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Abstracts

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KEYNOTES

Work stress and health in the context of economic globalisation and crisis: evidence and implications for cardiovascular disease?

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A major body of evidence indicates that more proximal conditions of stressful work, as defined by the demand–control and the effort–reward imbalance models, are associated with significantly elevated risks of stress-related disorders, mainly depression and ischaemic heart disease and some of their risk factors. However, distal conditions and consequences of stressful work, as manifest in terms of economically driven work intensification and extended threats to job loss, have been studied less frequently. In part, this may be due to the difficulties of collecting and analysing appropriate data.
In this presentation, an attempt is made to summarise available knowledge on health-adverse effects of pressures and threats attributable to economic globalisation in general, and to the recent financial crisis more specifically. The review demonstrates methodological challenges of multilevel, cross-country and time-variant analyses, taking into account the different national contexts and policy responses. Nevertheless, there is considerable evidence on short and medium-term health-adverse effects of rapid economic expansion and extensive downsizing/redundancy, two main consequences of globalisation and economic crisis. Although a majority of studies focus on risks of suicide, all-cause and cancer mortality, several implications for ischaemic heart disease prevention are discussed. Importantly, this presentation will also shed some light on new findings on the psychobiological pathways linking economically driven threats to control and reward at work with cardiovascular functioning. Finally, distinct challenges for future scientific research as well as for policy recommendations in the field of work and cardiovascular diseases are identified.

The multilevel 'associationalist' demand–control theory and the job content questionnaire 2.0

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The ADC model: The job content questionnaire 2.0 (JCQ2) is based on an integrated, new version of the classic demand/control model, labeled the associationalist demand/control (ADC) model. Its multilevel hypotheses attempt to describe how systems can either organise themselves into higher levels of complexity (active work hypothesis) or dissolve into systems with lower levels of complexity (strain hypothesis) – i.e. systems that grow and develop, or systems no longer able to sustain their original complexity and capability. Thus the key issues in this new generalisation are thus: ordering capacity, coordination and association of parts. The new multilevel ADC theory attempts to maintain some the advantages of the coherent (and now familiar) narrative from the demand, control,

support model, but to extend it to address the current complexity of work in the global economy.

A basic, very general 'ordering capacity' conception is at the core of the new theory, linked in the paper to two threads of modern organisation theory: to resources acquisition and resource limitation issues found in the organisation systems theory literature, and to the coordination and communication conceptions of the communicative construction of organisation literature.

Based on recent demand/control model extensions – the stress–disequilibrium theory to extend the job strain hypothesis, and conducive production theory to extend the active work hypothesis – new 'operating principles' are developed: first via a general theory and then adapted to the contemporary work environment via three challenges: multilevel work stress, stability in the face of change, and person and organisational growth. New concepts such as platforms of stability, equilibrium of flows, creation of highlevel ordering capacity, and new stress and growth process definitions are used to create multilevel versions of the demand, control and (re-labeled) stability-support constructs. At the task, organisation, and external levels, these concepts are used to evolve the specific JCQ2 scale definitions, then tested in a set of empirical papers.

The JCQ2: The JCQ2 pilot-testing process was undertaken to upgrade the JCQ 1.0 to capture a wider range of task level as well as work organisational and external-to-work psychosocial characteristics of the current global economy. Four JCQ2 pilot studies including 16,125 workers in Korea, China, Australia and Germany are used to develop, and then test a much-expanded, multilevel JCQ2 (with 25 recommended researcher scales in the most advanced pilot, Germany). The new JCQ2 scales are created and psychometrically assessed at task, organisation the external-to-work level, on the basis of both the pilot findings and the new multilevel ADC theory.

The full set of scales more than doubles the explained variance in a broad set of health and work-behaviour-related outcome measures (in preliminary cross-sectional tests only). Substantial confirmation of the ability to continue fruitful use of the demand/control 'proved narrative' is found for extended ADC model form – using a broad-coverage set of six health and work-related outcomes – based on the expected empirical relations for 'composite' scales for demand, control and stability-support ('support' is relabeled for multilevel expansion) at the task and organisational level and, as well, for task and organisational job strain and organisational level active work constructs (however, support for task level active work hypotheses was limited).

Thus, the JCQ2 retains the useful narrative links to dimensions of demands, control and support, but successfully extends their generality, also in an international context.

Workplace intervention research: promises and realities

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In research methodology the following hierarchy of research designs is normally accepted: case studies are considered to be the least conclusive followed by cross-sectional studies, case–control studies, prospective studies and controlled intervention trials. This viewpoint is in many ways well founded, but it has nonetheless had some unfortunate consequences, for which I shall try to argue in the following.

In the randomised controlled trial (RCT) we follow at least two groups and measure the relevant factors before and after the introduction of the intervention. The units have been randomly assigned to be in one of the groups, and are (ideally) not informed about the type of intervention group they belong to. This design is considered to be the gold standard in causal research for a number of reasons: (a) good control with the time factor; (b) confounding is minimised through randomisation; (c) information bias is minimised through blinding or other similar methods; (d) selection bias is minimised through randomisation. As these four points are the most serious methodological sources of errors in observational studies it is not strange that many have seen the RCT as not only a good solution but as the only acceptable solution.

It is, however, the key message of this presentation that we should not look at the RCT as the only way to reach conclusive causal knowledge. In fact, this view can very well be harmful and prevent us from gaining useful insight and – more importantly – from acting in appropriate ways. The RCT should not be seen as the best design in occupational epidemiology but rather as a theoretical model, which we can use to sharpen our thinking.

In occupational epidemiology there are many reasons for not using the RCT:

- Most important interventions cannot be studied due to the nature of the interventions. Such interventions can either be large changes (downsizing, mergers, lean, etc.) or they can be believed to be negative (injustice, poor leadership, dismissals, etc).
- Many interventions are not possible because of the attitudes of management or unions. If the intervention is believed to be positive, no one will be in the control group, and vice versa if the intervention is believed to be negative.
- The intervention in itself is often impossible to describe, allocate and evaluate in a sufficiently valid way. Hence the value for other workplaces is limited.

- Context matters. This means that an intervention in one workplace has little generalisability for other workplaces or sectors.
- The improvement of workers' wellbeing is not a top priority for most companies. They go for higher productivity and competitiveness.
- Prevention of chronic diseases is not seen as an issue of relevance for workplaces.

Instead of trying to squeeze reality into the RCT we should realise that we can do very well without. First of all, most of our knowledge of risk factors for disease or wellbeing has been identified without the use of RCTs. Examples are tobacco, obesity, asbestos, etc. Second, there are numerous situations at the workplaces that are very close to being 'randomised trials' although no one may have this in mind. As researchers we have many chances to study so-called natural experiments. In my presentation a number of examples of this will be given and further perspectives for research on psychosocial factors and cardiovascular disease will be discussed.

Methodological issues in assessing the association between JCQ and CHD incidence: results from northern Italian cohorts

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Aims: The assessment of the association between job strain and the risk of coronary heart disease (CHD) is challenged by several methodological key aspects which may explain discrepancies in results from different studies. We aimed at assessing the role of some of these potential biases and confounding effects.
Methods: A pooled analysis of North Italian men enrolled in population-based (MONICA-Brianza, PAMELA) and factory-based (SEMM) cohort studies carried out by a single team. WHO-MONICA standards were adopted for baseline risk factors assessJob strain was investigated using the job content questionnaire (JCQ). Construct validity of decision latitude and psychological job demand was assessed through factor analysis, and job strain categories were defined based on sample medians of psychological job demand and decision latitude scores calculated on all available items, and using items satisfying construct validity criteria only. The differential coverage of follow-up was reported as lost to follow-up percentage by occupational classes and job strain categories. Reverse causation was investigated excluding events that occurred during the first three years of follow-up. The consistency of the results in population and factory-based cohorts was assessed comparing the age-adjusted cumulative risk from Cox models. As the JCQ was originally designed to measure job strain in salaried workers, we also evaluated the consistency of the results by including a job strain–occupational classes interaction in Cox models to test the homogeneity of the association across occupational classes. Finally, in estimating the relative risk of high- strain workers, we compare the results adopting as a reference group the combined category of non-high strain (active, passive and low strain) versus keeping the low-strain group as the reference.
Results: Among 4201 working men (mean age 41 ± 9 years; 21% managers and proprietors, 35% non-manual and 44% manual workers), in a median follow-up of 14.6 years, 187 first CHD events occurred (incidence rate 3.0 per 1000 perspm-years). There was no difference in the age-adjusted cumulative CHD risk between population and factory-based cohorts. In the overall sample, after adjustment for major risk factors, high-train versus non-high-strain workers had a 33% CHD excess risk, not statistically significant, when the restricted-item JCQ categories were used. With the standard definition for decision latitude and psychological job demand, the hazard ratio for high strain was 0.86 (95% confidence interval (CI) 0.59–1.26). The lost to follow-up percentage was 0.9% (fatal) and 3.4% (non-fatal) events, with no difference between occupational classes and job strain categories. No association was found between job strain and CHD among managers and proprietors. Conversely, the hazard ratio of high strain versus non-high strain was 1.81 (95% CI 1.21–2.69) among non-manual and manual workers (interaction test *P* value 0.02). Results were confirmed in the sensitivity analysis for reverse causation. In non-manual and manual workers, high strain and active categories compared to the low-strain category showed hazard ratios of 2.94 and 2.34, respectively.
Conclusions: Our findings support the association of job strain with CHD incidence among manual and non-manual workers. Factor analysis is essential to exclude from decision latitude and psychological job demand scores those items not well understood or poorly representing constraints for the specific work context. Non-high strain may not be the best reference category. A differential participation rate by occupational classes or job strain categories could not be assessed.

Psychosocial work environment and risk of stroke: findings from the IPD-Work Consortium

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Aim: To quantify the associations of two aspects of the psychosocial work environment, job strain and long working hours, with the risk of incident stroke.
Methods: We conducted large-scale meta-analyses of working men and women from prospective cohort studies to evaluate job strain and long working hours at baseline as risk factors for incident stroke during a mean follow-up of 7–9 years. Job strain, which is one of several indicators of work stress, was defined according to the demand–control model, where those exposed to high psychological job demands in combination with low control (i.e. job strain) were compared with all others. Study-specific hazard ratios with 95% confidence intervals (CI) were estimated from 14 studies participating in the IPD-Work Consortium and were pooled in a random-effects meta-analysis (total $N = 196,380$). The definition of long working hours varied from 45 hours or more to 55 hours or more per week, depending on study. Study-specific hazard ratios or odds ratios were pooled into a common estimate of relative risk from 17 studies, including cohorts from the IPD-Work Consortium and published studies identified via a systematic literature review (total $N = 528,908$).
Results: During a mean follow-up time of 9.2 years, 2023 first-time stroke events were recorded in the job strain analysis. After adjusting for age and sex, no association was found between being exposed to job strain and the risk of overall stroke (hazard ratio 1.09, 95% CI 0.94–1.26) or haemorrhagic stroke (hazard ratio 1.01, 95% CI 0.75–1.36). However, an increased risk of ischaemic stroke was observed among those with job strain (hazard ratio 1.24, 95% CI 1.05–1.47). After further adjustment for socioeconomic status the hazard ratio was 1.18 (95% CI 1.00–1.39). In the analysis of long working hours, 1722 stroke cases were identified during a mean follow-up time of 7.2 years. After adjustment for age, sex and socioeconomic status, long working hours were associated with an increased risk of incident stroke (relative risk 1.33, 95% CI 1.11–1.61). Furthermore, a dose–response association between weekly working hours and risk of stroke was observed.
Conclusion: We observed an approximately 20% increase in the risk of ischaemic stroke for individuals exposed to job strain and a 30% increase in the risk of overall stroke among those working long hours. These results support the hypothesis that psychosocial factors in the work environment are important in the development of ill-health in terms of stroke. The potential mechanisms linking these workplace factors to increased stroke risk are unclear, but might involve both direct effects on the cardiovascular system through activation of the neuroendocrine stress response and dysregulation of the hypothalamopituitary axis, and indirect effects from changes in health-related behaviours, such as physical activity, diet and alcohol consumption.

What happens after return to work among workers with CVD: the trajectory of work stress and recurrent CVD

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Aim: Much research and clinical practice has focused on return to work among employees who survived cardiovascular disease (CVD). However, little is known about what happens after they return to work, whether they experience a worse psychosocial work environment, and whether they are at risk of recurrent CVD events. Therefore, I would like to address this knowledge gap.
Methods: Reviewing published materials in the past three decades, together with our findings using longitudinal data from Europe and Asia, the available evidence was synthesised.
Results: It has been assumed that functional impairment may conceivably limit the ability of employees with CVD to cope with their workload; meanwhile they may have restricted resources to influence their work arrangements, resulting in reduced autonomy. Moreover, these employees may also feel less recognised, receive fewer promotion opportunities and even experience fear of job loss again after return to work. Our new research indicated that the trajectory of work stress was generally increased, in terms of a demand–control model and effort–reward imbalance model, among employees with incident CVD after their return to work. Regarding recurrent CVD events, current results are mixed. Our recent meta-analysis based on studies from Sweden and Canada suggested that work stress in employees with CVD increased the risk of developing recurrent CVD events by 65%, but another recent study

from Denmark did not find any significant associations. However, the timing and trajectory of work stress measurement before and after return to work might be a critical issue for future research.
Conclusion: The clinical implications with respect to the tertiary prevention of CVD goes to cardiac rehabilitation (CR). The 2015 recommendations from the CR section of the European Association of Cardiovascular Prevention and Rehabilitation of the European Society of Cardiology highlighted the importance of psychosocial risk factors including work stress as 'a component of every CR programme'. A couple of studies have provided preliminarily exciting evidence that CVD patients receiving a comprehensive CR programme did not experience higher work stress after return to work; they even perceived reduced psychosocial stress at work. Therefore, CR programmes consisting of training on work stress management might help employees with CVD to remain in employment longer and to prevent recurrent CVD.

PLENARY SESSIONS LECTURES
Job strain, work stress and cardiovascular diseases

Effort–reward imbalance at work and job strain as risk factors for incident coronary heart disease: results from the multi-cohort IPD-Work Consortium

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Aim: Research on work stress as a risk factor for coronary heart disease has largely focused on job strain (DC), which defines stressful work as a combination of high demands and low control. Less is known about other aspects of modern working life. We examined if effort–reward imbalance (ERI) at work – a complementary operationalisation of work stress – predicted coronary events independently from job strain. In addition, we studied the combined effect of the two work stressors on incident coronary events.
Methods: Participants were 90,164 employed men and women without coronary heart disease at baseline from 11 European prospective cohort studies (the IPD-Work Consortium). Stressful work was assessed by harmonised measures. We defined incident coronary heart disease as the first non-fatal myocardial infarction or coronary death. Study-specific estimates were pooled by random-effects meta-analysis after adjusting for relevant covariates.
Results: At baseline, 31.7% reported ERI at work, 15.9% had job strain and 9.8% were simultaneously exposed to ERI and DC. We recorded 1078 coronary events during a mean follow-up of 9.8 years. Rates of coronary events were higher among those with ERI compared to those without ERI, the respective hazard ratio being 1.16 (95% confidence interval (CI) 1.01–1.34) after adjustment for age, sex, lifestyle risk factors, socioeconomic position and job strain. Combining both measures of work stress showed the highest hazards among persons simultaneously exposed to both types of work stress. The age and sex-adjusted hazard ratio for this group compared to those with neither ERI nor DC was 1.41 (95% CI 1.12–1.76).
Conclusion: These findings suggest that work stress in terms of ERI is an independent risk factor for coronary heart disease. We observed an additive effect of ERI and DC on incident coronary heart disease, which underlies the importance of recognising different sources of work stress in research and workplace health promotion.

Occupational and leisure time physical activity, fitness, coronary heart disease, and 22-year mortality: results from the Kuopio Ischemic Heart Disease Risk Factor Study

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Aim: The aim of this study was to assess prospectively the independent effects of occupational physical activity (OPA) and conditioning leisure time physical activity (LTPA) on atherosclerosis, coronary heart disease (CHD) and mortality among 1861 working middle-aged Finnish men with and without CHD at baseline.
Methods: Fitness (VO_{2max}), OPA (work posture, energy expenditure, relative aerobic workload), conditioning LTPA, cardiovascular disease (CVD) status and potential confounders were assessed at baseline. Repeat ultrasound

measures of carotid artery intima media thickness and national hospitalisation and death registry data were used to determine progression of atherosclerosis, incidence of acute myocardial infarction (AMI) and all-cause and CHD mortality during up to 27 years of follow-up. Relative hazards with 95% confidence intervals were estimated in Cox regression models incrementally adjusting for 18 demographic, biological, behavioural, socioeconomic and psychosocial factors. Interaction effects were determined followed by analyses stratified by baseline CHD.

Result: A predominantly standing work posture was associated with (up to ninefold) accelerated four-year progression of carotid artery intima media thickness compared to no standing work; effects were strongest among men with CHD at baseline and effect sizes were comparable to smoking. Energy expenditure at work and relative aerobic workload were positively associated with 20-year incidence of AMI and 22-year all-cause and CHD mortality. Among men without CHD, each 10% increase of relative aerobic workload increased AMI risk by 18% (hazard ratio (HR) 1.18, 95% confidence interval (CI) 1.08–1.28, $P = 0.001$), all-cause mortality by 15% (HR 1.15, 95% CI 1.07–1.24, $P = 0.000$) and CHD mortality by 30% (HR 1.30, 95% CI 1.14–1.49, $P = 0.000$). Among men with CHD the risk increases were 8%, 11% and 19%, respectively. LTPA was not associated with progression of atherosclerosis or incidence of AMI. LTPA also had no effect on mortality among healthy men but was positively associated with all-cause and CHD mortality among men with baseline CHD: each weekly hour of conditioning LTPA increased all-cause mortality risks by 10% (HR 1.10, 95% CI 1.03–1.18, $P = 0.005$) and CHD mortality by14% (HR 1.14, 1.04–1.26, $P = 0.08$). These results were adjusted for age, body mass index, blood glucose, plasma fibrinogen, low-density lipoprotein and high-density lipoprotein-cholesterol, participation in a lipid-lowering drug trial, lipid-lowering and anti-hypertensive medication, systolic blood pressure, alcohol, smoking, personal income, social support at work, mental strain at work, stress from work deadlines and LTPA or OPA.

Conclusion: Conditioning LTPA did not reduce CVD risk and, among men with CHD, increased mortality risk. Prolonged standing at work accelerated the progression of atherosclerosis, especially in men with CHD. High levels of OPA in terms of energy expenditure, especially if measured as relative aerobic workload taking individual fitness into account, were associated with elevated risks of AMI incidence and all-cause and CHD mortality. Future research, CVD risk assessment and physical activity recommendations need to differentiate between OPA and LTPA and take interactions with individual fitness and cardiovascular health status into account.

Work environment and strokes: an update of the most recent findings

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Aim: Stroke is the second leading cause of death worldwide. A fourth of all stroke events occur among people of working age, and the consequences with regard to production loss, sick leave, disability compensation and premature death are considerable. Stroke is not only a leading cause of disability but also the leading preventable cause of disability. Studies investigating stroke as an outcome using work environment as a predictor are lacking compared with those on ischaemic heart disease. This study aimed to review accumulated evidence on work environments and stroke.

Methods: A narrative review was conducted to estimate the risk of several work environmental factors on stroke incident and mortality. Modifiable work-related risk factors – shift work, long working hours and psychosocial work environment – were focused on and findings were discussed compared with those of ischaemic heart disease outcomes.

