometabolic disease, such as diabetes, myocardial infarction or stroke (hazard ratio 1.7, range from 1.2 to 2.4), but not in men without cardiometabolic disease or in women (Kivimäki et al., 2018).

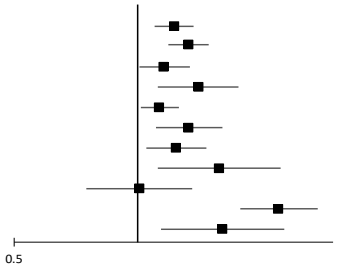
Effort-reward imbalance was not associated with all-cause mortality in that study (Kivimäki et al., 2018).

Long working hours: In a Europe-wide study, working long hours was associated with 1.7 times (range from 1.1 to 2.6) higher risk of cardiovascular death before age 65. The risk of mortality due to any cause was not elevated before or after that age.

This pattern of results is more consistent with the hypothesis that job strain and long working hours have a more important role as a disease trigger in individuals with high atherosclerotic plaque burden and as a determinant of prognosis and outcomes in those with pre-existing cardiovascular or cerebrovascular disease than as a risk factor for the development of CVD. This possibility is also supported by evidence on the associations of work stressors with factors increasing the risk of disease triggering, such as high ambulatory blood pressure, arrhythmias, increased systemic inflammation and likelihood of blood clotting (as indicated by higher platelet count and increased risk of venous thromboembolism), and high alcohol consumption (as indicated by self-reports and elevated GGT, a marker of liver disease) (Kivimäki & Steptoe, 2018). Figure 2 summarises the evidence on the associations between psychosocial risk factors and cardiovascular outcomes.

Figure 2. Association of psychosocial work-related stressors and cardiovascular outcomes in multicohort studies and meta-analyses

Cardiovascular outcome	Psychosocial risk factor	Number of participants	Number of studies	Hazard ratio (95% confidence interval)
Coronary heart disease	Job strain	197473	13	1.23 (1.10-1.37)
	Job strain	346329	27	1.33 (1.19-1.49)
	Effort-reward imbalance	90164	11	1.16 (1.01-1.34)
	Job strain and effort-reward imbalance	90164	11	1.41 (1.12-1.76)
	Long working hours	603838	25	1.13 (1.02-1.26)
Stroke	Long working hours	528908	17	1.33 (1.11-1.61)
Stroke, ischaemic event	Job strain	196380	14	1.24 (1.05-1.47)
	Job strain	138782	6	1.58 (1.12-2.23)
Stroke, haemorrhagic event	Job strain	196380	14	1.01 (0.75-1.36)
Stroke, high risk population	Psychosocial factors in general	26919	32	2.20 (1.78-2.75)
Recurrent cardiac event	Job strain	1778	3	1.61 (1.14-2.28)



Source: Kivimäki, M., & Steptoe, A. (2018). Effects of stress on the development and progression of cardiovascular disease. *Nature Reviews Cardiology, 15*(4), 215-229.

Job security, precarious employment and bullying: Research on other work-related psychosocial stressors have mainly focused on the development of CVD in employees without the disease at the start of the study. Job insecurity may arise from particular types of employment contracts or types of work (temporary employment, precarious employment), or from changes at work or organisational changes. A meta-analysis concluded that job insecurity is associated with 1.3 times higher risk of coronary heart disease (range from 1.1 to 1.6) (Virtanen et al., 2013). A large study found that consistent precarious employment was associated with 1.1 times increased risk of myocardial infarction (range from 1.1 to 1.2) and 1.2 times higher risk of stroke (range from 1.2 to 1.3) among Swedish men (Matilla-Santander et al., 2022). Evidence from other single studies suggest that other indicators of increased job insecurity, such as changes in management, lay-offs and organisational downsizing, may also be association with increased risk of CVD and cardiovascular mortality (Jensen et al., 2020; Vahtera et al., 2004).