Results: The literature indicates longer working hours and extensive strenuous activity during work, and sedentary/mental-type occupations as work-related risk factors of stroke. There is also evidence that occupational exposure to small and large particles is associated with an increased risk of ischaemic stroke. Unemployment also seems to be associated with a higher risk of stroke. Regarding socioeconomic status other than unemployed, some types of work, such as manual labour and housework, were found to be associated with the risk of stroke. Clear evidence is lacking of the associations between occupational noise and job insecurity and stroke. Unlike structural factors such as occupation, shift work, long working hours and psychosocial job characteristics are modifiable. A meta-analysis based on 34 studies totaling 2,011,935 people showed that shift work was associated with ischaemic stroke (risk ratio 1.05, 95% confidence interval 1.01–1.09). Another recent analysis reported the same risk level based on five cohort studies. With regard to long working hours, meta-analysis comprising data for 528,908 men and women showed employees who work more than 55 hours per week have a 33% increased risk of stroke compared with those who work a 35–40-hour week (1.33, 1.11–1.61). Evidence on psychosocial job characteristics has been accumulating for stroke incidence and morbidity. A meta-analysis based on six cohort studies totaling 138,782 participants showed high-strain jobs were associated with a more increased risk of stroke (1.22, 1.01–1.47) than low-strain jobs. The literature on the psychosocial work

environment and stroke reports different features from those on ischaemic heart diseases. Findings show an increased risk among women as well as men, and some studies have shown an even higher risk among women. Other than conventional risk factors, such as hypertension, metabolic factors and physical inactivity, evidence has emerged of potential risk factors through which adverse work environments lead to stroke, such as atrial fibrillation. Regional differences of stroke incidence and major pathological features, i.e. lacunar infarcts or small intracerebral artery lesions versus large artery occlusive infarctions, suggest that two hypothetical mechanisms – blood pressure elevation and metabolic disturbance – work differently through which adverse work characteristics lead to stroke.

Conclusion: Although still limited, studies on work environment and stroke are revealing additional insights on workers' cardio-cerebrovascular health.

Interventions at the workplace: what has been done and what works

Evaluation of short-term and long-term effects of work stress interventions on CVD risk factors: focusing on the individual level

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Objective: Although work stress interventions at the organisational level are supposed to produce powerful effects, most work stress interventions are at the individual level (here called stress management intervention (SMI)). So far, there is no direct evidence to reveal the effects of SMIs on cardiovascular disease (CVD) as an endpoint; however, several SMIs have been conducted targeting CVD risk factors in the past decades. Therefore, the aim of this presentation is to give an overview on the effects of SMIs on psychological and biological CVD risk factors; in particular, to pay attention to short-term and long-term evaluations of SMIs in the workplace.

Methods: A review of the published literature summarised the findings of worksite SMIs. Besides effects on mental disorders (especially depression), several established CVD risk factors and stress-related biological indicators were considered as outcomes. The review was complemented by findings from our own research on an individual-level SMI in a large production plant in Germany (MAN-GO), which was first evaluated by a randomised controlled trial (RCT, 1 year) and now completed with a long-term post-trial follow-up (9 years).

Results: The commonly used techniques in SMIs are cognitive–behavioural therapy, relaxation techniques, assertiveness training, time management, mindfulness-based intervention and recovery intervention. Frequently, a multimodal approach combined multiple types of interventions at the individual level. Whereas depression and other mental disorders were the main outcome of most SMI studies and meta-analyses showed positive effects, other CVD risk factors and indicators were used in fewer studies. Outcomes covered from systolic/diastolic blood pressure, pulse/heart rate, blood lipids, galvanic skin response, alpha-amylase, to hormones such as epinephrine, norepinephrine, cortisol, prolactin and testosterone. However, the sample size of most studies was relatively small, and the overall effects did not show a clear pattern. Dozens of SMIs concerning mental wellbeing have been conducted in the past decades. However, current knowledge is restricted to short or medium-term evaluations, usually weeks, but no more than three years. In the MAN-GO RCT, results indicated short-term effectiveness: after one year, perceived stress reactivity was significantly reduced in the intervention group compared to the control group while depression and work stress levels were improved in the intervention group, although statistical significance was not reached. Over nine years, work stress had improved in the SMI participants, while depression – after having improved immediately after the intervention – had returned to the previous level, nevertheless, in comparison to a well-matched external control group the trajectory of the depression over the nine years was much in favour of the MAN-GO participants.

Discussion: The available evidence suggests that SMIs are promising to have meaningful effects on established CVD risk factors, on top of the effect on depression and other common mental disorders. Yet, the results concerning biological outcomes are heterogeneous. Moreover, the evidence of long-term effectiveness of SMIs is still sparse, and direct evidence on CVD as an endpoint is still missing. Methodological issues concerning the evaluation of short and long-term effects on cardiovascular health should be taken seriously into account in future research.

Effectiveness of a workplace intervention targeting adverse psychosocial work factors on blood pressure and hypertension

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Aim: A number of large-scale prospective studies have documented the deleterious effects of adverse psychosocial work factors on high blood pressure (BP) and cardiovascular disease (CVD). However, little is known about the effect of workplace interventions targeting adverse psychosocial work factors on BP and hypertension. The present study assess the effectiveness of a workplace intervention targeting adverse psychosocial work factors in lowering ambulatory BP and hypertension prevalence.
Methods: This study used a quasi-experimental pre-post design with an intervention group ($N = 1093$) and a control group ($N = 1074$). Pre-intervention and post-intervention measurements were collected between 2000 and 2007 in Quebec City, Canada. The study population was composed of all white collar workers employed in three public organisations. The intervention was designed to reduce adverse psychosocial work factors by implementing organisational changes. These changes were made by the managers and monitored by the researchers. Ambulatory BP was measured at baseline and then at six and 36 months after the intervention. The evolution of ambulatory BP means and hypertension prevalence was examined.
Results: Ambulatory BP means and hypertension prevalence significantly decreased in the intervention group while no change was observed in the control group. The differential decrease in systolic BP between the intervention and the control group was 2.0 mmHg (95% confidence interval (CI) −3.0, −1.1). The prevalence ratio comparing change in hypertension prevalence in the intervention and control groups was 0.80 (95% CI 0.67–0.94).
Conclusion: At the population level, systolic BP reductions in the range of 2 mmHg, such as those observed in the present study, could prevent a significant number of premature deaths and disabling strokes. These findings suggest that adverse psychosocial work factors are relevant targets for the primary prevention of hypertension.

Organisational programmes and policies to prevent K-12 teachers' occupational stress

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Aim: Teaching primary or secondary school exposes teachers to a variety of job stressors, and recent trends in the USA appear to be increasing these stressors. Trends include reduced education budgets and layoffs, larger class sizes, attacks on seniority/tenure, integration of students with special needs into standard classes, teacher evaluation systems based on standardised testing and mandated curricula without adequate teacher preparation. Such trends may be increasing the demands faced by teachers, while simultaneously limiting their support, decision-making authority, professional judgement (skill use) and job security. Other important sources of stress among educators are physical assaults, threats, harassment, or bullying. Assaulted teachers are more likely to find work stressful and consider leaving the profession. However, there has been little research on cardiovascular risk among teachers.
Methods: We conducted a systematic review of 27 empirical studies and review papers published between 1990 and 2015 on organisational interventions in K-12 education with the potential to reduce job stressors. We also report the prevalence of organisational policies with the potential to reduce job stressors from 35,422 respondents to the 2015 national on- line American Federation of Teachers Quality of Worklife survey. We will report data, currently being analysed, on the effectiveness of workplace violence prevention programmes (mandated by Oregon legislation in 2013) in primary and secondary schools from 743 respondents to a 2016 Oregon statewide survey.
Results: Organisational interventions that may reduce job stressors faced by K-12 teachers take many forms, including support/skills building interventions, such as mentoring programmes, peer assistance and review (PAR), teacher assistance teams and teacher training on classroom management, as well as forms of job redesign. Most interventions have been designed primarily to improve or support professional practice and not explicitly to address work stressors or cardiovascular health. There is some evidence that mentoring/induction and PAR programmes can increase support, skill development, decision-making

authority and perhaps job security, for teachers. However, there is limited research evaluating these interventions for their impacts on teacher stress or teacher health. Collective bargaining has helped create mentoring, PAR and team teaching, and state legislation has been enacted on the prevention of bullying and harassment of teachers. In the national 2015 education survey, the prevalence of a 'good mentoring programmme' was 36–48% (depending on job title), a 'good system of peer evaluation' was 15–39%, and a 'workplace bullying policy or a harassment policy that includes a prohibition against bullying' in your district or school was 69–76%.

Conclusions: Some evidence exists that mentoring/induction and PAR programmes can increase support, skills development, decision-making authority and perhaps job security for teachers and thus should be more widely implemented. Further research is needed on the impact of these programmes (and related programmes and policies) on teachers' health, including cardiovascular health. Further research is needed on the impact of collective bargaining and legislative interventions on work organisation, job stressors and cardiovascular health among school staff. These are examples of 'natural experiments' which need to be evaluated.

SEMIPLENARY SESSIONS LECTURES

Methodological issues and new findings on the association between job strain–work stress and cardiovascular diseases

Work stress and CVD/CHD mortality in central and eastern Europe: the HAPIEE study

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Background: The role of work stress on cardiovascular mortality has been evaluated in the past; however, only limited literature is available on this relationship in the post-communist countries of central Europe and the former Soviet Union. The aim of this analysis is to examine the role of effort–reward imbalance and job demand–control on cardiovascular disease (CVD) and coronary heart disease (CHD) mortality using data from the longitudinal HAPIEE study set in Poland, Russia, the Czech Republic and Lithuania.

Methods: This analysis used data from the longitudinal population-based HAPIEE (Health, Alcohol and Psychosocial factors in Eastern Europe) study of men and women aged 45–69 years. Data from two waves of HAPIEE and mortality registers were analysed by logistic regression and Cox regression modelling.

Results: Higher effort–reward imbalance and a combination of high demand–low control at work at wave 1 was associated with higher CVD and CHD mortality during approximately 10 years' follow-up in age and fully adjusted models. We have observed some variation in the effects of work stress exposures between countries but these differences were not statistically significant, probably due to the relatively low number of cases.

Discussion and conclusions: These findings add new evidence to existing results, which mostly originate from western European and North American populations. Results from countries that have undergone rapid societal transition in the 1990s and 2000s further help with the generalisability of the findings related to the role of work stress in the development of CVD.

Occupational stress, cardiovascular risk factors and blood pressure among policemen

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Aim: The aim of the study was to assess the effect of occupational stress associated with a police job on circulatory function. Although an association between chronic occupational stress and arterial hypertension and/or ischaemic heart disease is well known, but only few data apply to the police job.

Methods: The group included 126 people (nine women and 117 men) aged 37.8 ± 7.3 years, with an average tenure of 14.4 ± 7.0 years. Due to the small number of women, the data were analysed regardless of gender. The test procedure comprised: general physical examination, with office blood pressure measurement (according to World Health Organization guidelines) and an interview on the risk factors of cardiovascular disease (CVD), dietary habits, physical activity, body mass index (BMI) and smoking habit. Twenty-four hour blood pressure monitoring (ABPM) was performed during normal professional

activities using DX-Medilog. The measurements were carried out automatically, every half an hour. Mean, systolic (SBP), diastolic (DBP) blood pressure and heart rate for 24 hours (OVERALL), day-time activity (D) and night-time rest (N) were calculated. The day–night ratios were determined for systolic and diastolic blood pressure (SBPD/SBPN, DBPD/DBPN). Stress at work was assessed using the subjective assessment of work characteristics questionnaire, developed and validated in the Nofer Institute of Occupational Medicine.

Results: Arterial hypertension was found in 36% people, 60% people reported chest symptoms, 32.5% people were tobacco smokers, about 60% of subjects reported intake of strong alcoholic drinks once or more times per week. Leisure time physical activity (20–30 minutes) at least once a week was practised by 54% of people. BMI was 27.6 ± 4.1; 66% of people were overweight or obese. Occupational stress was 128.0 ± 33.3 (a high value) and in 75% of the subjects was very high (141.4 ± 27.4). According to the level of stress, the group was divided into three subgroups (low 1, medium 2, high 3). The major stressor in almost 50% of the subjects was the awareness that a possible error committed during performing normal police duties might entail severe consequences. The mean values of SBP and DBP (D, N, OVERALL) were normal, but too high levels of SBP were detected in 38% people and in DBP in 24%. For the night there were 28% and 24% people, respectively. Statistically significant differences in SBP and DBP after work occurred between group 3 versus groups 1 and 2 ($P = 0.046$). The percentage of policemen with an abnormal circadian blood pressure rhythm was high (70% people), including 28% of people with an insufficient drop of SBP (<10%), 24% people with DBP. Too high a SBP drop (>20%) was found in 30% and DBP in 42% of people. The percentage of people with a normal drop (10–20%) of night heart rate was significantly lower ($P = 0.039$) in group 3 in comparison with groups 2 and 1 (16% vs. 28% vs. 28.6%). The proportion of subjects with an excessive drop in heart rate was significantly higher ($P = 0.029$) in group 3 (68%) compared with groups 2 and 1 (60% and 52%). Disturbed circadian blood pressure rhythm increases the risk of CVD.

Conclusions: Twenty-four hour blood pressure values were higher than in other professional groups studied by ourselves, just like the level of work-related stress and conventional CVD risk factors. Suitable steps should be undertaken in this occupational group to reduce the CVD risk factors and level of stress as well as to control arterial blood pressure using 24-hour ABPM.

Cardiovascular disease risk estimation in the working population: the contribution of lifestyle and job-related risk factors

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Aim: Lifestyle and job-related (LS&JR) characteristics, including physical activity at work and job strain, are recognised risk factors for cardiovascular disease (CVD) in the working population. However, their prognostic utility for CVD risk estimation remains to be established. We investigated the discrimination ability at 10 years of LS&JR risk factors in a northern Italian working male population.

Methods: The present analysis includes men who were 35–64 years old, free of CVD and employed at the time of recruitment in either the MONICA-Brianza and PAMELA (three population-based surveys) or the SEMM (one factory-based survey) studies. All participants underwent physical examination at baseline with standardised blood pressure measurement, and a blood sample was drawn for cholesterol measurement. Sport and work physical activity indices were derived from the Baecke questionnaire and dichotomised according to sample third quartile. Job strain was evaluated using the job content questionnaire and dichotomised as high versus non-high strain. Smoking (study variable: current vs. non-current smokers) and alcohol intake (abstainer, <50 g/day (reference), >50 g/day) were self-reported. The study endpoint was the first occurrence of a coronary event (including acute revascularisation) or ischaemic stroke, fatal and non-fatal, during follow-up (median time 15 years). A 10-risk estimation model was developed using lifestyle and job-related risk factors satisfying the Akaike information criterion for the selection of candidate predictors, and contrasted to a standard model including total and high-density lipoprotein-cholesterol, systolic blood pressure, smoking and diabetes. Model discrimination was estimated by the area under the receiver operating characteristic curve (AUC), in the

overall sample and among workers at 'low' cardiovascular risk (European Society of Cardiology SCORE 1%, no diabetes) and therefore not qualifying for preventive actions according to European guidelines.

Results: The study sample comprises $n = 2215$ men aged 45.3 ± 7.2 years at baseline, 14% managers, 50% non-manual, 27% manual workers and 9% proprietors; and $n = 145$ cardiovascular events during follow-up (observed 10-year risk 4.0%). In age-adjusted Cox models, smoking (hazard ratio 2.71, 95% confidence interval (CI) 1.94–3.78), elevated alcohol intake (1.41, 95% CI 0.92–2.15), job strain (1.38, 95% CI 0.95–1.99), high work (1.37, 95% CI 0.94–2.00) and sport physical activity (0.62, 95% CI 0.36–1.08), but not body mass index, satisfied the Akaike information criterion and entered into the model. In the overall sample, the discrimination ability of the LS&JR model (AUC 0.733, bootstrapped 95% CI 0.700–0.775) did not differ from the standard model (AUC 0.743). Among the $n = 1613$ workers (73% of the sample; $n = 59$ events, observed 10-year cardiovascular risk 3.1%) at 'low' risk according to guidelines, the AUC for the LS&JR model was 0.727. Of these men, 38% could have been selected for preventive action based on their estimated LS&JR risk; one out of every 17 was a cardiovascular case.

Conclusion: Our working male population characterised by a variety of job titles, lifestyle and job-related characteristics have the same discriminant ability as clinical and biological risk factors in identifying future cardiovascular events. In the occupational medicine setting, the LS&JR score may increase the feasibility and lower costs of cardiovascular screening. Furthermore, it may convey additional, clinically useful information to improve risk stratification among the overwhelming majority of workers classified at low risk by standard scores.

Psychosocial work environment and the risk of stroke

Hospitalisation due to stroke or myocardial infarction: are there any differences between self-employed individuals and employees?

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Aim: to examine hospitalisation due to stroke and acute myocardial infarction (MI), respectively, and to analyse differences between the self-employed and paid employees in the same industries.

Methods: Data from Statistics Sweden's population register (2003) were linked to hospital admission register and cause of death register (2004–2008), including 4.7 million people (7% self-employed). Individuals were classified as employees or self-employed persons, further classified as sole proprietors or limited liability company owners according to the legal form of self-employment. Eight industries were distinguished. Diagnoses of hospitalisation were classified as stroke (intracerebral haemorrhage I61, cerebral infarction I63 and unspecified acute cerebrovascular disease I64) and acute myocardial infarction (I21) based on the International Classification of Diseases (ICD-10). Stroke and MI hospitalisation incidence rate ratios (IRR) and 95% confidence intervals (CI) were estimated using negative binomial regression models adjusted for prespecified potential confounding covariates. Effect modification by occupational status, industrial sector and gender was investigated with two and three-way interaction terms.

Results: More than 90% of all individuals included were paid employees (91% of men and 96% of women). Among the self-employed, the majority was sole proprietors (66%), and the share of sole proprietors was smaller among men (64%) than women (68%). Among men, 0.7% had at least one hospital admission due to stroke and 1% due to MI. The corresponding proportions among women were 0.3% for both stroke and MI. Stroke and MI were more prevalent in the self-employed, specifically in the group of sole proprietors (stroke: 1.1% of men and 0.6% of women, MI 1.5% in men and 0.5% in women) as compared to the group of employees (stroke 0.6% of men and 0.3% of women, MI 0.9% in men and 0.3% in women). Compared to paid employees, the rate of hospital episodes (HES) due to stroke was significantly higher in sole proprietors (IRR 1.71, 95% CI 1.60–1.83) and limited liability company owners (IRR 1.67, 95% CI 1.52–1.83) in an unadjusted model. When adjusting for gender, age and country of origin the estimated associations were no longer observed. A significant difference in the incidence of stroke HES was observed by industrial sector with the highest rate in personal and cultural services (IRR 1.47, 95% CI 1.31–1.68) compared to agriculture, forestry and fishing. For MI, differences across occupational groups were statistically significant in the unadjusted models. When adjusted for potential confounding factors, limited liability company

owners had a significantly lower hospitalisation rate (IRR 0.92, 95% CI 0.85–0.99) compared to employees. Interaction between occupational group and industrial sector was observed for MI (*P* for interaction 0.0019), sole proprietors had a higher incidence of HES in trade, transport and communication (IRR 1.22, 95% CI 1.09–1.38), and lower in agriculture, forestry and fishing (IRR 0.81, 95% CI 0.68–0.97) as compared to paid employees.
Conclusions: Hospitalisation due to stroke and MI, respectively, was more prevalent among self-employed individuals than employees. Those self-employed operating as sole proprietors in trade, transport and communication had a higher hospitalisation rate for MI, and lower rate in agriculture, forestry and fishing than employees in the same industry.

Coronary heart disease and stroke in men occupationally exposed to noise and job strain

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Aim: Exposure to noise is common in many workplaces. There are studies indicating that occupational exposure to noise may increase the risk of cardiovascular diseases. The evidence is, however, rather weak, especially regarding the association with stroke. The aim was to investigate whether occupational noise increased the risk of coronary heart disease and stroke and to illuminate interactions with work-related stress in a longitudinal population-based cohort.
Methods: The study comprised 5753 men from the Primary Prevention Study, a random sample of men, born between 1915 and 1925 free from previous history of coronary heart disease or stroke at baseline (1974–1977). They were followed until death, hospital discharge or until 75 years of age regarding coronary heart disease and stroke, using Swedish national registers on cause of death and hospital discharge. Baseline data on occupation were used for classification of occupational noise levels and demand and control, strain, through previously published job exposure matrices regarding noise and strain. Cox regression was used to analyse the hazard ratios (HRs) for coronary heart disease and stroke.
Results: There was an increased risk of coronary heart disease in relation to noise levels 75–85 dB(A) and >85 dB(A) compared to <75 dB(A), HR 1.15 (95% confidence interval (CI) 1.01–1.31) and HR 1.27 (95% CI 0.99–1.63), respectively. Exposure to noise peaks also increased the risk of coronary heart disease (HR 1.19, 95% CI 1.03–1.38). Risk factor adjusted models did not change the results. Among those with high demands and low control, high strain, the risk of coronary heart disease increased further; 75–85 dB(A), 1.84 (95% CI 1.21–2.79) and >85 dB(A), 1.38 (95% CI 0.57–3.32). There was no significantly increased risk of stroke in any noise category.
Conclusions: Exposure to occupational noise increased the risk of coronary heart disease and the risk further increased among those with concomitant exposure for high strain. None of the analysed variables were related to a significantly increased risk of stroke.

Return to work of CVD patients

Return to work after cardiac interventions: key factors and health-related quality of life

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Aim: Return to work (RTW) after a cardiac event is a major goal of cardiac rehabilitation because it improves

patients' quality of life and economic security, and reduces occupational disability costs. It is well established that returning to work is not a simple function of clinical status, but is influenced by demographic, social and psychological factors. The aim of the present study was to explore: (a) which sociodemographic, medical and psychological factors are associated with return to work; and (b) the level of health-related quality of life after cardiac interventions.

Methods: The study population consisted of 454 patients with a history of recent cardiac intervention who were recruited from a rehabilitation cardiac centre in northern Italy. Participants were evaluated at the beginning of their cardiac rehabilitation and at 6 months after the discharge using validated self-report questionnaires: state–trait anxiety inventory (20 items); depression questionnaire (24 items); short form-36 (36 items). Information on sociodemographic, medical and occupational factors has also been collected.

Results: At 6 months follow-up, 383 patients (84.4%) returned to work while 71 (15.6%) did not. Results emerged from the comparison between the two groups showed that participants who had not returned to work had a lower education level ($P = 0.01$), a manual job ($P = 0.01$), an episode of heart failure during the cardiac rehabilitation ($P = 0.02$) and significantly higher levels of depression ($P = 0.003$) at baseline. At follow-up the non-RTW group perceived a worse quality of life in all domains of health, as reported in the index of physical ($P < 0.001$) and mental ($P < 0.001$) health compared to the RTW group.

Conclusion: Findings from this study show that RTW is associated with higher levels of psychological wellbeing and quality of life. In addition, these results suggest that in order to promote RTW it is important to evaluate not only clinical factors related to the disease but also deepening psychological factors, with particular reference to the management of depressive symptoms, which may adversely affect the RTW process.

Combined effect of job strain and psychological distress on the risk of recurrent myocardial infarction

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Aim: Cardiovascular diseases (CVDs) are the leading cause of death worldwide. As much as 42% of CVD deaths are attributable to coronary heart disease, most of which is due to myocardial infarction. After an initial myocardial infarction (MI), an important proportion of men and women returning to work experience psychological distress and job strain. Psychological distress and job strain can co-occur and are increasingly recognised as modifiable risk factors of coronary heart disease. Previous studies mainly used one-point measurements to evaluate psychological distress effect on recurrent MI. There is a gap in studies investigating the cumulative effect of psychological distress. Also, little is known about the combined effect of psychological distress and job strain on recurrent MI. The current study evaluates the combined effect of job strain and psychological distress on the risk of recurrent MI among workers returning to work after initial MI.

Methods: A prospective cohort study was conducted among 972 men and women who returned to work after a first acute MI. Workers were recruited in 30 hospitals in the province of Quebec. The mean follow-up duration was 5.9 years. Psychological distress and job strain were measured using validated questionnaires (Psychiatric Symptom Index and job content questionnaire, respectively) at baseline and at 2.2 years of follow-up. The outcome was a recurrent MI (fatal or non-fatal MI and unstable angina). Information on the incidence of recurrent MI from baseline to the end of follow-up (1998–2005) was collected from medical records. Adjusted hazard ratios (HRs) of recurrent MI were obtained with the Cox regression after adjustment for confounders.

Results: Workers having both high job strain and high psychological distress had a 2.7 times higher risk of recurrent MI (HR 2.68; 1.02–7.03) compared to unexposed workers. A chronic exposure to job strain or a chronic psychological distress was associated with an increased risk of recurrent MI: HR 3.05 (1.63–5.72) and HR 1.64 (1.01–2.68), respectively. No additive interaction was found.

Conclusion: Workers having chronic high job strain or chronic high psychological distress after an initial MI had an increased risk of recurrent MI. There was no indication of additional risk in patients having combined job strain and psychological distress. Secondary prevention efforts should include measures aimed at improving the psychosocial work environment and workers' mental health.

Syncope and working activity from Guidelines of European Society of Cardiology to Occupational Environment. The global risk stratification and patient management

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Syncope is a symptom that accounts for approximately 3% of the emergency department visits but its prevalence in the general population is likely to be as high as about 20-fold higher. Due to the loss of postural tone, even a benign vasovagal episode may turn into a fatal event for the individual and/or third parties when occurring in hazardous conditions such as driving trucks, working at a high workstation, on mobile stairs or close to hot materials. In addition, standing for long periods, particularly in a warm environment, exposure to frequent changes of environmental temperature or frequent changes of posture, emotion, stress and a high level job demand and fatigue may promote syncope recurrence in susceptible people. There are no compelling data concerning syncope and its relation to different work activities characterised by exaggerated hazard, including professional driving. This unknown scenario involves a large sector of the working population, particularly in developing countries where safety procedures and safety devices in work settings are still inappropriate.

The last version of the guidelines for the diagnosis and management of syncope of the European Society of Cardiology (ESC) furnished an update on this complex topic. Therefore, based on previous studies, recommendations were set only for professional driving. Regarding 'reflex syncope' the ESC guidelines suggest 'no restriction unless it occurs during high risk activity', if the syncope spell is solitary or the estimated recurrence is low. Conversely, the restriction has to be considered permanent if syncope is 'recurrent and severe, unless effective treatment has been established'. For unexplained syncope, the patients may return to professional driving only after 'diagnosis and appropriate therapy is established'. Lately, the interest on the global stratification of workers with syncope has increased among emergency department physicians and occupational physicians. In a recent paper a new quantitative model that might help doctors to stratify the risk and manage patients with syncope before returning to work has been proposed. According to that, the global risk index for a worker is computed taking into account the syncope recurrence risk, the job task duration, the environmental features facilitating syncope during work and the presence of pre-syncope symptoms, which may reduce the risk of accidents because of syncope. Additional studies are needed to facilitate an early and proper return to work after syncope and to ensure workers' safety. The aim of this contribution is to furnish an update on the topic and to stimulate discussion and collaborations among researchers.

Work and leisure time physical activity and CVD: an update of scientific evidences

Objectively measured occupational physical activities in blue collar jobs: do psychosocial resources matter?

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Aim: Occupational physical activity (OPA), and particularly static postures and physically exerting activities, is known to impact worker health and to increase the risk of cardiovascular disease, musculoskeletal problems, sickness absence and premature retirement. The exploration of structural preventive measures at the workplace against the adverse health effects of excessive OPA is needed. The psychosocial work environment is hypothesised to buffer the adverse effects of OPA, and as such psychosocial resources might directly influence the performance of OPA. However, this has not been previously investigated with detailed objective measurements. The aim of this study is to describe OPA within blue-collar workers, and to examine the role of psychosocial job resources in the performance of OPA.

Methods: Results are based on a sample of 198 blue-collar workers from the NOMAD (New method for Objective Measurements of physical Activity in Daily living) study, recruited from seven workplaces in Denmark. The sample included 112 men (56.6%) and 86 women (43.4%); the mean age was 44.9 years (SD 9.9). Data were collected with two Actigraph devices placed on the thigh and trunk, during four consecutive days. The accelerometer data were processed and analysed using the Acti4 software, to determine working time spent

standing, walking, on feet and in activity of moderate to vigorous intensity level (MVPA). The level of influence and social support at work were assessed by questionnaire, and measured with a four-item scale. Analysis of (co-)variance and (multiple) linear regression models were conducted. All analyses were stratified by gender predominance of occupations.
Results: The different types of OPA significantly varied by particular job type. Within male predominant occupations, job type accounted for 50–70% of explained variance, depending on the type of OPA. Manufacturing workers showed the highest average proportions of working time standing (33%) and on feet (79%), while garbage collectors had the highest proportion of working time in MVPA (33%). Mobile plant operators and construction workers had the lowest average working time spent walking and in MVPA. Differences in OPA between job types in female predominant occupations were less pronounced, but healthcare workers and cleaners had higher average proportions of time spent walking and in MVPA compared to assembly workers. The addition of age and psychosocial resources to the models did not contribute to a larger explained variance in OPA and the relations with job type remained significant. Social support at work showed an independent positive relation with working on feet, and with standing in female predominant jobs only. Influence at work was not related to OPA.
Conclusion: The positive relation of social support with working on feet and standing is likely to be explained by the nature of the work tasks, as jobs that require these activities probably comprise more close interactions and as such create more intensified levels of cooperation at the work floor. Overall, our hypothesis that psychosocial job resources would affect the performance of OPA within blue-collar workers was not confirmed. These findings suggest that the performance of OPA within blue-collar jobs – and particularly within male predominant occupations – is mostly affected by work organisational factors related to specific job type, and not by psychosocial job resources.

The relationship between prolonged occupational standing and sitting and incident cardiovascular disease

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Aim: To examine the relationship between prolonged occupational sitting and standing and incident cardiovascular disease.
Design: A prospective cohort study combining a population health survey with administrative health care records.
Methods: The data for this study were 7320 employed labour market participants (50% men) who were working 15 hours a week or more and free of heart disease when surveyed, in Ontario Canada. Incident cardiovascular disease was assessed using administrative records over an approximately 12-year follow-up period. Occupational standing and sitting were objectively imputed to each individual based on their occupational title. Time to event regression models examined the risk of cardiovascular disease associated with occupational standing, occupational sitting, mixtures of sitting, standing and walking and other body positions.
Results: Prolonged occupational standing was associated with an approximately twofold risk of cardiovascular disease compared to occupations involving prolonged sitting. This association was robust to adjustment for other health, sociodemographic and work variables.
Conclusions: Prolonged occupational standing represents an important work-related cardiovascular risk factor. Occupational standing warrants similar, if not greater, attention as currently afforded to prolonged occupational sitting.

Occupational physical activity and risk of ischaemic heart disease in women: the modifying effect of leisure time physical activity, hypertension and influence at work

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Aim: The aim of this study was to investigate whether high occupational physical activity (OPA) is a risk factor for ischaemic heart disease (IHD), and to test for effect modification by physical activity during leisure time physical activity (LTPA), hypertension and high influence at work.
Methods: From the Danish Nurse Cohort Study, we identified 12,093 female nurses who, at baseline in 1993,

were aged 45–64 years, were actively employed, had no prior hospital admission for IHD and had completed the questions about OPA and psychosocial work factors. Information on OPA, LTPA, known risk factors for IHD and occupational factors at baseline in 1993 had been collected by way of a self-administered questionnaire. OPA was classified as sedentary, moderate, demanding or strenuous. Strenuous OPA and demanding OPA were collapsed into the category 'high' in some of the analyses. Information on incident hospitalisation with IHD during 15-year and 20-year follow-up was obtained by individual linkage in the Danish National Patient Registry. Cox proportional hazards models and additive hazards models were used to investigate the association between exposures and the risk of IHD and to test for multiplicative and additive interaction, respectively.

Results: A total of 580 nurses were hospitalised with IHD during the 15-year follow-up period and 869 during the 20-year follow-up period. High OPA was associated with an increased risk of IHD. Compared to nurses with moderate OPA, those with demanding OPA had a 22% higher risk of IHD and nurses with strenuous OPA had a 41% higher risk of IHD. The association between OPA and IHD differed according to the level of LTPA. In the group of nurses with high OPA, a graded increased risk of IHD was observed, depending on the level of LTPA, which ranged from a 75% higher risk of IHD among those engaged in vigorous LTPA to a 2.6 times higher risk among those with sedentary LTPA. Hypertension modified the association between high OPA and IHD. Nurses with hypertension had almost a three times higher risk of IHD from high OPA, compared to normotensive nurses with moderate OPA. Normotensive nurses with high OPA did not have a significantly higher risk of IHD. In an additive hazards model, a significant additive interaction between hypertension and high OPA was found. This additive interaction explained 40 out of 60 additional cases of IHD per 10,000 person-years among hypertensive nurses with high OPA compared to normotensive nurses with moderate OPA. A modifying effect of high influence at work on the association between strenuous OPA and the risk of IHD was observed. Strenuous OPA in combination with low influence at work was associated with a higher risk of IHD, but this detrimental association was not found in combination with high influence at work. An additive hazards model investigating the association between different combinations of OPA and influence at work and IHD indicated a detrimental additive interaction between strenuous OPA and influence at work.

Conclusion: This study suggests that high OPA is a risk factor for IHD among women. It further suggests that vigorous LTPA could lower, but not completely eliminate, the increased risk of IHD among women with high OPA. The results also indicate that hypertensive women could be at particular risk of IHD from exposure to high OPA. Furthermore, the present study suggests that high influence at work may buffer and thus counteract some of the adverse effects of strenuous OPA on the risk of IHD.

ORAL AND POSTER PRESENTATIONS BY TOPIC

Psychological, social, organisational, physical and chemical risk factors of CVD at work

Job strain and cardiovascular risk: a large survey among enterprise employees from Thailand

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Aim: Morbidity and mortality of cardiovascular diseases in Thailand are notably rising during the past two decades. In many industrialised countries, a number of epidemiological studies have suggested the contribution of adverse psychosocial work environment, especially job stress, to the development of cardiovascular diseases. Although a couple of small-scale surveys have been conducted in Thailand to investigate the impact of job stress on mental and behavioural outcomes, to the best of our knowledge, no research evidence is available, so far, on the effects of job stress on cardiovascular health among the Thai working population. Therefore, the aim of this current study was to examine the associations of job stress with cardiovascular risk in a large sample of Thai enterprise employees.

Methods: We conducted an epidemiological study in 16 enterprises covering various industries and occupations, across five different regions of Thailand. In total, 2141 employees (858 men and 1283 women) without any diagnosed cardiovascular diseases participated in our questionnaire survey and medical examinations. The measurement of job stress was based on Karasek's demand–control model, and cardiovascular risk was evaluated by the second derivative of the finger photoplethysmogram (SDPTG), a non-invasive measurement of arterial stiffness.

Multivariate linear regression was applied to test associations between job strain (a combination of high demand and low control) and SDPTG-aging index (an established indicator of cardiovascular risk), adjusting for relevant covariates.

Results: In men, job strain was significantly associated with elevated SDPTG-aging index ($\beta = 0.078$, 95% confidence interval 0.026 to 0.130, $P = 0.003$), after taking age, marital status, socioeconomic status, smoking, alcohol drinking, exercise, vegetable/fruit intake, fatty/fried food consumption, body mass index and hypertension into account. However, the association in women was not significant ($\beta = 0.015$, 95% confidence interval -0.032 to 0.062, $P = 0.542$).

Conclusion: As the first study in Thailand on job stress and cardiovascular risk, we found job strain might be an important risk factor for cardiovascular diseases among Thai working men. Further studies with a prospective design and intervention trials are needed.

Situations of psychosocial environment and cardiovascular disease in Cambodian migrant workers at Buriram Province, lower north-eastern part, Thailand

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Aims: The objectives of this study aim to describe the situations of the psychosocial environment and cardiovascular disease of Cambodian migrant workers in Thailand.

Methods: A cross-sectional study was carried out during the end of 2015. Sample size and sampling methods were done statistically. The study was approved by the ethical research review committee of the Faculty of Public Health, Mahidol University before enrolling the study. A job content questionnaire was used to assess the psychosocial environment, and blood pressure of migrant workers was measured by nurses. Data on migrant workers were collected by Cambodian translators. Data were summarised by SPSS and described by simple statistic.

Results: There were 300 Cambodian workers enrolled in this study. Their main occupations were mostly working in the agricultural sector such as pig farms, rubber and sugar palm trees. By gender it was found that 146 were men and 154 were women with a male to female ratio of 1.04:1. Most of them had low education, of which 46.7% graduated in primary school and 41.3% were not learned before. More than half of them (66.3%) received an income of more than 5000 THB with an average of 6136.67 THB; 65.0% were married and 23.3% were single. The psychosocial working environment found 22.0% in high strain, active 27.3%, passive 19.33% and low strain 22.0%. The prevalence of high blood pressure found 1.7% in systolic hypertension and 3.3% in diastolic hypertension.

Conclusion: This study suggested that the psychosocial environment and cardiovascular disease of Cambodian migrants workers were not so good and needed to be improved. The knowledge gains will be useful for the governmental and private sectors that are in charge and related with these migrant workers to improve their health status, which will enable them to do their jobs better.

Prospective associations of job burnout with quality of life among nurses with cardiovascular disease: evidence from China

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Aim: The evidence of the relationship between psychosocial work factors and cardiovascular disease from the eastern world are still relatively sparse. The aim of this study was to investigate prospective associations between job burnout and quality of life among nurses with cardiovascular disease in China.

Methods: The study sample was derived from a large prospective study among Chinese nurses. All nurses with any cardiovascular disease at baseline were selected. Job burnout was measured by the work-related burnout subscale of the Copenhagen burnout inventory (CBI) at baseline, and health-related quality of life (including both physical and mental health functioning) was assessed by SF-8 (score range 0–100) at baseline and at one-year follow-up, respectively. Linear regression was used to examine the prospective associations between job burnout at baseline and health-related quality of life at follow-up, adjusting for values of quality of life at baseline.

Results: Three hundred and five nurses were included in this study. Using tertile scores of job burnout, we categorised the study participants into three groups, low, intermediate and high levels of job burnout. After adjusting for baseline values to take into account ceiling and floor effects, it was found that physical health functioning was declined 2.53 (95% confidence interval 0.36–4.69, $P < 0.05$), and mental health functioning was declined 3.02 (95% confidence interval 0.03–6.01, $P < 0.05$) in the high job burnout group compared with the low job burnout group. Dose–response relationships were also

observed. These associations were not significantly changed by additional adjustment for relevant covariates at baseline such as age, marital status, education, smoking, alcohol drinking, physical exercise, work tenure, work hours per week, position rank, departments and shift work.
Conclusion: Job burnout at baseline predicts decline of health-related quality of life one year later among Chinese nurses with cardiovascular disease.

Systematic review of studies on stress as a cardiovascular risk factor in police officers

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Aim: Several studies suggest that work-related stress in police officers is associated with an increased risk of cardiovascular diseases; however, results are inconsistent with regard to definitions and measurement of perceived stress, features of individual study design, study conduct and conclusions drawn. We performed a systematic review of studies assessing the association between stress and health effects in police officers.
Methods: Systematic searches of PubMed, Isi Web of Science, CINAHL and PsycInfo were undertaken between January and December 2016 using a string based on PICOS components. A manual search was followed. Applying the predefined criteria, two reviewers independently screened the titles, abstracts, selected full texts, and validated their quality using the Newcastle Ottawa scale. Discrepancies were resolved by discussion between reviewers.
Results: The search resulted in 748 records. Eighteen studies fulfilled the inclusion criteria and were retrieved (total population 17,698). The epidemiological design was cross-sectional (14 studies) or longitudinal (four studies). Studies were of medium (7) or low (11) quality. Small sample size, lack of controls and selection bias were the most common weaknesses. Exposure was defined as perceived stress, post-traumatic stress, distress and work-related stress. The outcome included cardiovascular disease and cardiovascular risk factors, i.e. hypertension, hyperlipidaemia, diabetes, obesity and other metabolic disorders. An association between chronic psychosocial stress and the development of cardiovascular risk factors was generally supported. In particular, cross- sectional studies supported the association of stress with hypertension, hypertriglyceridaemia and obesity. Studies on work-related stress, however, showed conflicting results. Too few prospective studies on psychosocial stress as a risk factor were available to draw a conclusion.
Conclusion: Due to the lack of longitudinal studies, and the heterogeneity of cross-sectional observations, the evidence of the association between stress and cardiovascular disease or cardiovascular risk factors in police officers is very limited.