Single studies have also studied other psychosocial stressors. A study pooling data from cohort studies from Denmark and Sweden (n=79,201) found that being **bullied at work** was associated with 1.6 times (range from 1.3 to 2.0) higher risk of CVD. Being exposed to workplace violence was associated with 1.3 times higher (range from 1.1 to 1.4) risk of CVD (Xu et al., 2019).

Favourable psychosocial work environment has been examined as a resource and protective factor against CVD. A recent study pooling data from Denmark, Finland and Sweden (n=135,669) found that a culture of **collaboration and co-worker support** in combination with good **leadership quality** and high **procedural justice** was associated with 1.3 times (range from 1.01 to 1.6) lower risk of myocardial infarction. Leadership quality and organisational procedural justice were associated with 1.3 times (range from 1.01 to 1.7) lower risk of cerebrovascular disease (Xu et al., 2022). An inverse association between high justice at work and lower risk of coronary heart disease and cardiovascular mortality has also been shown previously in other cohorts (Elovainio et al., 2006; Kivimäki et al., 2005).

Evidence linking psychological and social work environment with cardiovascular disease

Psychosocial risk factors linked to cardiovascular disease

- Job strain (low job control, high job demands)
- Imbalance of efforts given to work and rewards received
- Long working hours
- Job insecurity
- Workplace bullying

However, there is also evidence that a positive work culture where there is collaboration, co-worker support and a sense of fairness can lower the health risks.

5. Behavioural and physical work-related risk factors

In addition to psychosocial risk factors, physical risk factors at work may also pose cardiovascular risks. The findings on the effects of prolonged occupational sitting and standing have been inconsistent. Sedentary lifestyle in general has been associated with adverse health outcomes and prolonged sitting with musculoskeletal disorders, certain types of cancers, diabetes, CVD and obesity (EU-OSHA, 2021b); no clear associations have been found between prolonged occupational sitting and ischaemic heart disease or cardiovascular mortality (Smith et al., 2018). In contrast, occupations involving **prolonged standing** were associated with a two-fold increased risk of heart disease as compared to occupations involving predominantly sitting (EU-OSHA, 2021a; Smith et al., 2018). While the analysis controlled for a wide variety of sociodemographic and health-related confounders and work-related exposures, residual confounding of other occupational characteristics, including psychosocial factors, may have biased observed associations. Indeed, a meta-analysis of interventions on replacing sitting with standing yielded very small but statistically significant beneficial effects on some CVD risk factors (fasting blood glucose and body fat mass) (Saeidifard et al., 2020).

A growing body of evidence also suggests that **physically demanding work with very little rest**, while increasing the levels of physical activity, may not be beneficial for cardiovascular health. A recent study using objective accelerometer-based data on physical activity profiles observed that workers accumulating physical activity throughout the day and during recreational hours were likely to have

favourable cardiovascular risk factors, while this was not the case for workers accumulating physical activity only during daytime work hours (Biswas et al., 2022).

Shift work is hypothesised to increase the risk of CVD by contributing to several psychosocial (difficulties in controlling working hours, imbalance of work and private life, poor recovery), behavioural (weight gain, smoking), and physiological/biological (activation of the autonomic nervous system, inflammation, changed lipid and glucose metabolism mechanisms) factors, which are interrelated (Puttonen et al., 2010). Shift work seems to increase the risk of CVD, particularly in the long run (+5 years of exposure). A meta-analysis concluded that after the first five years of shift work, a 1.07-fold (95% CI from 1.05 to 1.10) higher risk of cardiovascular event was observed for each additional year of exposure to shift work (Torquati et al., 2018). Long-term night shifts were also associated with a 1.1 to 1.2-fold increased risk of atrial fibrillation and coronary heart disease (Wang et al., 2021).