Occupational stress and cardiovascular reaction among managers

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Aim: The aim of the study was to estimate the cardiovascular reaction to mental workload in industrial managers. The subjects of the examined group were employed as executives in a large industrial plant.
Methods: The study group included members of the board of directors, heads of departments and lower rank managers. The examined group consisted of 39 subjects: 23 men aged 46 ± 6years, period of employment as an executive 12.7 ± 8.2 years, and 16 women aged 42 ± 6 years, period of employment as an executive 11.8 ± 5.3 years. The workers had the following performed: interview including cardiological history, habits (smoking, coffee drinking) and 24-hour ECG monitoring. The ECG monitoring was classified as pathological according to the standards of the Polish Cardiac Society. Heart rate was calculated for working time, leisure time and sleep. During Holter monitoring the examined persons completed activity diaries noting duration of the period of work, house chores, rest and sleep as well as the kind and duration of the performed tasks. Detailed description of activities allowed estimating energy expenditure. The subjects were asked to estimate the perceived mental load according to method developed at the Department of Work Psychology of NIOM, involving subjective estimation of work demands and of an ability to cope with them. It includes six measures of mental workload: mental difficulty, monotony, risk, responsibility, interpersonal conflicts and time pressure. The assessment involves the comparison of the subjects' work with the descriptions of tasks or names of professions to which particular values are attributed (in points 1–9). The rating of work demands corresponds to the mean value of activities associated with workload at work. Three levels of assessment are possible both for work demands and the ability to cope with them: low level (0–3.5), medium level (3.5–5.5) and high level (5.5–9.0) points. The results were subjected to a statistical analysis.

Results: Nobody had diagnosed cardiovascular diseases. During the recording time men performed work for a longer period of time than women did (women worked for 7 hours and men 8.25 hours on average). The commuting time and sleep were similar in both groups. Generally, the subjects reported high work demands, but coping abilities were higher than work demands. Both in the men and women, a relationship was found between the intensity of subjective estimation of mental load and heart rate response. However, the reaction of the cardiovascular system to the mental workload in men was long-lasting (its effects continued until late at night); in women it was more direct (only during work) but short-term. The frequency of abnormalities in 24-hour ECG monitoring for both groups was not very high, a little higher in men (30%) than in women (25%).These data were comparable with the frequencies in selected population groups.
Conclusion: Our results may indicate that mental workload of the managerial staff, does not cause increased ECG abnormalities. Our findings suggest that men's work was objectively more stressogenic than women's work. The prolonged relatively high heart rate at night in men is a typical reaction for significant workload.

Allostatic load and psychosocial stress at work in civil servants: the Brazilian longitudinal study of adult health (ELSA-BRASIL)

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Aim: This study has the main objective of investigating the association between the exposure to psychosocial stress at work and the allostatic load of civil servants from federal universities and a research institute in Brazil.
Methods: Data were obtained from the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil), a Brazilian multicentre study, the main goal of which is to investigate the development and progression of clinical and subclinical chronic diseases, mainly cardiovascular diseases and diabetes mellitus and their biological, behavioural, environmental, occupational, psychological and social risk factors. The baseline was composed of 15,105 active and retired civil servants aged 35–74 years from five universities and one research institute located in different regions of Brazil. For this cross-sectional study data from the baseline study (collected from 2008 to 2010) were analysed. The exposure to psychosocial stress at work was evaluated using the Brazilian version of the Swedish demand–control–support questionnaire. The job strain was classified based on the quadrant approach in which the demand and control scales were split at the median, and job strain is indicated by the combination of above median demands and below median control, resulting in low strain, active, passive and high strain. The allostatic load was measured based on multiple organic parameters: heart rate variability measured by root mean square of standard deviation, body mass index, waist-to-hip ratio, waist circumference, total cholesterol, triglycerides, high-density lipoprotein, low-density lipoprotein, fasting plasma glucose, glycosylated haemoglobin, diastolic and systolic blood pressure, C-reactive protein, leukocytes and urinary albumin (microalbuminuria). Thereby, the allostatic load was calculated summing the number of variables for which the individual was over subclinical cut-off values. Individuals scored '1' for being over the cut-off (except for high-density lipoprotein and heart rate variability, for which lower values indicate higher risk) and '0' for being in a normal range. The sum score could range from 0 to 15, of which higher scores indicating higher allostatic load. A logistic regression model tested the relationship of allostatic load as dependent variable with job strain as independent variable, adjusting for age, gender, occupational level, smoking and present diseases such as diabetes mellitus, arterial hypertension and hypercholesterolaemia. To enable the logistic regression analysis, the allostatic load score was divided into two categories in which the upper tertile (>6) was considered higher risk and the lower two tertiles, reference category.
Results: The final model had shown that participants within the highest tertile of allostatic load and high occupational level had higher odds (odds ratio 1.54, 95% confidence interval 1.06–2.25; $P=0.025$) of high strain, compared with those in the two lowest tertiles. After adjustment, there was no association between job strain and allostatic load in participants classified as passive or active. All covariables remained significantly associated with allostatic load in the final model.
Conclusion: In this study the occupational level seems to be a mediating factor between job strain and allostatic load, especially concerning those with high occupational levels.

Depression and related risk factors among high-tech workers in southern Taiwan

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Aim: Depression, which might lead to the accumulation of stress and in turn lead to various physical and mental illnesses, has become an important issue among workers in

the high-tech industry. In recent years, there have been many reports on the work stress associated with depression, but few were from Taiwan. Therefore, we conducted a study to evaluate the associations between depression and burnout among high-tech workers.

Methods: We recruited workers working in a scientific park in southern Taiwan between 1 January and 31 December 2016. Information on demographic characteristics was collected through a self-administered questionnaire. Participants also completed a job content questionnaire and reported habits of smoking and drinking.

Results: A total of 865 workers participated in this study. We observed positive associations between depression and supervisor, perceived stress, economic stress, work stress and social support (all with $P < 0.05$). After adjusting for other factors, we found perceived stress (adjusted odds ratio (AOR) 3.42, 95% confidence interval (CI) 2.03–5.76), supervisor (AOR 5.30, 95% CI 1.25–22.43), passive work stress (AOR 3.21, 95% CI 1.69–6.09) and high work stress (AOR 4.83, 95% CI 2.11–11.07) were independent risk factors for depression.

Conclusion: Among the high-tech workers, depression is associated with perceived stress, management and work stress. Therefore, intervention strategies for depression should take into consideration these factors.

STARS: a European project for preventing cardiovascular diseases in the healthcare workers, through the use of an e-health tool for stress management in surgical patients

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Aims: Stress is widely considered one of the most important health problems related to work, as it can increase blood pressure and heart rate, leading to myocardial infarction in the worse cases. The issue of stress in the workplace is particularly present in the healthcare field, due to the high emotional commitment connected to the care of patients and the excessive workload in terms of the quantity and diversity of the tasks to be performed. The professionals assigned to the operating theatre would be the most vulnerable workers at risk of developing work-related stress. The aim of this paper is to present the European project STARS (GA), the main objectives of which are the development of an advanced e-health tool for the prevention and reduction of stress in surgical patients, that consequentially would decrease the occupational stress of the health professionals.

Method: The STARS Consortium (composed of 11 partners from six European countries) will conduct a study to design an e-Health platform which will help optimise patients' medical and psychic condition, beginning already in the preclinical phase, prior to entering the hospital; then, it will reduce the stress during the hospital stay and, at last, shorten the rehabilitation time post-clinically. This communication/training device will be coupled to various sensors (e.g. weight, activity, heart rate, skin conductance) and custom-made questionnaires depending on the treatment. The device is connected to a central ICT database, which ideally interacts with the patient directly, but also allows the clinical expert to monitor the proceedings and give additional feedback. Moreover, the system will integrate an inhospital navigation and it will require the active participation of the patients to self-manage their health, in order to empower them on one side and provide a considerable workload relief for the health professionals on the other.

Results: The project will provide useful results, in terms of: (a) giving appropriate and prompt information to the patients and the family in the pre-clinical phase; (b) reducing the time and human resources devoted to the preoperative evaluation of the patients at organisational level; (c) decreasing the reduction of the stress in all the actors involved in the care path (i.e. patients, professionals and family caregivers).

Conclusion: The ambition of the STARS project is to develop an innovative e-health intervention, to ensure a strong support to the patients and their families in counteracting the stress related to the surgery, and thus preventing the risk of developing cardiovascular diseases and health deterioration in general. The positive impact of the intervention will also involve the health operators in terms of workload relief.

Evaluation of ischaemic heart disease and its risk factors among the employees of the steel industry in Iran

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Aim: Cardiovascular diseases are responsible for nearly 30% of mortalities worldwide. Although physical inactivity has been known as a risk factor for these diseases, few

researchers have yet evaluated occupational physical activity at the workplace. The aim of this study was to compare the risk factors of ischaemic heart disease among the productive and administrative staff in an Iranian steel corporation during one year.

Methods: In this cross-sectional study, the studied subjects were divided into production and administrative workers. A check list consisting of demographic characteristics, medical and occupational history, and physical examination was used for data collection. Statistical analysis was performed using SPSS 20 software with the chi-square test for qualitative variables and the t-test to compare quantitative variables.

Results: Overall, 248 men were enrolled in the study. The mean age in the office and production workers was 36.84 ± 7.11 years and 38.12 ± 6.59 years, respectively. The average of work experience in office workers was 12.56 ± 6.21 years and in production workers was 11.35 ± 6.04 years. The prevalence of ischaemic heart disease and its risk factors among production and office workers was ischaemic heart disease 0.7% and 6.2%, hypertension 5.9% and 6.2%, dyslipidsemia 11.1% and 15%, diabetes 0.7% and 0.9%, smoking 12.6% and 3.5%, elevated body mass index 59.3% and 60.7%, respectively. Among these items, only heart disease showed a statistically significant difference between the two groups ($P = 0.02$).

Conclusion: This study showed that continuous sedentary jobs per se could increase the possibility of ischaemic heart disease and its risk factors in men. In contrast, physically active jobs (walking, manual labour, etc.) have a protective effect on the cardiovascular risk factors. Therefore, encouraging employees to increase their physical activity in daily life and the workplace is beneficial for preventing cardiovascular diseases.

Exploring the combined effect of job strain with levels of occupational and sport physical activity on cardiovascular disease incidence: the MONICA Brianza–PAMELA follow-up study

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Aim: The aim of the study is to investigate the interplay between job strain and occupational physical activity (OPA) and sport physical activity (SPA), respectively in determining the risk of cardiovascular events, including coronary heart disease and ischaemic stroke, in a working male population.

Methods: $N = 1409$ participants to three population-based (WHO–MONICA Brianza II and III survey and PAMELA) north Italian cohorts, who were 35–64 years old, employed and free of cardiovascular disease at baseline, were included in the present study. Job strain was investigated using the MONICA–MOPSY short version of the job content questionnaire, and dichotomised in non-high (including active, passive and low-strain categories) and high-strain classes. Habitual physical activity was assessed using the Baecke questionnaire, with eight items on OPA and four items on SPA. The study variable for OPA was based on sample tertiles, with the second tertile as the reference category. The age-adjusted hazard ratios (HRs) (with 95% confidence intervals (CIs)) for the incidence of cardiovascular events were estimated from Cox proportional hazard models, with OPA tertiles, job strain and their interaction as exposure variables. Stratified analyses were carried out by occupational classes and sport physical activity levels, dichotomised to the sample median.

Result: In a median 17 years of follow-up, 96 first cardiovascular events, fatal and non-fatal, occurred. As compared to the second OPA tertile, workers with low and high OPA had a higher age-adjusted HR of 1.60 (95% CI 0.90–2.84) and 1.96 (95% CI 1.12–3.45), respectively; and high-strain in comparison to non-high-strain workers had a HR of 1.26 (95% CI 0.74–2.13). Among manual and non-manual workers only, the above reported HRs for OPA were 2.36 and 2.84 and for high-strain SPA 1.80. In the entire sample, we did not find evidence of an interaction between OPA and job strain categories on cardiovascular risk (Wald chi-square interaction $P = 0.9$). In stratified analyses by SPA categories, the association between OPA and job strain with cardiovascular incidence was confirmed, especially in workers at low SPA, but again there was no evidence of interaction between OPA and job strain. Among manual and non-manual workers, and keeping non-sedentary and non-high strain as the reference category, high-strain workers with low OPA showed a HR of 2.48 (95% CI 1.00–6.19). In this joint analysis, the presence of either low OPA or high strain did not increase the risk.

Conclusions: A joint additive effect between sedentary work and high job strain in increasing the risk of incident cardiovascular events was observed in salaried male workers. Low levels of SPA exacerbate the detrimental effect of sedentary work and job strain on cardiovascular risk. These findings should be further explored in wider cohorts.

Work environment, lifestyle and hypertension: a study of construction workers employed in a transportation infrastructure project (TAV) in Italy

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Introduction: Construction work is highly physically demanding and it involves many hazardous activities. The workforce employed in the transportation infrastructure project in the Florence area (Italy) experienced exposure to several occupational risks and to adverse life conditions, such as living alone far from home.
Aims: To examine the relationship between lifestyle, work environment factors and the risk of hypertension among construction workers employed in a transportation infrastructure project.
Methods: Workers answered questionnaires, comprehensive on sociodemographic data, health profile and work environment factors, at the health control. Blood pressure was recorded using a mercury sphygmomanometer after 30 minute' rest. In accordance with the European Society of Cardiology, a systolic blood pressure (SBP) $\leq$140 mmHg and/or a diastolic blood pressure (DBP) $\leq$90 mmHg was considered as hypertension. Besides, workers under antihypertensive treatment were included. The study was commissioned by the ASL of Florence (Italy).
Results: Of the 257 workers (all men) examined, 54% belonged to the 46–67 years age group. The mean age was 45 years. The majority of workers (72%) lived alone in the base camp, far from their own family. Only 28% were active, while 71% were not physically active; 139 workers (54%) were found to have hypertension. The highest prevalence of hypertension by occupation was found among drivers (80%), foremen (67%) and machine operators (64%). Workers experienced exposure to physical factors: dust, climate, noise, and to ergonomics: heavy lifting, twisted and dangerous positions. Regarding psychosocial and organisational factors, workers reported: high cognitive demanding work requiring great attention and concentration, being interrupted, shift work. The results showed a relationship between hypertension and highly cognitive demanding work (odds ratio (OR) 4.82), age (OR 3.38), body mass index >25 (OR 2.88) and shift work (OR 2.78). Age-adjusted ORs showed that the risk of hypertension significantly increased for the worker group who reported higher cognitive demanding work requiring great attention and concentration (OR 3.71) and for those who were employed in shift work (OR 2.47).
Conclusions: The study found a considerable prevalence of hypertension in construction workers employed in the Florence area. The results suggest that work environment factors are important when explaining the risk of hypertension. Furthermore, the analysis of work characteristics highlights the influence of cognitive demands and working time, which are important areas of intervention in order to improve working conditions.

Benefits and risks of occupational and leisure time physical activity

Evaluation of occupational and leisure time physical activity in acute coronary syndrome patients admitted in an emergency centre in Iran

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Aim: Physical inactivity is an important risk factor for ischaemic heart disease (IHD). Considering the importance of occupational and leisure time physical activity in preventing cardiovascular disorders, this study was conducted to evaluate the relationship between physical activity and ischaemic heart disease in patients admitted to an emergency centre of the medical university in Mashhad, Iran.
Methods: A total of 148 male patients with IHD were selected randomly as a statistical sample in an academic hospital. A questionnaire including individual, medical and occupational history was used for data collection. Occupational and leisure time physical activity was evaluated by the Beck questionnaire. The studied population was divided into low activity (clerical work, driving, shopkeeping,...) and high activity (construction, agriculture,...) groups based on the work index of the Beck questionnaire. Data analysis was done by SPSS 20.
Results: Eighty-six (58.1%) of the studied population had low and 62 (41.9%) had high occupational physical activity at work. The mean of age, leisure time physical activity index and ejection fraction was lower in the low occupational physical activity group but only the leisure time

physical activity index had a statistically significant difference compared with the high occupational physical activity group (2.5 vs. 2.9, $P = 0.001$). The prevalence of hypertension, dyslipidaemia, diabetes and obesity was higher in the low occupational activity group without a statistically significant difference. ST-elevated myocardial infarction compared with unstable angina had a higher prevalence in sedentary jobs ($P = 0.002$).

Conclusion: The results of this study showed that most of the IHD patients admitted to the emergency heart centre have low occupational and leisure time physical activity. We could find a significant correlation between the amounts of occupational and leisure time physical activity and acute coronary syndrome. In other words, physical activity in the workplace can be effective in the prevention of IHDs and its risk factor prevalence.

Sedentary workers have more to gain from sport physical activity in terms of cardiovascular disease risk reduction: the MONICA–Brianza, PAMELA and SEMM cohort studies

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Aim: The aim of the study was to investigate the association of occupational and sport physical activity (SPA) with the risk of incident cardiovascular disease (CVD), including coronary heart disease (CHD) and ischaemic stroke (IS), in a working male population.

Methods: Participants of three population-based (WHO–MONICA Brianza II and III survey and PAMELA) and one factory-based (the SEMM study) north Italian cohorts, for a total of 3202 25–64-year-old men, currently employed and free of CVD at baseline, were included in the analysis. Habitual physical activity was assessed using the Baecke questionnaire, which comprises eight items for occupational physical activity (OPA) and four items for SPA. Cox proportional hazard models were used to explore the associations between different types of physical activity and the incidence of coronary heart events or ISs, adjusting for age, behavioural risk factors (i.e. cigarette smoking, alcohol intake, body mass index (BMI)) and job strain.

Results: In a median 14 years of follow-up, 152 first CVD events, fatal and non-fatal, were registered. Higher age-adjusted CVD rates were found in the first (4.04 per 1.000 person-years) and third tertiles (4.01), in comparison to the second (3.13) of OPA, corresponding to hazard ratios (HRs) of 1.25 (95% confidence interval (CI) 0.83–1.89) and 1.41 (0.92–2.17), respectively. These HRs were modestly modified when adjusting for behavioural risk factors and job strain. For SPA, a lower age-adjusted rate was detected in the last quartile in comparison to the other three combined, the age and multiple-risk factors adjusted HRs were 0.55 (95% CI 0.31–0.95) and 0.66 (95% CI 0.38–1.15), respectively. A stratified analysis revealed that the protective effect of SPA was prominent in prevalently sedentary OPA subjects (lower OPA tertile), with an age-adjusted HR of 0.30 (95% CI 0.11–0.81), in comparison with workers in the second (HR 0.69, 95% CI 0.24–1.95) and third (HR 0.96, 95% CI 0.41–2.25) OPA tertiles. The adjustment for cigarette smoking, alcohol intake, BMI and job strain mitigated these results, with the notable exception of the HR in the lower OPA tertile, which remained statistically significant 0.35 (95% CI 0.13–0.97).

Conclusions: In the investigated male cohorts, we report slightly higher CVD risks both in low and high physical demands at work. The protective effects of regular SPA was prominent and independent from other behavioural risk factors in sedentary workers. Due to the increasingly large number of sedentary workers in post-industrialised countries, interventions to promote SPA in working populations could contribute to reduce the burden of CVDs.