Further possible work-related risk factors for CVD include occupational exposure to **high temperatures** (Pradhan et al., 2019), **noise** (Moretti Anfossi et al., 2022; Skogstad et al., 2016; Teixeira et al., 2021), polycyclic aromatic hydrocarbon (Mallah et al., 2021), and a variety of other **chemicals** (Hu et al., 2021; Humblet et al., 2008; Moon et al., 2017; Zago et al., 2020). However, as the risk factors and exposures tend to accumulate in the same occupations, the contribution of a single risk factor is difficult to determine. Exposure to loud noise can also create psychological stress.

Other work-related risk factors for cardiovascular disease

Work-related behavioural and physical risk factors for cardiovascular disease include

- Prolonged standing
- Physically demanding work with very little rest
- Shift work
- Working in high temperatures
- Working in an environment with loud noise
- Working with various chemicals

6. Gender and CVD risk at work

CVD is more prevalent among men than women before menopause. However, due to differences in clinical manifestation, heart disease may be under-recognised and under-treated among women (Backholer et al., 2017; Maas & Appelman, 2010). The traditional cardiovascular risk factors, such as smoking, alcohol use, obesity and physical inactivity, are also more prevalent among men, but as the gender differences in adverse lifestyle habits are declining, gender difference in ischaemic heart disease is also decreasing. The contribution of comorbid diseases may also vary by sex/gender. For example, diabetes is associated with worse prognosis of coronary artery disease in women than men. Depression and anxiety are risk factors for CVD, and they are more prevalent in women than in men (EUGenMed et al., 2016).

While there are gender differences in prevalence of work-related psychosocial risk factors (e.g. long working hours tend to be more prevalent in men than women (Ervasti et al., 2021)), multicohort studies and meta-analyses suggest no significant sex/gender differences in the associations between these risk factors and CVD. In pooled analyses of multiple cohort studies, no gender difference has been observed for job strain (Kivimäki et al., 2012), effort-reward imbalance (Dragano et al., 2017) and long working hours (Ervasti et al., 2021; Kivimäki et al., 2015; Li et al., 2020). Stress related to private life (Low et al., 2010) and informal caregiving of an ageing or disabled relative (Mortensen et al., 2018) are risk factors for coronary heart disease that may be particularly prevalent in women. However, although CVD in women differs from that in men in many ways, there are more similarities than differences with respect to psychosocial risk factors (Low et al., 2010).

Gender and cardiovascular disease

In summary, sex/gender affects the risk and manifestation of cardiovascular disease. However, it seems that the relative risk of psychosocial risk factors is broadly similar in men and women.

7. Age and CVD risk at work

Older age is a major risk factor for several chronic conditions, including CVD (Damen et al., 2016). Little differences in the relative risk of CVD associated with work-related psychosocial factors have been observed. For example, the associations of job strain and long working hours with CVD did not differ between employees younger than 50 years and those aged 50 or older in multicohort studies (Ervasti et al., 2021; Kivimäki et al., 2012). The relative risk of coronary heart disease for employees with effort-reward imbalance compared to those without such imbalance was 1.4 in age group <50 years compared to 1.1 in age group 50 years or older (Dragano et al., 2017). Given the higher incidence of CVD at older ages, a similar relative risk between age groups means that the absolute difference in CVD incidence between those exposed versus not exposed to work-related psychosocial factors is greater in older employees. This is likely to apply at least to exposure to job strain and long working hours.

At workplaces, ageing and increasing working years may be reflected in cumulative exposure to occupational risk factors (EU-OSHA, 2016). For example, continuous exposure to shift work has been linked with adverse cardiovascular health outcomes (Torquati et al., 2018). Moreover, the benefits to improved sleep quality were most pronounced among ageing employees transferring from shift work to daywork (Härmä et al., 2019). Improved sleep quality may, in turn, be reflected in lower blood pressure, thus contributing to lower CVD risk.