Objectively measured sitting time during work and leisure and the risk of cardiometabolic disease: a study protocol based on 2144 participants in the Copenhagen City Heart study

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Aim: Time spent sitting during leisure time has been associated with a number of health consequences, such as metabolic syndrome, type 2 diabetes and increased incidence and mortality of cardiovascular disease. However, the evidence for such associations is inconsistent for

occupational sitting. This may be due to methodological limitations, including self-reported measures of sitting time that are characterised by poor reliability and an increased risk of inaccurate and biased results. Objective measures are hence preferred and these can in addition allow investigation of the temporal patterns of sitting and its influence on the risk of cardiometabolic disease. In addition, further knowledge about factors determining excessive sitting is needed. The objectives of this project are twofold: (a) to investigate the relationship between sitting time and the pattern of sitting during occupational hours and leisure time and risk factors for cardiometabolic disease, and (b) to identify determinants for excessive occupational and leisure sitting time in adults.

Methods: Physical activity behaviours were measured using tri-axial accelerometers worn on the frontal thigh and iliac crest during seven consecutive days on participants in the fifth wave of the Copenhagen City Heart Study (CCHS). A dedicated MATLAB-based software (Acti4) will be used to derive estimates of sitting time from the accelerometer data. These data will be combined with other self-reported and objectively measured data from the fourth and fifth wave of the CCHS, including sociodemographic, work and lifestyle-related factors, previous and present disease, mental health, medication use, anthropometrics, blood pressure, carotid intima-media thickness, electro and echocardiography and blood samples. Cross-sectional associations between sitting time, patterns of sitting and risk factors for cardiometabolic disease will be investigated using data from the fifth wave of the CCHS. Furthermore, longitudinal associations between sociodemographic and other factors and sitting time will be analysed using data from the fourth and fifth wave of the CCHS.

Results: There were 6237 participants in the fourth wave of the CCHS. In the fifth wave, 2144 participants agreed to wear accelerometers and thereby to contribute with data about physical activity behaviours. Cleaning and quality check of physical activity data are ongoing and study protocols will be developed during spring 2017; the statistical analyses are expected to be initiated during autumn 2017 and the first results published during 2018.

Conclusion: This project will provide valid information on patterns of sitting time and physical activity over one week from a large general population, and extend our knowledge of the association between occupational and leisure time sitting and cardiometabolic risk factors, and of predictors for extensive daily sitting time. This information can significantly add to the existing body of evidence that will inform future guidelines on sitting time. Furthermore, the results of the project can assist to identify populations susceptible to high levels of sitting time and potentially inform preventive interventions targeted at these populations.

A longitudinal study of physical demands, musculoskeletal complaints and employees' psychosocial job resources

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Aim: Previous academic research has elaborated the impact of physical demands on cardiovascular and musculoskeletal health for employees in physically demanding jobs. Studies investigating musculoskeletal complaints are mainly cross-sectional, which is a limitation to draw conclusions on causality. This study was designed to examine longitudinally the relation between physically demanding activities at work and musculoskeletal complaints. The first aim was to investigate the relation between baseline physical demands and musculoskeletal complaints, 12 months later. A second aim was to verify whether psychosocial job resources (job autonomy and social support) are moderators in the relation and as such reduce the effect of physical demands.

Methods: Results were based on a longitudinal study including employees from a company in the technology industry in Belgium. All employees were invited to fill out a self-administered questionnaire, provided in two languages (Dutch and French). To provide longitudinal data, respondents were encouraged to participate over time. A total of 1190 individuals participated at the baseline measurement and for 457 persons full information (baseline and follow-up) was available. The exposure measurements used in the study (physical demands and psychosocial job resources) were obtained from 'the work design questionnaire'. A four-item scale concerning musculoskeletal complaints in the previous six months was applied. Multiple linear regression analyses were conducted.

Results: Participants were between 22 and 67 years old (mean age was 48.8 years; SD 10.3). Men were highly represented (92.6% men) and more than half of the sample had a lower educational background (54.9%). After adjusting for gender, age, language, educational level and baseline musculoskeletal complaints, regression analyses indicated that greater physical demands were associated with greater musculoskeletal complaints, 12 months later. Contrary to expectations, however, neither job autonomy nor social support at work showed a moderating effect on the relation between physical demands and musculoskeletal complaints.

Conclusion: The conclusion of the research was the confirmation of a clear positive relation between physical demands at work and musculoskeletal complaints over time. The main strength of the study was its longitudinal

design. A possible limitation was the underrepresentation of women in the study. However, no different results in men and women were found. Further research is necessary to unravel the role of generic and specific psychosocial job resources in relation to physical demands and complaints. Finally, the need for objective measurements of physical demands is high as it allows a differentiation between different kinds of physical work tasks to be made and to provide insights into the physiological mechanisms.

Effects of aquatic physical training on cardiac autonomic control and pain in women with fibromyalgia

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Aim: Pain is a predictor factor of work disability and is associated with sympathetic overactivity to the heart and vessels in patients with fibromyalgia syndrome (FMS). Aquatic physical training (APT) is known to reduce pain; however, little is known about its effects on cardiac autonomic control. To assess the effects of a 16-week APT on pain and cardiac autonomic modulation in patients with FMS.
Methods: Eighteen women with FMS were randomly allocated to a 16-week APT, comprised of two 45-minute sessions per week (trained group, TG, $n = 8$, age 51 ± 7 years) or to 16 weeks of follow-up (control group, CG, $n = 10$, age 47 ± 9 years). APT sessions consisted of warm-up, aerobic exercises, resistance exercises and cool-down. In every participant, we assessed, at baseline and after treatment or follow-up, the pressure pain threshold (PPT) at 18 specific tender points, using a digital algometer. In addition, all participants underwent RR interval recording for 15 minutes in the supine position. Spectral analysis was carried out by applying an autoregressive model in a previously selected RR section. The spectral components were obtained in low frequency (LF, 0.04–0.15 Hz) and high frequency (HF, 0.15–0.4 Hz) bands in absolute units (ms^2). Then, the LF/HF ratio was calculated to evaluate sympathovagal balance.
Results: A significant increase in PPT was observed after the APT in the TG ($P = 0.04$) and remained unchanged after 16 weeks of follow-up in the CG ($P = 0.45$). Results regarding the indices of the cardiac autonomic control are presented in Table 1 The LF/HF ratio significantly decreased in the TG after APT ($P = 0.03$), while it remained unchanged in the CG after 16 weeks of follow-up ($P = 0.93$). No significant differences were observed for the mean RR intervals (μ_{RR}), RR variance (σ^2_{RR}) and systolic arterial pressure (μ_{SAP}) presented no significant differences ($P > 0.05$).
Conclusion: As expected, FMS patients presented low PPT (values lower than 4.0 kg/cm^2) and cardiac sympathetic overactivity at rest (LF/HF ratio values higher than 1.0). Furthermore, a 16-week APT was effective in enhancing PPT and improving cardiac autonomic control in women with FMS. Thus, considering that pain is a major factor for work disability, and is related to sympathetic overactivity, this treatment approach may be useful in improving work status and reducing absenteeism in this population.

Table 1. Pressure pain threshold and indices of cardiac autonomic control from both groups (trained group and control group) at baseline and Post16.

	Trained group		Control group	
	Baseline	Post16	Baseline	Post16
PPT (kg/cm^2)	1.96 ± 0.47	2.63 ± 0.86*	1.91 ± 0.47	1.80 ± 0.31
HR (bpm)	68 ± 6	67 ± 6	67 ± 8	70 ± 8
μ_{SAP} (mmHg)	109 ± 47	107 ± 11	122 ± 25	123 ± 14
μ_{RR} (ms)	872 ± 98	893 ± 98	891 ± 74	855 ± 69
σ^2_{RR} (ms^2)	936 ± 572	1516 ± 738	1159 ± 487	1399 ± 1163
LF/HF	2.54 ± 2.30	0.53 ± 0.41*	1.79 ± 1.02	1.85 ± 1.69

Data are expressed as mean ± SD.; PPT: pressure pain threshold; HR: heart rate; Post16: treatment or follow-up; μRR: mean of RR; μSAP: mean of systolic arterial pressure; LF/HF: ratio between low and high frequency components.; *$P < 0.05$ vs. trained group baseline.

Health promotion in the workplace: a fitness programme addressed to wellness promotion and disease prevention in employees of a geriatric hospital – INRCA

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Introduction: It is estimated that heart disease, including stroke and high blood pressure, is responsible for more costs than any other disease. Epidemiological data have shown a relationship between occupational stress and

cardiovascular disease (CVD). On the other hand, the benefits of habitual levels of exercise on CVD outcome have been well established. Few studies have addressed whether the mitigation of work stressors, through fitness programmes in the workplace, would reduce the risk of CVD. The present study aimed to: (a) evaluate the effectiveness of a fitness programme on occupational stress; (b) promote physical activity in care workers, through a project of fitness in the workplace.

Methods: From 2014 the geriatric hospital of the National Institute of Health and Science on Aging (INRCA) of Ancona has implemented a fitness plan for their workers. The workers could carry out physical activity in a physical therapy gym with a cardio fitness machine. The cardio machines are connected through the Net-tutor software, so the physical therapist could develop a personalised exercise programme, including the evaluation of hearth rate during the training. The individual training lasted about 90 minutes: 30 minutes dedicated to cycle exercise, then 30 minutes for the treadmill workout. The last 30 minutes were dedicated to training of the upper limbs with Ercolina and the abdominals on the mat. At the beginning of the programme (T0) the physical therapist evaluates weight, height, blood pressure, heart rate, back flexibility, visual analytic scale (VAS) and the Borg rate of perceived exertion (RPE). The measurements were repeated after 3 months (T1).

Results: During the years 2014–2016, 45 workers participated in the project, 90% were women and 10% were men. The average age was 47 years (range 33–62). The mean weight was 66.2 kg. Among the surveyed workers, 45% were not physically active, 50% did physical activity occasionally, only 5% carried out regular physical activity. The mean blood pressure decreased from T0 (120/77 mmHg) to T1 (112/72 mmHg). Heart rate decreased from 83 bpm (T0) to 77 bpm (T1). Workers reported a modest decrease of pain on the VAS scale. After the fitness programme all workers reported a reduction of perceived exertion on the RPE.

Conclusions: The fitness project was highly appreciated by the workers, who have reported feeling better, less stressed at work and with a higher level of energy. Physical activity helped them to manage better the demands of work with everyday life. The decrease in heart rate and blood pressure after fitness confirms the role of physical activity for the prevention of CVD. The study results suggest the importance of health promotion and disease prevention initiatives in the workplace.

Contrasting effect of objectively measured physical activity during work and leisure on heart rate variability during sleep

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Aim: Leisure-time physical activity (LTPA) has a beneficial effect on cardiovascular health and longevity, while occupational physical activity (OPA) is associated with an increased risk of cardiovascular diseases and mortality. The physiological mechanism of this apparently contrasting relationship between LTPA and OPA on cardiovascular health remains unknown. A possible explanation is that OPA and LTPA exert different effects on the autonomic nervous system. Thus, we aimed to investigate whether objectively measured OPA and LTPA are differentially associated with cardiac autonomic regulation in an occupational sample.

Methods: Cross-sectional data from the Danish cohort DPHACTO were analysed. The study comprised 514 blue-collar workers who took part in ambulatory monitoring of physical activity and heart rate variability (HRV). Physical activity (i.e. time spent in walking, climbing stairs, running and cycling) was assessed objectively using accelerometers (Actigraph) worn on the thigh, hip and trunk over 4–5 working days. Simultaneously, a heart rate monitor (Actiheart) was used to collect inter-beat intervals from the ECG signal. Heart rate and HRV indices were analysed during nocturnal sleep as markers of cardiac autonomic activity. Multiple regression analysis was used to determine the main effects of OPA and LTPA and their interaction on heart rate and HRV indices, adjusting for multiple confounders (age, gender, body mass index, smoking and cardiovascular ailments).

Results: Time spent in physical activity was on average (SD) 1.4 (0.6) hours/day for OPA and 0.9 (0.4) hours/day for LTPA. OPA showed generally negative associations with nocturnal HRV indices, while positive estimates were observed for LTPA. There was a statistically significant interaction effect between OPA and LTPA on heart rate ($P < 0.0001$) and HRV indices in time (root mean square of standard deviation, $P = 0.004$: standard deviation of normal to normal sinus beat, $P = 0.019$) and frequency domains (high frequency power, $P = 0.022$; low frequency power, $P = 0.033$). The favourable effect of LTPA on nocturnal HRV clearly diminished with higher levels of OPA, and high levels of both OPA and LTPA had a detrimental effect. The observed associations persisted after adjustment for possible confounders.

Conclusion: Our findings suggest that time spent in OPA and LTPA have interactive effects on nocturnal autonomic regulation. Future longitudinal studies should examine whether autonomic regulation is a mediator for the effect of OPA and LTPA on cardiovascular disease and mortality.

An update of the epidemiological evidence linking CVD and work exposures

Priority, methodological and conceptual issues regarding epidemiological research of occupational psychosocial risk factors for coronary heart disease

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Aim: In psychosocial occupational epidemiology, past research has focused on the demand–control (job strain) and the effort–reward–imbalance (ERI) models in order to detect risk factors for coronary heart disease. These models and the focus on them raise priority issues, conceptual and methodological issues we take up in the following. The priority issue pertains to whether there is empirical evidence for the focus on the two models. With regard to the conceptual issues, one has to deal with the question of whether the empirical confirmation of the assumptions of these models holds and whether the sub-dimensions of the models' scales have equally strong health effects. Last but not least, relating to methodological issues, we discuss how exposure to job strain is categorised, how effort–reward imbalance (ERI) has previously been measured, and the validity of self-reports of job strain.
Methods: To tackle the open questions, a thorough review of the literature was conducted in order to integrate available information.
Results: With regard to priority, we find that there is indeed a strong research focus on the demand control model and its components, but not on the ERI model. Empirical justification of this focus on the job strain model is ambiguous when solely considering sufficiently powered studies. Considering conceptual aspects, one has to state that there is a lack of empirical approval of: (a) the assumptions behind both models; and (b) the construction of the scales used in the models. Furthermore, in relation to methodological aspects, we argue that: (a) a population independent definition of job strain is lacking; (b) the older measurements of ERI mix exposure and effect; and (c) we know little regarding the validity of the measurement of job strain.
Conclusion: So far, there has been a lack of awareness in the research community regarding the priority, conceptual and methodological issues presented in this paper. Such an awareness is needed to improve the quality and relevance of this important research field. Among other things, in order to shed light on the priority issue discussed above, there is a need for longitudinal data on a wider range of psychosocial work environment factors. We suggest the use of monitoring data, which often have a broader focus on the psychosocial working environment than the cohorts established by researchers. More suggestions to tackle the conceptual and methodological issues will be presented.

Differences in heart rate reserve during occupational and leisure time physical activity in Danish blue-collar workers

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Aim: Physical activity (PA) is considered to be an important factor in the prevention of various cardiovascular diseases. However, recent studies suggest that while leisure time PA promotes cardiovascular health, occupational PA might impair cardiovascular health. An explanation for this PA health paradox may be a difference in the intensity and associated physical demands between occupational and leisure time PA. Occupational PA often consists of low-intensity, long-lasting physically demanding tasks, such as repetitive work and prolonged static working postures, which are presumed to cause sustained elevated heart rate that may stress the cardiovascular system. Despite this notion, the differences in physiological responses between occupational and leisure time PA are not well understood. Therefore, we aimed: (a) to study the difference in intensity of occupational and leisure time PA (expressed in percentage heart rate reserve; %HRR); and

Figure 1. Average percent of Heart Rate Reserve during occupational and leisure time physical activity

(b) to assess whether this potential difference varies by gender and cardiorespiratory fitness level.

Methods: We used data from the NOMAD study, in which Danish blue-collar workers from seven different workplaces took part in a four-day protocol of objective measurements of PA (using hip and thigh-worn accelerometers) and heart rate (using an ambulatory heart rate monitor). During occupational and leisure time, activities of sitting, standing, moving, walking and stair climbing were identified, and %HRR in each of these activities was determined. Differences in %HRR between occupational and leisure time PA were tested using generalised estimating equations (expressed in regression coefficient – beta with 95% confidence interval (CI)) adjusted for personal, health, work and lifestyle confounders.

Result: In 124 workers with data on PA and heart rate, %HRR was higher for occupational PA compared to leisure time PA (beta −1.9, 95% CI −2.4, −1.4, $P < 0.001$). Differences in %HRR between occupational and leisure time PA were more pronounced in men than in women, and in those with high cardiorespiratory fitness compared to those with low cardiorespiratory fitness.

Conclusion: This study is the first to assess differences in %HRR between occupational and leisure time PA, using objective measurements in blue-collar workers. Cardiovascular intensity was higher in occupational activities (possibly due to additional physical and/or mental workloads) compared to the same activities during leisure time. The increase in cardiovascular intensity at work may be a contributing factor to the health paradox of occupational and leisure time PA, suggesting negative cardiovascular health consequences for engagement in occupational PA (see Figure 1).

Does occupational lifting increase the risk of hypertension? A study protocol

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Background: Hypertension is a major risk factor for cardiovascular disease and contributes to 14% of all annual deaths globally. The prevalence of hypertension is thought to be affected by factors within the working environment, such as heavy occupational lifting. However, there is only limited scientific evidence of a relation between heavy occupational lifting and hypertension. Lifting acutely increases the blood pressure, but whether workers free of hypertension are at increased risk of developing hypertension when exposed to heavy occupational lifting, or exposure to repeated occupational lifting poses a risk in workers with hypertension is largely unknown. Furthermore, does increased blood pressure, caused by heavy occupational lifting, lead to cardiac damage, such as hypertrophy and diastolic dysfunction, increasing the risk of cardiovascular disease. Thus, an investigation of the association between heavy occupational lifting and the risk of hypertension and cardiac damage holds potential for developing prevention of cardiovascular disease.

Aim: The objective is to estimate the cross-sectional and long-term associations of heavy occupational lifting with blood pressure and cardiac damage.

Methods: Data from the third, fourth and fifth round in the Copenhagen City Heart Study, and data from the first and second round in the Copenhagen General Population Study will be included in the association between heavy occupational lifting and the risk of hypertension. Self-reported information on occupational lifting was obtained by use of the question: 'Please describe your level of occupational physical activity within the past yea' with the following response categories: (1) predominantly sedentary; (2) sitting or standing, some walking; (3) walking, some handling of material; (4) heavy manual work. If answering 3 or 4 an additional question was applied: 'Do you lift heavy burdens?' with the response categories: (1) yes; (2) no. By answering 'yes' to the question concerning heavy burdens, the participants will be classified as exposed to heavy occupational lifting. Classification as being hypertensive will be determined by reporting to use antihypertensive drugs or a measured consultation blood pressure of systolic $\leq$140 mmHg or diastolic

≤90 mmHg. The possibility to shift from normotensive to hypertensive, as a function of heavy occupational lifting, will be modeled in a logistic regression, adjusted for relevant confounders. The odds ratio between exposed and non-exposed participants will be calculated and presented with a 95% confidence interval. Data from the fourth and fifth round of the Copenhagen City Heart Study will be included for the cross-sectional and long- term associations between heavy occupational lifting and cardiac damage in a nested case–cohort design. Early subclinical structural changes of the heart will be recognised by advanced echocardiographic analyses.
Conclusion: This study aims to increase our very limited knowledge of cardiovascular risk from heavy occupational lifting, and in doing so, contributing to the prevention of cardiovascular disease among workers with heavy occupational lifting.

Heart rate variability and other biomarkers of early effects of work exposures on the cardiovascular system

Exposure to nanoparticles and diesel pollutions and cardiac arrhythmias: new insights

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Background: Nanoparticles in polluted environments are of current concern because of their strong link with cardiovascular diseases (CVDs). Although epidemiological studies consistently suggest the link of ambient particulate with CVDs, they cannot directly prove a direct causation and cannot correlate the time of exposure with the abnormal heart function. The intriguing perspective emerges that pollution-derived nanoparticles might be involved in CVDs much more directly than previously thought. Moreover, the presence of a devious disease such as hypertension may increase the vulnerability to arrhythmias.
Methods: We focused our attention in normal and spontaneous hypertensive rats (SHRs), exposed to two different categories of nanoparticles: (a) from nanomaterial, i.e. titanium dioxide (TiO_2); and (b) from air pollution, i.e. diesel exhaust particles from Euro3 and Euro4 derived engines. We explored the interaction between nanoparticles and in-vivo cardiac tissue and we determined the effect on cardiac electromechanical performance by evaluating genetic, morphological, functional and toxicological alterations.
Results: We clearly observed a direct contamination of cardiac tissue by tracheally instilled nanoparticles, correlated with myocardial structural remodeling, reactive oxygen species production, epigenetic modulation and DNA damage. We detected modulation of: (a) cardiac excitability; (b) refractoriness; (c) ECG and QRS complex and increment of arrhythmic events in both acute and chronic administration. Such conditions are further aggravated in normal animals acutely exposed to Euro4 diesel exhaust particles and in SHR animals chronically exposed to TiO_2 nanoparticles.
Conclusions: Our proposed approaches reinforce our concept of direct involvement of nanoparticles linked to CVDs, by establishing a novel arrhythmogenic mechanism, and pointing towards the need for preventive action on people exposed to nanomaterials.

Work-related stress based on Karasek's taxonomy and QT prolongation in male workers

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Aim: Several studies have investigated the relationship between work-related stress and cardiovascular diseases. The mechanisms involved seem to implicate an imbalance of the autonomic nervous system characterised by a relative reduction in cardiac vagal control and hyperactivity of the sympathetic system. Autonomic imbalance may be a final common pathway to increase morbidity and mortality from a host of conditions, including cardiovascular diseases. The effects of these phenomena on the cardiovascular system can be assessed by several indexes of early dysfunction, such as QT interval prolongation on the electrocardiogram and some QT-related indicators, which can be obtained from annual health check-ups, like QT corrected by heart

rate (QTc) and QT index (QTi). The aim of our study was to test the association between work-related stress and QT-related indicators of autonomic function, along with blood pressure, body mass index (BMI) and work shifts.
Methods: Overall, 484 male workers of a logistic support company for safe communications and intelligence were included in our study population. During annual health check-ups from January 2016 to October 2016 we measured work-related stress using the Health and Safety Executive (HSE) indicator tool and general wellbeing using the well-being index (WHO5). The frequency corrected QT (QTc) interval on the electrocardiogram was measured according to Bazett's formula and QT index (QTi) was calculated by the Rautaharju formula, as the ratio between measured QT and predicted QT. Blood pressure, BMI, medications, work shifts, lifestyles and comorbidities were also recorded. A total of 123 subjects were excluded as a result of the following exclusion criteria: presence of cardiovascular and metabolic diseases, endocrine diseases, drug therapy that potentially caused prolonged QT interval, lack of data on alcohol consumption and smoking habit. Based on Karasek's taxonomy, we compared high-strain jobs, low-strain jobs, active jobs and passive jobs with respect to QTc, QTi, blood pressure, BMI, work shifts, smoking habit, age and WHO5. Group differences were analysed by means of parametric and non-parametric tests.
Results: The mean age of study population was 42 years (SD 7.6) and all subjects were men. Employees with passive jobs (low demand and low control) had a significantly longer QT index than workers in other job categories (high strain, low strain and active) ($P < 0.05$). QTc values did not show differences between the four study groups. In the subgroup of high-strain jobs we found a higher level of mental exhaustion measured by WHO5. Between the four study groups of Karasek's taxonomy, as for the other variables we investigated, there were no significant differences.
Conclusion: In our study, subjects employed in passive jobs, when compared with other Karasek's categories, showed an autonomic imbalance, as indicated by a prolonged QTi. None of the other variables we explored, such as blood pressure, BMI, work shifts and smoking, showed an effect on QT-related indicators. Nevertheless, as expected, the QT interval tended to increase with age. More insight is needed to confirm the hypothesis, and to test the influence of job control in the genesis of autonomic dysfunction due to work-related stress, considering QT index as a tool to monitor the effects of better job organisation.

Association between job strain and biomarkers of glucose homeostasis: results from the MONICA–Brianza cohort study

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Aim: Several studies have investigated the association between job strain (JS) and diabetes mellitus (DM), with apparently divergent results. We investigated the association of JS with DM as well as biomarkers of glucose homeostasis in a large Italian population-based employed sample.
Methods: Men 25–64 years old, enrolled into the WHO–MONICA Brianza population-based study (northern Italy), free of cardiovascular disease at baseline, currently employed at the time of recruitment were included in the analysis. JS was evaluated using the job content questionnaire (JCQ), assessing psychological job demand (PJD) and decision latitude (DL), each on a four-point scale (from 'completely agree' to 'completely disagree'). Four categories were derived with the quadrant approach: (a) high strain, PJD values higher than the overall sample median and DL values lower than or equal to the median; (b) active, high PJD and high DL; (c) passive, low PJD and low DL; (d) low strain, low PJD and low DL. Differences in DM prevalence as well as in age-adjusted means of glucose homeostasis biomarkers (fasting glucose, glycated haemoglobin, insulin and C-peptide) across JS categories were analysed.
Results: A total of 1490 subjects were included in the analysis. High-strain workers were 16.9%, while active, passive and low-strain workers were 15.6%, 34.7% and 32.8%, respectively. DM prevalence, fasting blood glucose, insulin levels and glycated haemoglobin were not significantly different across the categories. C-peptide levels, C-peptide/glucose ratio and C- peptide/insulin ratio were significantly different ($P = 0.001$) across JS categories, with the highest values in subjects at high strain. When high strain versus the other categories combined were compared, C-peptide/glucose and C-peptide/insulin ratios were confirmed to be higher in subjects at high strain than in the other categories (0.13% vs. 0.11%, $P = 0.04$, and 7.49% vs. 6.53%, $P = 0.03$, respectively; ratio calculated using number of moles). Glycated haemoglobin was also higher in subjects at high versus non-high strain (5.7% vs. 5.4%, $P = 0.02$).

Conclusion: The increase in C-peptide (higher production of insulin) disconnected by an increase in insulin levels (higher activity of insulin-degrading enzymes) indicates an effect of JS on insulin release and hepatic clearance, both involved in insulin resistance and coronary heart disease pathogenesis. C-peptide levels and C-peptide/insulin ratio were associated with JS categories and could be considered markers of a pre-clinical effect of high job strain, potentially useful in monitoring the health of workers at high job strain.

Patterns of circulating biomarkers across occupational classes: results from the MONICA–Brianza cohort study

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Aim: In our previous analysis from an Italian population-based employed sample, occupational classes (OCs) were associated with coronary heart disease (CHD) risk. An increased CHD risk, adjusted for all traditional cardiovascular risk factors, of about 2.1, 1.7 and 2.5 was observed for professionals/administrators, manual workers and self-employed, respectively, with respect to non-manual workers. We analysed in the same sample the association between several circulating biomarkers and OCs as well as CHD risk, to identify potential patterns and provide suggestions in the mechanisms underlying CHD risk differences across OCs.
Methods: Men 25–64 years old, enrolled into the WHO–MONICA Brianza population-based study (northern Italy), free of cardiovascular disease at baseline, were included in the analysis. The four occupational classes were derived from the Erikson–Goldthorpe–Portocarero social class scheme. Circulating biomarkers such as insulin (glucose homeostasis), estimated glomerular filtration rate (eGRF, kidney function), C-reactive protein (CRP) (inflammation), NT-pro-BNP (endothelial and heart injury), apolipoproteins (lipid transport/metabolism), testosterone and vitamin D (hormones) were measured in the laboratories of the BiomarCaRE Project Consortium. Differences in age-adjusted means of circulating biomarkers across OCs were analysed. Furthermore, the association between all biomarkers and CHD were evaluated (Cox regression) in the whole group and stratifying by OC, considering in the model all biomarkers and age or age plus all traditional risk factors.
Results: A total of 1892 subjects (mean age 45.0 ± 11.0 years; 15% professionals/administrators, 24% non-manual, 40% manual workers and 22% self-employed) were included in the analysis. Insulin ($P = 0.002$) and troponin ($P = 0.007$) were significantly different across OCs showing the same pattern of CHD risk. NT-pro-BNP showed similar results ($P = 0.0002$); however, the lowest level was observed in professionals and administrators. Creatinine values were also different across OCs ($P = 0.004$), but with lower levels in self-employed and manual workers. No significant differences were found for the other biomarkers. Considering the age-adjusted association with CHD, in the whole sample (CHD 152) insulin (hazard ratio 1.20; 95% confidence interval 1.03–1.40), CRP (1.41; 1.20–1.65) and NT-pro-BNP (1.21; 1.03–1.43) were significantly associated with the end point. In non-manual workers (CHD 17) CRP (2.27; 1.27–4.04), NT-pro-BNP (2.09; 1.00–4.40) and eGRF (2.65; 1.22–5.77) were associated with CHD, while in professionals and administrators (CHD 24) NT-pro-BNP was the only biomarker associated (1.78; 1.10–2.87). No significant associations were found for biomarkers in manual workers or in the self-employed. The analyses adjusted also for traditional cardiovascular risk factors led to similar results.
Conclusion: Circulating levels of glucose homeostasis and microischaemia-related biomarkers showed distribution patterns across OCs similar to CHD risk, as expected. Although professionals and administrators showed levels of NT-pro-BNP lower than expected, this biomarker was the only one associated with CHD in this category. Interestingly, kidney function appears to be the strongest biomarker of CHD risk in non-manual workers. These results suggest that biological mechanisms marked by NT-pro-BNP and eGRF could have a different effect among OCs. The presence of OC-specific risk factors modulating their effects could explain this effect and the different CHD risk patterns found across OCs.

Heart rate variability frequency domain alterations among healthy nurses exposed to prolonged job strain

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Aim: The deregulation of the autonomic nervous system assessed through the analysis of heart rate variability (HRV) is a promising pathway linking work stress and cardiovascular disease (CVD). A decrease of HRV has been found to be associated with a higher CVD risk. The aim of this study is to assess the variation of frequency–domain HRV parameters during work days (WDs) and rest days (RDs), in three groups of healthy nurses and nurse assistants respectively characterised by stable low job strain (SLS), recent high job strain (RHS) and prolonged high job strain, lasting at least one year (PHS).
Methods: A total of 313 nurses and nurse assistants working in medical and surgical wards of a northern Italian university hospital were investigated twice one year apart through self-administered Karasek's job content questionnaire (JCQ) and Siegrist's effort reward imbalance (ERI) questionnaire. Of them, 36 healthy workers met our inclusion criteria and were classified in the PHS ($n = 10$), RHS ($n = 7$) and SLS ($n = 19$) groups. At each visit, 'high' and 'low' strain were defined when either the JCQ or the ERI standard criteria were met, using sample percentiles as threshold values for psychological job demand, decision latitude and ERI ratio, respectively. Two 24-hour ECG recordings were obtained for a working and a resting day for each subject, and the frequency domain measures of HRV (high frequency (HF) and low frequency (LF)) were calculated for both registrations. An analysis of covariance model was applied to estimate trends in HRV parameters across stress categories, adjusting for age and smoking status ($\alpha = 0.05$, two sides).
Results: The spectral analysis of HRV performed in the WDs has shown a reduction of the ln HF in PHS (geometric mean 76.3 ms^2; standard error (SE) 18.2) and RHS (79.1 ± 22.4 ms^2) group compared to the SLS group (139.1 ± 23.9 ms^2), with a significant trend ($P = 0.03$). A similar trend, but not statistically significant, was detected through job strain (JS) categories of ln HF values in RDs. The ln LF in the WDs was lower in the PHS group (380.2 ± 82.8 ms^2) and in the RHS group (494.7 ± 128.8 ms^2) compared with the SLS group (753.3 ± 119 ms^2); test for trend $P = 0.01$. The same trend of ln LF values was found in RDs: 377.1 ms^2 (SE 98.0) in the PHS group, 660.9 ms^2 (SE 205.2) in the RHS and 820.2 ms^2 (SE 154.6) in the SLS group (test for trend $P = 0.02$). No significant changes were detected for the LF/HF ratio.
Conclusions: The reduction of the HF spectral component in job strain confirms previous studies; our findings highlight the relevant role of prolonged strain. The reduction of LH values again in high job strain categories supports the theory of a depressive modulation of the vagal tone in persistent job stress conditions.

Psychosocial factors in employees with ischemic heart disease in relation to high-sensitivity C-reactive protein and interleukin-6

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Background: We had studied the psychosocial factors of the workplace (psychological demands and job control) in relation to high-sensitivity C-reactive protein (hsCRP) in male employees with ischaemic heart disease (IHD).
Methods: The groups of male employees with IHD and those without (control group) each contained 32 persons of equivalent age (average 51.1 vs. 50.0 years). Data on psychosocial factors were obtained using the Karasek theorell questionnaire. A blood sample was tested for the hsCRP and IL-6 and high-density lipoprotein cholesterol. In statistics analyses we used the Mann–Whitney U-test.
Results: Median blood concentrations of CRP and IL-6 were higher in the IHD group ($P < 0.001$), and a connection between job control ($\#2(3) = 7.92$, $P = 0.048$) and hsCRP was revealed, while no relationship between job control and IL-6 was found. Analysis of the basis pair comparison revealed that the median hsCRP concentrations were statistically significantly different between categories of job control <22/22–25, 22–25/26–28 and 22–25/>28 (expressed in point) ($P < 0.044$).
Conclusion: We found differences of the concentration of CRP and IL-6 between IHD and control groups, but we could not conclusively confirm a relationship between the psychosocial factor and the inflammation mediators.

Energy expenditure in cement plant workers

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Aim: Cement production is characterised by a wide variability in physical efforts. No data are available on the energy expenditure levels (EE) requested by different job tasks in the cement industry. The aim of this study is to evaluate the EE based on the individual oxygen uptake

directly measured during working activity in a cement plant.

Methods: Eleven healthy blue-collar workers (M, age 41.6 ± 7.2 years; BMI $27.5 \pm 2.4\,kg/m^2$) participated in the study. They underwent a first cardiopulmonary exercise testing (CET) in the occupational medicine clinical laboratory by the VMAX29 device to quantify the maximum VO_2 uptake. In the same day, after one hour of recovery, they underwent an additional CET by the portable ergospirometric device that would be used in the workplace (Jaeger Oxycon Mobile, JOM). On a different day, all subjects underwent the ergospirometric recordings by JOM while performing their specific job tasks in the workplace. The average time duration of the workplace recordings was 72 minutes (range 41–103 minutes). VO_2 and metabolic equivalents (METs) have been quantified. Data are expressed in mean, minimum and maximum for each of the job tasks evaluated.

Results: In Table 1 the values of VO_2 and METs recorded during the job tasks are shown. METs values were characterised by a wide range with high peak levels and mean values higher than 3 in 10 of 12 job tasks. The value of 3 METs (as a threshold from light to moderate and heavy work) was exceeded for about 15% of the job task duration. For the rotary packer worker the EE values were unexpectedly high probably due to an extraordinary intervention requested for a malfunction of the machine. On the other hand, the cyclone cleaning team member, who performed a routine intervention, showed an EE unexpectedly low, despite wearing heavy protective clothes, the exposure to high environmental temperatures and the use of heavy tools in an awkward posture close to the vertical kiln.

Conclusion: The use of the portable device to quantify the EE directly during working activity proved crucial to assess the intensity of efforts required by different job tasks and may guide technical workplace interventions to reduce the physical effort. Consequently, it may support the occupational physician in the evaluation of workers' job task fitness in health and disease.

Table 1. VO2 and Metabolic Equivalents (METS) mean values by job task.

Job task	Recording (min)	VO_2 (ml/kg/min)	METs
CRO 1	103	12.7 (3–20)	3.6 (0.9–5.7)
CRO 2	65	16.9 (5–34.5)	4.8 (1.4–9.9)
Laboratory test worker	68	7.1 (3.2–16.7)	2 (0.9–4.8)
CCTM 1	65	10 (3.3–20)	2.8 (1–5.7
CCTM 1 (additional recording)	47	13 (5.2–19)	3.7 (1.5–5.8)
CCTM 2	59	11.5 (4–18)	3.3 (1.2–5.2)
Rotary kiln cleaning team member	67	11.1 (6–27)	3.3 (1.8–7.7)
Shotfire	91	12.8 (3.5–25.2)	3.7 (1–7.2)
Mechanical maintenance technician	92	12.7 (4.3–23.6)	3.6 (1.2–6.8)
Rotary packer worker	82	14.1 (4.7–20)	4 (1.3–7.7)
Check sample picker	86	12.4 (4.9–20)	3.6 (1.3–5.8)
Electrician	41	11.1 (6–16.7)	3.2 (1.7–4.7)

METs: metabolic equivalents; CRO: control room operator; CCTM: cyclone cleaning team member.

Heart rate variability trend in quay crane simulation test

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Aim: In our study we focused on heart rate (HR) and heart rate variability (HRV) to evaluate the behaviour of the cardiovascular autonomic control for a specific task consisting of a challenging quay crane simulation trial.

Methods: Sixteen male expert quay crane operators working in three different Italian harbours were enrolled in the study. Each one performed two simulation tests on different days, lasting 4 hours, in an immersive quay crane simulator 'Chameleon' located in the engineering laboratories of the University of Cagliari. A total of 32 tests were performed in a period from October 2013 to April 2016. The sample of operators undergo the same task consisting of loading and unloading a cargo ship with different virtual environmental conditions imposed by the simulator, starting with relatively good weather in daylight, that at hourly intervals become gradually more challenging, with increasing wind flow pattern and artificial light in a night scenario. The simulator allows the installation of different seats and cockpits. In our study, two different types of seats and cockpits have been used: the first was a traditional seat, the second was a dynamic Brieda seat, provided with new ergonomically designed seating arrangements. For each study subject, we recorded a medical chart including age, current job and prior jobs, job seniority, height, weight, body mass index (BMI), smoking habits, alcohol intake, physical activity, pathological history, systolic and diastolic blood pressure and visual deficit. We also performed an electrocardiogram (ECG) at rest and detected HR, ECG abnormalities and QTc interval. Every worker was examined during the simulation test by means of a Holter ECG

(Cardiette – giOtto Holter system) to detect HR and HRV. We collected several time domain HRV parameters: standard deviation of normal to normal sinus beat (SDNN), standard deviation of average normal to normal sinus beat for 5 minute intervals (SDaNN), triangular index, root mean square of standard deviation (RMSsd). Every parameter was collected for the total duration and at every hour of the test. Trends of HR and HRV parameters were detected for every subject. Comparisons between first hour and last hour HR and HRV values, as well as correlation between HR and HRV values obtained with the two different cockpits were also performed by mean of parametric and non-parametric tests.

Results: The study population had a mean age of 37 years (SD 5.1), with a mean job seniority of 8.25 years (SD 2.05). Mean BMI, HR at rest and QTc were in the normal range and none of the subjects showed ECG alteration either before or during the test. HR showed a significant decrease during the 4 hours of the test. Comparisons between the first and last hour for HRV parameters, as well as for parameters obtained using different cockpits, did not show any significant difference, although SDNN had a tendency to decrease during the test.

Conclusion: These preliminary results show a decrease in HR and SDNN that could suggest emerging fatigue due to monotony and repetitive operations, with the consequences of loss of attention that can cause very serious accidents and injuries. Emerging fatigue and lack of autonomic control on the cardiovascular system could be better detected by a study of HRV. More analysis has to be done in the long run better to assess the behaviour of the cardiovascular system in quay crane operators during their job tasks.