Ageing employees in physically highly demanding tasks are at particularly high risk of CVD. This includes, for example, firefighters, among whom CVD is the leading cause of death. This indicates that periodic medical and fitness evaluations should be organised. Moreover, as firefighters with established heart disease have markedly higher risk of on-duty death and disability, they should be restricted from participating in strenuous emergency duties (Soteriades et al., 2011). The example is based on research on firefighters but also holds for any occupation with highly strenuous work.

Age and cardiovascular disease

In summary, there is little evidence of an age difference when it comes to psychosocial risks – exposure to the risk factors rather than age is the main determinant. However, for highly physically demanding tasks, an increased risk with age is seen. For shift work, some of the increased risk of CVD may be from exposure over time and not only age per se.

8. Different types of work and CVD risk

Multicohort analyses stratified by occupational position suggest that the association of some work-related psychosocial factors with CVD may be modified by the type of the job. While no consistent differences in the associations of job strain and effort-reward imbalance with coronary heart disease have been observed according to socioeconomic status (Dragano et al., 2017; Kivimäki et al., 2012), a literature-based meta-analysis found that working long hours was associated with a 1.7-fold (range from 1.3 to 2.3) increased risk of incident heart disease in low socioeconomic status occupations, the corresponding relative risk being 1.2 (range from 1.0 to 1.6) in moderate socioeconomic status occupations (Kivimäki et al., 2020). There was no association between long working hours and incident heart disease in high socioeconomic status occupations (p for interaction 0.005 (Kivimäki et al., 2020)), a finding also reported in analyses of a census-based cohort study (O'Reilly & Rosato, 2013).

Specific occupational groups not determined by socioeconomic status may also have a modified risk. There is indicative evidence that jobs requiring repressing emotions and those that include anger-provoking situations, such as those in healthcare, may increase the risk of coronary heart disease (Härenstam et al., 2000), but more research is needed to confirm these findings. CVD and its risk factors are very prevalent, for example, in firefighters (Pedersen et al., 2018; Soteriades et al., 2011), motor vehicle drivers, food and drink preparatory workers, fishery, cargo, and in manual work/blue-collar occupations in general (Backholer et al., 2017; Fukai et al., 2021). However, the extent to which occupational differences in cardiovascular risk are explained by differences in lack of physical activity, unhealthy eating or unsocial working hours, warrants further investigation. Greater social adversity in general, including income insecurity, lower education, poorer neighbourhood and physical environment, is linked with cardiovascular risk factors and outcomes (Jilani et al., 2021), although it remains unclear to what extent these factors act as effect modifiers.

Different types of work and cardiovascular disease

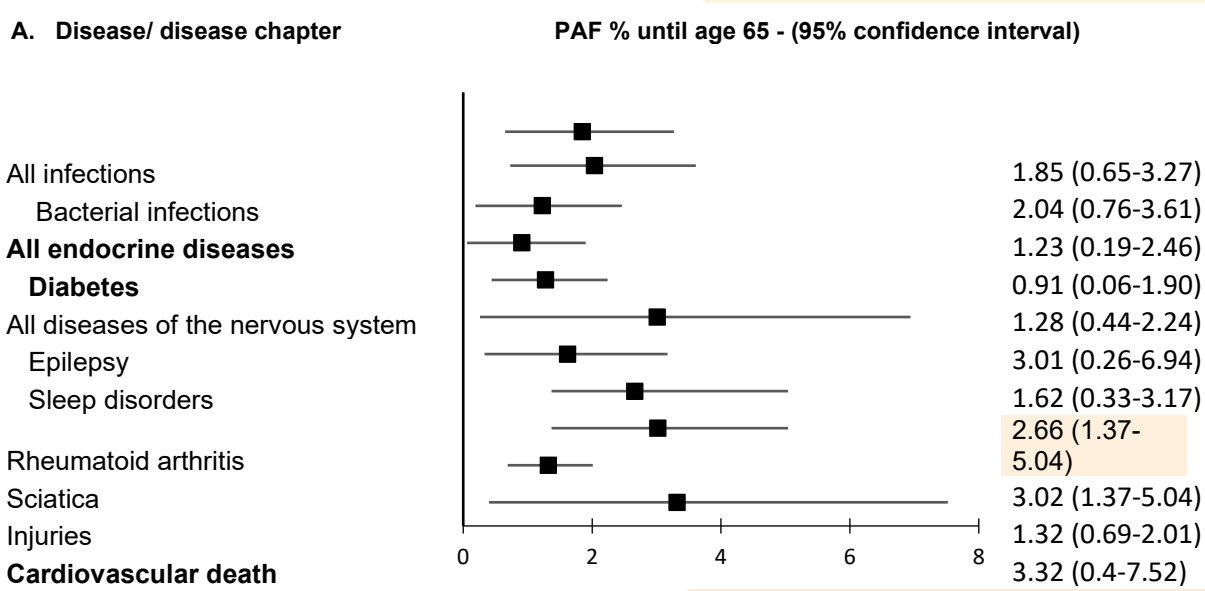
In summary, long working hours may pose a particular risk in manual jobs. Indicative evidence suggests that jobs that require repressing emotions and include anger-provoking situations may have a higher risk of cardiovascular disease, but more research is needed to draw more definite conclusions.

9. What is the absolute contribution of work-related psychosocial stressors to cardiovascular health?

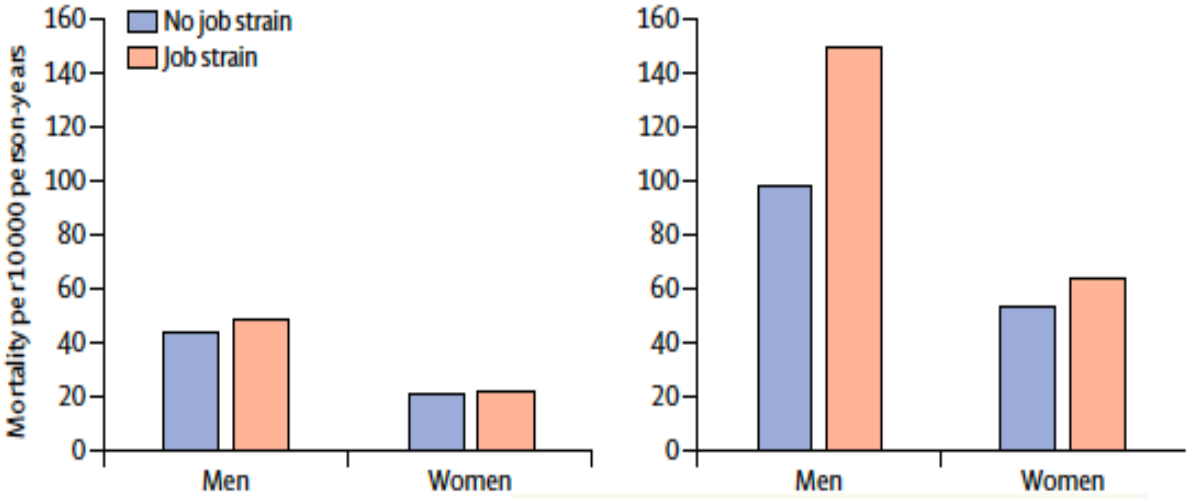
In the general population, adults with either work or private life stress have been reported to have from 1.1 to 1.6 times higher relative risk of incident coronary heart disease or stroke compared to individuals without stress. The excess risk associated with stress is less marked than the risks associated with smoking, high blood pressure, high serum cholesterol, obesity or that of childhood adverse experiences. However, work-related psychosocial stressors may have an important role as a disease trigger in individuals with high atherosclerotic plaque burden and as an element in prognosis and outcomes in those with pre-existing cardiovascular or cerebrovascular disease (Kivimäki & Steptoe, 2018).