Blood pressure and work: new findings and evidence of effective interventions

Effort–reward imbalance at work and the prevalence of unsuccessfully treated among white-collar workers

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Aim: We examined the association between effort–reward imbalance (ERI) exposure at work and unsuccessfully treated hypertension among white-collar workers from a large cohort in Canada.

Methods: The study relies on a repeated cross-sectional design involving three waves of data collection over a 5-year period. The study sample was composed of 474 workers treated for hypertension, accounting for 739 observations. At each time, ERI was measured using validated scales and ambulatory blood pressure (ABP) was measured every 15 minutes during the working day. Unsuccessfully treated hypertension was defined as daytime ABP greater than or equal to 135/85 mmHg. Adjusted prevalence ratios and 95% confidence intervals (CIs) were estimated using generalised estimating equations.

Results: Participants in the highest tertile of ERI exposure had a higher prevalence of unsuccessfully treated hypertension (prevalence ratio 1.42, 95% CI 1.14–1.76) after adjustment for gender, age, education, family history of cardiovascular disease, body mass index, diabetes, smoking, sedentary behaviours and alcohol intake.

Conclusion: The present study supports the effect of adverse psychosocial work factors from the ERI model on blood pressure control in treated workers. Reducing these frequent exposures at work might lead to substantial benefits on blood pressure control at the population level.

Masked hypertension and effort–reward imbalance among 2369 white-collar workers

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Aim: Cardiovascular diseases (CVDs) are the main cause of death worldwide. Hypertension is the leading CVD risk factor. The diagnosis of hypertension traditionally relies on clinic blood pressure (CBP), but the use of ambulatory blood pressure measurement (ABPM) has refined hypertension classification. The refined classification includes 'masked hypertension', a clinical condition in which the CBP level is normal but ABPMs are in the hypertensive range. Studies have reported that associations between masked hypertension and CVD are as strong as those found for sustained hypertension (i.e. hypertension diagnosed with both CBP and ABPM). Evidence has

accumulated on the key role of adverse psychosocial work factors on blood pressure (BP), but little is known on the effect of these factors on masked hypertension. The objective of the present study was to determine whether adverse psychosocial work factors from the effort–reward imbalance (ERI) model are associated with the prevalence of masked hypertension in a population of white-collar workers.

Methods: White-collar workers were recruited from three public organisations. BP was measured at the workplace for CBP (mean of the first three readings taken by a trained assistant) followed by ambulatory measurements (mean of all subsequent readings taken during the working day). Masked hypertension was defined as CBP less than 140/90 mmHg and ambulatory BP $\geq$135/85 mmHg. ERI exposure at work was measured using Siegrist's validated questionnaire.

Results: Blood pressure readings were obtained from 2369 workers (participation proportion 85%). ERI exposure (odds ratio (OR) 1.53, 95% confidence interval (CI) 1.16–2.02) and high efforts at work (OR 1.61, 95% CI 1.13–1.29) were associated with masked hypertension, after adjusting for sociodemographic and cardiovascular risk factors.

Conclusion: Workers exposed to an imbalance between effort spent at work and reward had a higher prevalence of masked hypertension. High efforts at work might be of particular importance in explaining this association. Future studies should be designed to investigate how clinicians can include questions on psychosocial work factors to screen for masked hypertension and how workplace interventions can decrease adverse psychosocial exposures to lower BP.

Acute effect on ambulatory blood pressure from aerobic exercise: a crossover study among female cleaners

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Background: Hypertension is a major health issue and a significant risk factor for cardiovascular disease. High levels of occupational physical activity and high aerobic workload stress the cardiovascular system and increase the blood pressure. Accordingly, high levels of occupational physical activity increase the risk of hypertension. An aerobic exercise session is shown to lower the blood pressure acutely up to 24 hours post exercise, and may therefore be an initiative for the prevention of hypertension among workers with high levels of occupational physical activity. Yet it is unknown whether an aerobic exercise session acutely lowers the blood pressure among workers exposed to high levels of occupational physical activity. Cleaners constitute a relevant occupational group for investigation of this question because they are highly exposed to occupational physical activity and have a high prevalence of cardiovascular disease.

Aim: The objective was to investigate the acute effects on ambulatory blood pressure from an aerobic exercise session among female cleaners.

Methods: Twenty-two female cleaners, aged 30–55 years with a resting blood pressure of systolic 115 mmHg and diastolic 78 mmHg, were randomly assigned to a crossover study with a reference and an aerobic exercise session (30 minutes at a mean of 60% VO_{2max}). The aerobic exercise session was performed at the worksite during paid working time. Between-group differences in 24-hour and occupational ambulatory blood pressure changes were evaluated by intention-to-treat analysis using a repeated-measure 2×2 multi-adjusted mixed-models design, adjusted for body mass index, smoking status and occupational aerobic workload.

Results: The fully adjusted model showed that, relative to the reference session, the 24-hour systolic ambulatory blood pressure significantly decreased post aerobic exercise by 2.6 mmHg (95% confidence interval (CI) -1.3 mmHg to -3.9 mmHg). The 24-hour diastolic ambulatory blood pressure was unaltered. Likewise, the systolic ambulatory blood pressure during occupational hours showed a decreasing tendency post aerobic exercise (systolic 4.1 mmHg (95% CI -9.0 mmHg to 0.7 mmHg)). The diastolic ambulatory blood pressure during occupational hours was unaltered.

Conclusion: An aerobic exercise session significantly decreased 24-hour systolic ambulatory blood pressure and showed a tendency towards a decreased occupational systolic ambulatory blood pressure among female cleaners. Thus, an aerobic exercise session during occupational hours seems to be beneficial for lowering the risk of hypertension among cleaners. However, investigations of the long-term effects on ambulatory blood pressure from worksite aerobic exercise among workers with high levels of occupational physical activity are needed to confirm this finding.

Investigating the associations between JDC/ERI models and ambulatory blood pressure in white-collar workers

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Aim: To explore whether the Job Demand Control (JDC) and effort–reward imbalance (ERI) models are independently associated with ambulatory blood pressure taking into account several potential confounding factors to test the strength of the associations.
Methods: Participants (89 women and 30 men) underwent four-hour ambulatory blood pressure and heart rate monitoring (BP One OPCB monitor, Cardioline, Milano, Italy) on two workdays of two next workweeks according to the subjective work schedule preference (pleasant and unpleasant, respectively), and completed the Italian version of both the job content questionnaire (JCQ) and ERI questionnaires (11 and 21 items, respectively). The questionnaire contained additional information on demographic information, cigarette smoking, alcohol consumption and educational level. Ambulatory blood pressure (ABP) was analysed using the generalised estimating equations (GEE) method with work stress as between subject factor, work shift preference, and time of day (working hours, at home, sleep period) as a within-subject factor. The relation between repeated ABP measures and several covariates was assessed by means of the GEE method in order to account for the within-subject correlation. We separately examined the relation between ABP and: (a) job strain categories (high strain, active work, passive work and low strain; (b) job strain dimensions (psychological demands, decision latitude); (c) ERI model. Gender, age, body mass index (BMI), cigarette smoking, marital status, educational level, work schedule and time of day) were included in the models. A *P* value of 0.05 was chosen as the limit for statistical significance.
Results: No work stress × time interactions have been found in the job strain model, while subjects reporting higher rather than lower imbalance had significantly higher at work (shift 14.00–22.00 hours) systolic blood pressure (4.52; 95% confidence interval (CI) 0.16–9.20), diastolic blood pressure (4.17; 95% CI 0.50–7.85) and mean arterial pressure (4.33; 95% CI 0.44–8.23). The work stress by time interactions were no longer significant after adjustment for covariates in GEE analyses. No significant relationship between job strain, ERI and ABP was observed. In the job strain model, decision latitude, but not psychological demands, showed a pattern of associations with ABP in the expected direction. A relatively more consistent pattern of associations has been found for the ERI model. In the regression analyses, only BMI, work schedule preference, and time of day explained ABP values in a systematic ways. Compared to job strain, the results of the regression analysis document a relatively better relation between the ERI model and ABP: both extrinsic, and intrinsic components of this model and ABP were shown to be associated in a more consistent way in the directions expected according to the theoretical construct, although the associations did not achieve statistical significance. In contrast, a pattern of association has been found in the job strain model for the decision authority dimension only.
Conclusions: The results of this study do not support the hypothesis that blood pressure is influenced by work stress measured by means of the Karasek and Siegrist models. Although this study did not find significant differences between the two work stress models in term of associations with ABP, the more consistent pattern of association for decision latitude in the JDC model and for the extrinsic part in the ERI model deserves to be confirmed in populations with larger variance in subjective work stress or in heterogeneous work settings.

Safe return-to-work after cardiovascular events

Assessing fitness for work in workers with cardiovascular diseases: the clinical and functional profile may be more important than a mere diagnosis definition – a case report

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Background: Arrhythmogenic right ventricular dysplasia (ARVD) is a genetic heart disorder, characterised by myocyte loss and fibrofatty degeneration of the right ventricle that predisposes to ventricular arrhythmias. ARVD clinical manifestations vary widely: from patients being entirely asymptomatic to others experiencing arrhythmias and

heart failure. ARVD is a common cause of sudden death and sudden disability among young adults; for this reason it affects work ability. In addition, when patients' work implies third party responsibilities it is important to consider possible repercussions, as in the case of drivers, who may produce an increased risk of car accidents for the general population. Moreover, driving in emergency conditions (ambulance drivers, for instance) represents an additional source of emotional burden and occupational stress, which may have effects on the performance of these patients.

Case presentation: We present the clinical assessment of two ARVD patients, both working as ambulance drivers. A preliminary assessment of their occupational physicians exists in advancing for strict limitations concerning both driving and night shift. In order to determine individual susceptibility, we further assess clinical conditions in collaboration with expert cardiologists.

Case 1: Male patient, aged 28 years, suffered from multiple episodes of syncope which led to a diagnosis of ARVD. He had a positive family history of sudden death (father and grandfather died at the age of 40 and 35 years, respectively). The patient underwent a cardiac stress testing, ECG Holter monitoring, transthoracic echocardiography, cardiac magnetic resonance tomography and an electrophysiological study, revealing a profile of a high arrhythmic risk. The cardiologist advised positively for an implantable cardioverter-defibrillator (ICD).

Case 2: Male patient, aged 35 years, had no family history of cardiovascular diseases or other clinically relevant disorders and no syncopal episodes. The diagnosis of ARVD had been made upon occasional findings of non-specific repolarisation abnormalities on 12-lead surface ECG. He underwent the same cardiac assessment as for case 1. The cardiologist was able to determine a low arrhythmic risk profile, not different from a healthy individual. There was no need for pharmacological treatment, and an annual follow-up only was requested.

Conclusion: The clinical evaluation carried out by the occupational physician and the cardiologist resulted in two different conclusions: 'unfit to work' for case 1 (even after ICD implantation, as syncope risk would still persist), and 'fully fit to work' for case 2, with no restrictions. Only a strict collaboration between the occupational physician and an expert cardiologist may end with a better risk stratification and work performance, avoiding unnecessary work restrictions and improving worker's reward.

Changes in working status after diagnosis of coronary heart disease

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Aim: The aims of this study are to determine work status change and affecting factors after a diagnosis of coronary heart disease (CHD).

Methods: This is a retrospective cohort study. The participants were selected from the Manisa Public Health Directorate database. The people who lived in Manisa District, who have worked in an income-generating job and were diagnosed with CHD for the first time ($n = 41$) by a doctor between 1 December 2012 and 1 December 2013, were recruited to the study. The data were obtained from questionnaires filled by face-to-face interviews. The chi-square test analysis was performed to examine the relationship between dependent and independent variables. The significance level was set at $P = 0.05$. Dokuz Eylul University ethical committee approved the study. Verbal and written consent was obtained from all participants. The project was funded by Dokuz Eylul University research fund.

Result: It was found that 24% ($n = 10$) of patients had not returned to work, of those 50% ($n = 5$) were retired and 50% ($n = 5$) became unemployed after the diagnosis of CHD within a year. Many of the CHD patients (73%) felt self-sufficient to return to work and 68% of them returned to work due to economic insufficiency. Sixty-one per cent of them thought that their job affected the prognosis of CHD negatively. Approximately half of the patients (49%) said that their disease reduced their work opportunities. Many ($n = 19$) of the CHD patients' doctors did not make recommendations about their working life. There was no significant difference observed between the CHD patients who returned to work and others for age, gender, marital status, educational level, occupational class, economic status and general health perception ($P > 0.05$). There was no significant relationship between the patients who returned to work and others for having a history of angiography, angioplasty, or cardiopulmonary resuscitation, congestive heart failure, hypertension, chronic obstructive pulmonary disease, history of bypass operation or previous myocardial infarction ($P > 0.05$). The redundancy rate was found to be significantly higher among diabetes patients than others ($P = 0.003$). The people who worked in the public sector were more likely to return to work than those in the private sector ($P < 0.05$). No significant difference was observed between the CHD patients who returned to work and others for the levels of physical activity requirements at work, working period at the last workplace, job insecurity, quantitative demands at work,

commitment to the workplace and job satisfaction ($P > 0.05$). Many of the patients informed their employers and colleagues (68% and 88%, respectively) about their disease. One third of them (34%) believed that they were faced with stigmatisation to some extent in the workplace due to their diagnosis.

Conclusion: CHD patients had a lot of apprehension in the workplace and there were many factors affecting their return to work. In particular, the return to work rate of the CHD patients who had diabetes and worked in the private sector was lower than the others. Moreover, many physicians did not evaluate the patients' ability to work and provide suggestions about their working status after diagnosis. CHD patients should be evaluated properly and physicians need to have careful examination about the ability to work of their patients.

Shift work and long working hours and CVD

Skin temperature variation in shift workers

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Aim: The circadian rhythm is a physiological phenomenon of the human body with a cycle of 24 hours. Methods for measuring the circadian rhythm include sleep–wake cycle measurement, activity–cycle measurement using an actigraph, body temperature measurement and melatonin or cortisol measurement. The purpose of this study was to investigate the changes in circadian rhythm during shift work by measuring skin temperature.

Methods: The subjects were 68 day workers and 98 shift workers working in the electronics industry. The shift work schedule was six morning shifts, six evening shifts and six night shifts with two rest days between each shift. We recorded the skin temperature to measure circadian rhythm using a thermochron ibutton device, which was a small button-type device capable of measuring the temperature. The thermochron ibutton was attached to the wrist of the non-dominant arm of the subjects, and skin temperature was measured every 2 minutes. Skin temperature was measured during four night shifts, two rest days and three morning shifts in shift workers, and during two working days in day workers. We analysed skin temperature variation with cosinor analyses, and estimated mesor, period, acrophage and amplitude.

Results: The periods in shift workers and day workers were not different (23.6 hours in shift workers and 23.4 hours in day workers). The acrophage of shift workers was delayed by about 10 hours compared with day workers (01:46 p.m. in shift workers and 04:11 a.m. in day workers). The amplitude of shift workers was significantly lower than day workers. In addition, the amplitude was significantly lower on rest days (0.72 ± 0.31#) than on night shifts (0.81 ± 0.34#).

Conclusion: Circadian rhythm in shift workers was delayed by about 10 hours compared with day workers. The amplitude in shift workers was lower than day workers, which was consistent with previous research. In the present study, the amplitude in shift workers was significantly lower on rest days after night shifts, which means the decrease of the amplitude was most prominent during the change of circadian rhythm. Decrease of the amplitude was reported with poor tolerance to shift work. Therefore, the measurement of circadian rhythm using skin temperature may be helpful in the plan for shift work schedules.

Effects of clockwise and counterclockwise rotation of job shift on sleep quality and concentration capability in nurses

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Aim: The nursing job based on a rapidly rotating shift schedule is common practice in hospitals as it provides continuity to the patients' care. However, data suggest that shift work rotation may negatively influence job performance, physical health and psychosocial wellbeing. This is because of a disruption of the worker's circadian rhythms due to a daily routine which is out of phase with the day and night cycle. In addition, counterclockwise (CCW) shift rotation seemed to be associated with poor sleep quality compared to clockwise (CW) shift rotation.

The present study aimed to evaluate the subjective quality of sleep and levels of attention capability in two groups of hospital nurses working on a CW and CCW rapidly rotating shift schedule.
Methods: This study was conducted in two different Italian hospitals. One hundred nurses (F, age range 20–50 years), working in internal medicine and surgical wards with similar years of working experience, were enrolled. Fifty nurses worked according to a clockwise shift rotation (CW: morning, M 6 a.m.–2 p.m.; afternoon, A 2 p.m.–10 p.m.; night, N 10 p.m.–6 a.m. followed by two rest days) and 50 in counterclockwise rotation shifts (CCW: A, M, M, N followed by three rest days). The North America nursing diagnosis questionnaire was used to assess the overall nurses' quality of sleep. Nurses were also required to fill out a daily diary at the end of each work shift. From the diary, information was extracted concerning the duration and quality of sleep and the level of fatigue perception and concentration ability during the concluded shift.
Results: Sleeping time was greater ($P < 0.0001$) in nurses following a CW shift schedule (7.39 ± 0.13 hours) than in nurses working according to a CCW schedule (6.09 ± 0.10 hours). In addition, the former reported feeling more rested, thus ready to face work load, compared to nurses working on CCW (70% vs. 16%; $P < 0.0001$). Sleep disturbances, including abrupt awakening episodes, were reported more frequently by nurses working CCW (80%) than CW (40%) ($P < 0.0001$). Finally, nurses working CCW reported more frequent (56%) difficulty in maintaining attention during job tasks and keeping up with the requested work rate than those working CW (20%) ($P < 0.0001$). It is worthwhile mentioning that the reduced capability to maintain attention reported by nurses working CCW compared to CW was predominant during the night shift (46% vs. 24%; $P < 0.05$).
Conclusions: The results of our study suggest that in a rapidly rotating shift schedule the CW shift rotation system seems to favour longer daily sleep duration. Furthermore, it may permit a more suitable equilibrium between work activity and quality of sleep, ultimately resulting in a subjective better quality of life reported. These preliminary observations were seen in spite of the fact that CW is associated with fewer rest days than CCW. The higher number of rest days associated with CCW, although misleading, may seem more appealing to nurses and explain their tendency to prefer the CCW schedule. All together, these data should be taken into account when planning work schedules in order to prevent errors and help maintain health.

Age and experience-related changes in cardiovascular system of surgeons under 24-hour duties

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Aim: To reveal the age and experience-related changes in cardiovascular system (CVS) functioning in surgeons working 24-hour duties.
Methods: Blood pressure systolic and diastolic (SBP and DBP) in the upper extremities, heart rate (HR), height and weight were measured in surgeons at their work places. Haemodynamic parameters were calculated. Altogether, 66 surgeons (aged 23–74 years, 1–56 years of general experience, 1–43 years of surgeon experience, 1–37 years of 24-hour duties experience) were observed at the beginning of their 24-hour duties. World Health Organization classification (1999) was used to qualify the blood pressure levels. The classification of Buzunov (1991) was used to evaluate the functional state of CVS by haemodynamic parameters.
Results: Due to the mean group data, SBP in surgeons was 134 ± 2 mmHg (left hand) and 136 ± 2 mmHg (right hand) that qualifies as the high normal level, while DBP (83 ± 1 mmHg in both hands) and HR (75 ± 1 beats per minute) showed normal levels. SBP difference in left and right hands was 8.5 ± 0.9 mmHg, DBP – 6.0 ± 0.6 mmHg. Systolic blood volume (51 ± 1 ml) and circulatory minute volume (3835 ± 123 ml) were found to be within the middle class level, while peripheral vascular resistance (2391 ± 116 kPa*s/l) was below the middle level, Kerdo's vegetative index (-13 ± 2.9) – the vagotonia, circulatory failure index (SBP/HR 1.82 ± 0.05) – the strain regulation. Hypertension was found in 38% of surgeons, broken blood circulation self-regulation – in 94%, blood pressure asymmetry higher than 10 mmHg – in 50% of surgeons. Age-related increase (Pearson correlation $P < 0.05$) in SBP at the left hand was found along with age and experience-related decreases in HR, both systolic and minute circulatory volume, Kerdo's vegetative index, increases – in periphery vascular resistance, circulatory failure index and pulse pressure. No age or experience-related changes in DBP at the left hand, SBP or DBP at the right hand were revealed. The differences in SBP in the upper extremities become higher after 10 years of 24-hour duty experience ($P < 0.03$), in DBP – after 19 years ($P < 0.04$). The functional state of CVS of surgeons passed from the middle to the lower than middle class at 45 years of age, or 23 years of general experience, 20 years of surgeon experience, 19 years of 24-hour duties experience, from the lower than middle to the low class – at 55, 36, 30, 30 years correspondingly, from the low to the very low class – at 67, 48,

42, 42 years correspondingly. In this, parameter of the vascular part of CVS functioning passed to the lower class at the younger age compared to the parameters related to its cardiac part (2–13 years depending on the parameter and class border).
Conclusions: The unfavourable state of CVS was found to be significantly related to the age and experience of surgeons working daily duties. The vascular part of CVS was aging before the cardiac part. The break in the blood pressure symmetry regulation in the upper extremities of surgeons was found to be related to the 24-hour duty experience. The functional state of CVS in surgeons became lower than middle at 45 years of age, low – at 55 years of age while surgeon retirement age is 60 years. This manifests the need for preventive measures aimed primarily at the blood circulation regulation normalising under 24-hour duties and also gives the reason to raise the issue on the retirement age decrease for surgeons working daily duties in the case of no effective organisational measures applied.