The population attributable fraction (PAF) is defined as the fraction of all cases of a particular disease or other adverse condition in a population that is attributable to a specific exposure. According to a large European multicohort study, the PAF associated with **working long hours** is rather small: 3% for early cardiovascular deaths, epilepsy, sciatica and rheumatoid arthritis, 2% for incident infections and sleep disorders requiring hospital treatment, and around 1% for diabetes and injuries (Figure 3A) (Ervasti et al., 2021). Findings on total mortality suggest that the importance of psychosocial work-related factors may be greater in individuals with pre-existing chronic conditions, such as cardiometabolic disease. In an analysis of a large dataset from various cohorts in different countries, job strain was not associated with total mortality in men or women without cardiometabolic disease (Kivimäki et al., 2018). However, job strain was associated with a substantial excess risk of mortality in men with cardiometabolic disease at baseline, the corresponding excess mortality being smaller in women with cardiometabolic disease (Figure 3B).

Figure 3. Absolute risk of A.) early cardiovascular mortality and other disease outcomes with long working hours and B.) all-cause mortality with job strain in participants with and without pre-existing cardiometabolic disease



B. Participants without cardiometabolic disease **Participants with cardiometabolic disease**



Sources: A. – Ervasti et al. (2021). Long working hours and risk of 50 health conditions and mortality outcomes: A multicohort study in four European countries. *The Lancet Regional Health - Europe, 11*, Article 100212. doi:10.1016/j.lanepe.2021.100212; B. – Kivimäki, M., & Steptoe, A. (2018). Effects of stress on the development and progression of cardiovascular disease. *Nature Reviews Cardiology, 15*(4), 215-229.

Absolute contribution of work-related psychosocial stressors on cardiovascular disease

The excess risk of CVD associated with work-related stress is smaller than the risks associated with poor lifestyle or adverse childhood experiences. However, psychosocial stressors may have an important role as a disease trigger in individuals with pre-existing cardiovascular disease. Work-related stress can also lead to poor lifestyle habits.

10. The management of psychosocial risks and cardiovascular risks at the workplace

There is an evident need for evidence-based and cost-effective interventions for CVD prevention. Employers have a legal duty to prevent work-related risks, including those linked to cardiovascular ill health. Health promoting workplaces go beyond prevention, creating workplaces that promote physical and mental health and wellbeing, and supporting continued working and return-to-work for those with health problems. Many prevention and health promotion activities could contribute to cardiovascular ill health prevention (EU-OSHA, 2010).

10.1 Occupational risk prevention

Prevention activities relevant to cardiovascular health include preventing stress risk factors such as long working hours, job strain and imbalance of efforts and rewards, heavy physical and strenuous work, and other poor working conditions. Preventing prolonged standing and more active working as well as minimising and improving shift work are also examples of relevant prevention activities. Physical and psychosocial risks should be prevented together in a holistic approach that looks at the total load or demands on the body.

10.2 Health promotion

Many health promotion activities are relevant to cardiovascular health. Promotion of mental wellbeing should form a part of workplace health promotion. Other aspects of workplace health promotion relevant to CVD include promoting physical activity, healthy eating (including making healthy eating choices available), anti-smoking programmes, activities targeting alcohol and substance abuse, health

screening and referral, and information provision and specific counselling to reduce CVD risk factors (CDC, 2017; EU-OSHA, 2010).

There are evidence-based **interventions for workplaces to target traditional cardiovascular risk factors**. A meta-review[11] found evidence for beneficial effects of workplace preventive interventions for CVD targeting physical activity and healthy diet (Proper & van Oostrom, 2019). Interventions that used **individual contact and tailored** the intervention to the occupational setting yielded the greatest effects on CVD risk factor reduction in individuals working in blue-collar occupations (Crane et al., 2021).

10.3 Return to work

In addition to CVD prevention, it is also important to consider interventions to improve the prognosis of disease for those who have experienced a cardiovascular event. Return to work is a key goal in successful rehabilitation for this patient group at working age. A managed programme including physical exercise, consulting programmes of lifestyle changes, education and psychological intervention to help recovery after a cardiovascular event has shown an improved rate of return to work (66%) when compared to usual care (58%). Moreover, in terms of return to work, out-patient cardiac rehabilitation has been found more effective than in-patient cardiac rehabilitation (Sadeghi et al., 2022).

Psychosocial factors might have a role in successful return to work. They are known to be important for return to work for other conditions such as musculoskeletal disorders (EU-OSHA, 2021c, 2021d). A meta-review concluded that job strain represents a strong barrier to return to work in cardiac patients, whereas supervisor support and job control were found to facilitate successful return to work. Other barriers of successful return to work included high levels of physical job demands, disease perceived as an obstacle to return to work, comorbidity including depression, disease duration, older age, low education and female gender. Other facilitators included high self-efficacy and motivation towards return to work, good work ability and perceived health, high job satisfaction, being symptom-free after surgery and a white-collar occupational position (Gragnano et al., 2017).

Following medical advice, there should be a return-to-work plan agreed with the worker that includes support and adjustments to work, working time and work tasks as necessary. This should include addressing any psychosocial risk factors in the workplace. Practical advice for work and a heart condition can be found online, for example, the British Heart Foundation (BHF, 2018).

10.4 Clinical practice targeting work

Too often, work-related components of ill health are ignored by healthcare professionals. However, the European Society of Cardiology's (ESC) 'Guidelines on CVD prevention in clinical practice' acknowledges that work stress is independently associated with the development and prognosis of atherosclerotic CVD in both sexes. Owing to the importance of stress symptoms among patients with atherosclerotic CVD, the guideline recommends screening of these patients for psychological stress with questions, such as 'Are you bothered by stress at work, financial problems, difficulties in the family, loneliness, or any stressful events? Are you interested in a referral to a psychotherapist or mental health service?' The main emphasis in recommended interventions is on addressing standard cardiovascular risk factors (ESC, 2021; Visseren et al., 2021).

The approach recommended in the ESC guideline can be summarised as:

'Treat work-related psychosocial stressors as risk markers to identify at-risk groups for primary prevention and focus on the management of standard cardiovascular risk factors in this group.'

[11] A review of review articles.

11. Conclusions

As the global burden of CVDs remains large and is projected to continue to increase with population ageing, identifying modifiable risk factors is important. Raising awareness among employers about the health and cost benefits of a good psychosocial work environment and ensuring a decent work environment and level of job security by legislation may be beneficial for employee health, potentially including cardiovascular health.

The reviewed epidemiological research evidence suggests that compared to traditional risk factors, such as hypertension, high serum cholesterol, diabetes, smoking and obesity, work-related psychosocial stressors have a more modest role in cardiovascular aetiology among healthy individuals. However, work-related stressors might represent an important risk for vulnerable persons and those with pre-existing CVD. In addition, stress can result in unhealthy eating and alcohol and substance abuse.

The evidence reviewed in this article suggests that work-related psychosocial stressors like job strain, effort-reward imbalance, long working hours, job insecurity, workplace bullying and violence at work should not be ignored. These stressors are linked to reduced wellbeing among employees and for this reason alone should be targeted.

A possible strategy for workplace CVD prevention and work-related stress reduction is a multicomponent approach with both individual-level stress management and health promotion, covering cardiovascular risk prevention (promotion of healthy lifestyle), ensuring a healthy physical work environment (prevention of prolonged static postures) and workplace-level stress prevention, including tackling psychosocial risk factors (excessive workload, poor team climate and poor leadership practices). This ‘holistic’ approach is consistent with the existing epidemiological research evidence, although interventional evidence on the effectiveness and cost-effectiveness of this approach is lacking.

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