Work stress and related risk factors among high-tech shift workers in southern Taiwan

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Aim: Work stress, which might lead to the accumulation of stress and lead to various physical and mental illnesses, has become an important issue among workers in the high-tech industry. The relation between work stress and shift work is still controversial. Therefore, we conducted a study to evaluate the associations between work stress and shift work among high-tech workers.
Methods: We recruited workers working in a scientific park in southern Taiwan from 1 January to 31 December 2016. Information on demographic characteristics was collected through a self-administrated questionnaire. Participants also completed a job content questionnaire and reported habits of smoking and drinking.
Results: There were 865 workers who participated in this study. We observed positive associations between work stress and shift work, perceived stress, economic stress, depression, insomnia, job instability and social support (all with $P < 0.05$). After adjusting for other factors, we found shift work (adjusted odds ratio (AOR) 1.56, 95% confidence interval (CI) 1.13–2.17), perceived stress (AOR 2.07, 95% CI 1.54–2.78), moderate insomnia (AOR 1.42, 95% CI 1.01–2.00) and severe insomnia (AOR 2.71, 95% CI 1.44–5.07) were independent risk factors of work stress.
Conclusion: Among the high-tech workers, work stress is associated with shift work, feeling stress in recent year and insomnia. Therefore, intervention strategies for work stress should take into consideration these factors.

Worksite interventions to prevent CVD risk factors

Healthy lifestyle promotion among workers of a major hospital in northern Italy

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Objectives: A health promotion campaign should be looked at as the preferred action to spread the idea that healthy habits could reduce morbidity and mortality linked to cardiometabolic risk factors. Projects related to the health promotion have been implemented over the years, but anyway a prescriptive or training approach has shown limited efficacy. Therefore, it was decided to structure a multi-step Workplace Health Promotion project (OspedaleInForma) using the motivational interview technique with the aim of making workers aware of their lifestyle without giving up the freedom of choice. The employees of Cà Granda Hospital Milan have appeared to be the proper sample for this study with regard to number, availability, supervision, different working position and shifts.
Methods: Step 1 – the workers are recruited during the periodic health surveillance visit to check and record body mass index (BMI), blood tests, job and work shifts. Step 2 – a nutritional motivational interview is conducted by the counselor who must assess the worker's lifestyle based on the Nutrition Status Assessment Score (NSAS) questionnaire and on information obtained from the previous health surveillance visit. The counselor and worker decide a change in lifestyle and assess an objective to be tested at 6 months' follow-up (e.g. increase antioxidant food or physical activity). Step 3 – introduction of innovative elements in the canteen: placemats with healthy messages, new healthy dishes, billboards with healthy menus, labels with the intake for portion of the food served. Step 4 – installation of vending machines with healthy foods. Step 5 – organisation of walking groups.

Results: Currently, 1002 workers have participated in the project (73.25% of women, 26.65% of men, mean age 45 years (SD 10.3), 25.32% BMI >25). Nurses are the most represented workers (33.9%). Night shift workers represent 45% of the sample, 39.2% are non-shift workers and 14.1% are daytime shift workers. The score of the NSAS questionnaire shows how the lifestyle is different for gender ($P = 0.006$) and work ($P < 0.001$, physicians and health specialists), but not for work shifts and age. In subjects who came back to the follow-up (364) lifestyle ($P < 0.0001$) has improved and the use of antioxidant food ($P < 0.001$) shows an encouraging increase even if there is no reduction of BMI. An extensive use of fruit and vegetables (27.13%) was the most successful fixed aim. A percentage of 51.65% of workers have achieved the objectives, 17.86% partially achieved them and 30.49% failed. Those who have not modified their lifestyle show worse values, in particular in total cholesterol and triglycerides. Nine months after the beginning of the step 3 project, 70% of the people interviewed stated they had modified their habits because of the new food experience in the canteen.
Conclusions: From the collected data it seems that the intervention is effective because 69.51% of the subjects have made progress in their lifestyle. Apart from being good practice in health promotion, the study appears to be a valid preliminary contribution to future operative guidelines. A one-year after follow-up could help to verify if changed habits have been successfully maintained.

Effectiveness of a Texas worksite health monitoring programme on detection, intent to be treated and follow-up care for cardiovascular diseases/risk factors

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Aim: The study aims to determine the effectiveness of a workplace health-monitoring programme on the detection, intent to be treated and follow-up care related to multiple cardiovascular diseases (CVDs) and risk factors.
Methods: The Occupational Safety and Health Administration (OSHA) mandates health monitoring of employees for specific work-related conditions. Relatively few occupationally related health problems are detected during the monitoring exams. However, a small percentage of employees are found to have health conditions (cardiovascular, pulmonary, neurological, orthopaedic) significant enough to be restricted from engaging in one or more work-related activities (i.e. use of a respirator, climbing). Environmental investigators for the state of Texas are required to undergo annual health monitoring exams. The 350 exams are conducted yearly during the months of January to March. The purposes of the exams are to determine fitness for duty and the detection of undiagnosed work-related illnesses. Each year the exams are conducted on a mobile health van at 15 different worksites throughout Texas. Exams include: complete work and personal health history, vital signs, chest X ray, spirometry, electrocardiography, audiometry, laboratory work (complete blood count, 24 chemistries, lipids, cholinesterase and lead levels), workplace-appropriate immunisations and a complete physical examination. The employees receive a personal follow-up consultation four weeks post exam.
Results: Personal versus work-related health problems/diseases are often difficult to discern and the study did not attempt to differentiate between the two. Final data analysis for the 2017 exams will be available in March 2017. However, experience from the past 20 years indicates significant numbers of employees diagnosed with new CVDs and/or risk factors (hypertension, obesity, diabetes, abnormal ECG, hyperlipidaemia, sedentary lifestyle). Furthermore, experience indicates a relatively high percentage of employees dropping out of previous treatment for a CVD condition or failing to return for follow-up medical care to their primary care provider/cardiologist. After undergoing an exam and follow-up consultation during the health monitoring programme significant numbers of employees indicated an intent to start, return to treatment and/or adopt lifestyle changes to address one or more CVD problems and/or risk factors. Data from the 2017 programe will quantify past experience and provide statistics on how to build future interventions.
Conclusion: The described health monitoring programe detects significant numbers of employees with known and unknown CVDs and CVD risk factors. Follow-up counseling sessions are pivotal in moving employees to indicate intent to re-enter or begin treatment and lifestyle changes.

Changes in pesticide protective behaviours and cardiovascular risk in Thai rice farmers: a quasi-experimental intervention study

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Aim: In recent years, increasing numbers of observational studies suggest that exposure to pesticides may lead to the incidence of cardiovascular diseases. So far, the evidence of intervention trials is still very limited on this topic. Thailand is one of the major countries to produce rice, and Thai farmers are frequently exposed to pesticides. Therefore, we aimed to

provide a preliminary intervention among Thai rice farmers. Our hypothesis was that cardiovascular risk would be reduced by improvement of pesticide protective behaviours.
Methods: We conducted a quasi-experimental intervention study. Sixty-one farmers participated in this study, 30 in the intervention group and 31 in the control group. The intervention group received one day of comprehensive educational training which was based on the core theory of self-efficacy. The intervention programme included health damages related to pesticide exposure, explanation of health benefits applying protective behaviours, and a demonstration on how to use personal protective equipment (PPE). In addition, all subjects in the intervention group were encouraged to continue protective behaviours in the workplace by a follow-up field visit of the research team. The control group received regular health education on health damages related to pesticide exposure. Pesticide protective behaviours (such as using PPE during preparing and spraying pesticidea, cleaning hands and body after work, washing clothes and storing pesticides) were measured by questionnaire, and cardiovascular risk was evaluated by the second derivative finger photoplethysmogram (SDPTG). The differences between pre-intervention and post-intervention with a 1.5-month interval were examined.
Results: Before the intervention, pesticide protective behaviours and cardiovascular risk were not different between the intervention group and control group. After the intervention, the score of pesticide protective behaviours was significantly improved in the intervention group ($P < 0.01$) but not in the control group. Compared to the control group, cardiovascular risk (SDPTG agring index) was observed to be reduced, although the difference did not reach statistical significance ($P = 0.10$).
Conclusion: The results showed that our intervention successfully improved pesticide protective behaviours among Thai rice farmers. Interestingly, we also found a tendency towards cardiovascular risk reduction, but the long-term benefit on the cardiovascular system is still not known.

Metabolic syndrome, diabetes mellitus and work exposures

Work-related stress and cardiovascular risk in healthcare workers: a cross-sectional study

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Aim: Healthcare workers (HCWs) may be exposed to high levels of job-related stress in the course of their activities, mainly as a result of compassionate fatigue, lack of skills, organisational factors and low social support at work. Some recent meta-analyses and an umbrella review indicate modest or moderate evidence for the association between psychosocial stress at work and cardiovascular diseases. We analysed the association between perceived stress and cardiovascular risk in HCWs of a Rome hospital.
Methods: Workers enrolled for a course on biohazards were invited to complete a questionnaire that included the effort–reward imbalance (ERI) scale of Siegrist and the support scale from the demand–control– support model of Karasek. Health data (height, weight, body mass index, blood pressure, total cholesterol, high-density lipoprotein (HDL)-cholesterol, triglycerides, blood glucose) were obtained from medical surveillance records. The association between predictive factors (i.e. stress variables) and the metabolic syndrome (MetS) was studied with logistic regression analysis.
Results: A total of 826 HCWs (men 33%, women 67%) participated in the study. The sample included 152 physicians (18.4%), 550 nurses (66.6%) and 124 technicians and other employees (15.0%). The mean age was 49.1 ± 7.5 years. The prevalence of HCWs with high blood pressure (153, 18.5%), high cholesterol/reduced HDL-cholesterol (268, 32.4), high triglycerides (105, 12.7%), high blood glucose (34, 4.1%) and obesity (288, 34.9%) led to a diagnosis of MetS in 100 HCWs (12.1%). Work-related stress, measured by the effort/reward ratio, corrected by social support and overcommitment, was significantly associated with the occurrence of MetS (odds ratio (OR) 1.68, 95% confidence interval (CI) 1.05–2.68, $P < 0.05$). The association between ERI and MetS was still significant after correction for age and gender (OR 1.67, 95% CI 1.02–2.73, $P < 0.05$). ERI was also significantly associated with hypertriglyceridaemia (OR 1.69, 95% CI 1.06–2.69, $P < 0.05$); the strength of the association was not reduced by correction for age and gender (OR 1.73, 95% CI 1.05–2.85, $P < 0.05$).
Conclusion: The observed association between work-related stress and MetS deserves particular attention. The root causes of stress in HCWs must be investigated so as to have information for prevention.

Association between job strain and alteration of glycaemic levels in public workers of the Brazilian Longitudinal Study of Adult Health (ELSA–Brasil)

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Aim: Consistent evidence shows that the prevention and control of chronic diseases, even diabetes, depends on biological and psychosocial factors. Among the psychosocial factors, chronic stress is one of the most relevant for diabetes. In the studies that have investigated psychosocial stress as a risk factor for health problems, the work environment has gained prominence because it is the place where people spend a considerable part of their time, exercising work activities often considered stressful. Psychosocial stress at work was shown to be a causal factor for the development and aggravation of type 2 diabetes, with a more evident association among women. This study intends to evaluate the association between psychosocial stress at work according to the demand–control model and changes in glycaemic levels, investigating the role of gender.
Methods: The Brazilian Longitudinal Study of Adult Health (ELSA–Brasil) is a multicentre study whose objective is to investigate the incidence and progression of cardiovascular diseases and diabetes. In this transversal cut, 11,922 active workers were selected at the baseline. Job strain was evaluated through the Brazilian version of the Swedish demand–control–support questionnaire (DCSQ). Briefly, the questionnaire was classified in three subscales: psychological demands, skill discretion and decision authority. Glycaemic levels were assessed through glycosylated haemoglobin (HbA1c) classified into three categories: normal (HbA1c $<$ 5.7%), intermediate (HbA1c $\geq$5.7% and $<$6.5%) and altered (HbA1c $\geq$6.5%). Directed acyclic graphs were used to identify the covariables needed to estimate the total effect of the association. We calculated odds ratios (ORs) with respective 95% confidence intervals (CIs) to three models: crude (model 1), adjusted by socioeconomic covariates (model 2) and adjusted by socioeconomic and occupational covariates (model 3), with multiplicative interactions between each for education level and job strain components. The study was approved by the national research ethics commission (CONEP; no. 976/2006) and by all institutions involved in the study.
Result: After adjustment, there is multiplicative interaction between education level, low skill discretion and low decision authority among men (*P* values 0 and 0.002, respectively) and women (*P* values 0.056 and 0.023, respectively). For men with low education, the low skill discretion is strongly associated with altered glycaemia (OR 1.91, 95% CI 1.56–2.25). An equivalent pattern is observed among women of low education (OR 1.51, 95% CI 1.18–1.9). Likewise, low decision authority is associated with altered glycaemia among men of low education (OR 1.62, 95% CI 1.29–1.95). Among women of low educational level, there is an association between low decision authority at work and intermediate glycaemic levels (OR 1.19, 95% CI 1.01–1.37) and altered levels (OR 1.65, 95% CI 1.28–2).
Conclusion: The relationship between job strain and changes in glycaemic levels was mediated by education level that stands out as a determining factor for glycaemic changes at intermediate (pre-diabetes) and elevated (diabetes) levels, for both men and women.

Syncope and work: new guidelines in clinical practice

Risk stratification and short-term prognosis in workers admitted to emergency department for syncope

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Aim: Syncope is a common clinical problem affecting about 6.2/1000 person-years, accounting for 1–3% of emergency department (ED) admissions. Previous studies indicated that about 50% of patients admitted to the ED for syncope are of working age. In the ED, risk stratification is crucial to identify patients with potential short-term adverse outcomes or who are likely to develop syncope recurrence. Both these aspects have important implications in the occupational setting to avoid unnecessary hospitalisation or unsafe job readmission. As part of a multicentre ongoing project, the aim of the present study was to describe the results of risk stratification

and short-term prognosis of workers admitted to the ED for syncope.

Methods: All patients older than 18 years, admitted to the ED of the Humanitas Research Hospital, Rozzano between 1 February and 31 April 2016 for syncope were enrolled. Here we consider a subgroup of patients identified as workers by an ad hoc questionnaire. The Gargnano criteria for short-term risk stratification have been applied. In every subject, demographic and clinical features, ED discharge diagnosis or reason for hospital admission were recorded. Prognosis at 7 and 30 days from syncope index event was also assessed.

Results: Twenty-seven out of 98 patients admitted to the ED for syncope were workers (30%, 19 women, aged 50 years). All patients were active workers before syncope occurred. Ten patients were classified as high, seven as intermediate and 10 as low risk. In 16 patients, the diagnosis was obtained in the ED and 11 of them were directly discharged because of a benign neuromediated syncope (vasovagal, hypotensive or situational). Eight patients were discharged from the ED without an aetiological diagnosis. Among them, three were at low and four at intermediate risk, with no contraindications to resume working activity on the day following discharge; only one patient was at high risk, and has been referred to the outpatient syncope unit with the suggestion to resume normal working activity after 7 days from discharge. The reason for hospital admission was necessity of treatment in the four patients (two high and two intermediate risk) with an aetiological diagnosis of syncope (one haemorrhagic shock for gastrointestinal bleeding, one carotid sinus syndrome, one sick sinus syndrome, one atrial fibrillation at high ventricular response). In two patients (one high and one intermediate risk) the reason for hospital admission was the treatment of an underlying condition encountered with a syncopal event (one mild pulmonary embolism, one intracerebral haemorrhage), and the last two patients (one low and one intermediate risk) were inappropriately admitted to complete the diagnostic work- up. Among the entire group of workers only one adverse outcome was observed in the following 30 days (i.e. recurrence of gastrointestinal bleeding requiring a blood transfusion).

Conclusion: These preliminary data show that in this population of workers, Gargnano criteria seemed to be effective in identifying patients who require hospitalisation from those who may be safely discharged from the ED. This may result in a decrease in the number of work days missed and hospitalisation expenses. We stress here the need to improve the collaboration between the ED and the outpatients syncope unit to optimise diagnostic work-up and to manage the additional risk potentially associated with hazardous job tasks and environmental exposure.

Indoor and outdoor air pollution affecting the cardiovascular system

The short-term relationship between particulate matter and cardiovascular drug prescriptions in northern Italy

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Aim: Daily fluctuations in the exposure to particulate matter with an aerodynamic diameter $<10\,\mu m$ (PM_{10}) have been associated with cardiovascular diseases and in particular with acute events, such as myocardial infarction, exacerbation of cardiac arrhythmias and congestive heart failure and hypertensive peaks. Several epidemiological studies focused on the association between PM_{10} and severe outcomes such as hospitalisation and death, but little is known about milder adverse events, which could be detected through drug prescriptions. The aim of this study was to analyse the short-term relationship between exposure to PM_{10} and prescription of cardiovascular drugs in the Lombardy region (northern Italy) from 2007 to 2008.

Methods: We estimated daily mean PM_{10} exposures at a municipality level, based on concentrations from a chemical transport model that covers the whole region and that was implemented by the regional environmental protection agency. From administrative databases of the Lombardy Healthcare System, we extracted all prescriptions of cardiovascular treatments occurring in the regional population in 2007 and 2008. In order to highlight heterogeneity in the pollutant effect, we divided the region into zones that are homogeneous for pollutant emissions and meteoclimatic conditions. In each zone we applied a time-stratified case-crossover design, building distributed lag models to investigate the relationship between PM_{10} concentration averaged from lag 0 to lag 6 and drug prescriptions. We adjusted for influenza epidemics, holidays and other exceptional circumstances affecting the prescription frequency and temperature. We evaluated the effect modification due to season, distinguishing between warm (April–September) and cold, gender and age. We pooled the zone-specific estimates through a fixed effect metanalysis.

Results: Average daily PM_{10} concentrations varied from $19.3\,\mu g/m^3$ (SD 14.6) in the mountainous zone to $39.9\,\mu g/m^3$ (SD 26.5) in the urban agglomeration zone of Milan. Overall, we extracted 23,743,841 drug prescriptions, equally distributed between genders and seasons and

predominantly absorbed (71%) by the elderly population (≥65 years old). Meta-analytic results revealed that an increase of 10 $\mu g/m^3$ in the PM_{10} concentration averaged from lag 0 to lag 6 was associated with an increase in the prescription of diuretics, beta-blockers and calcium antagonists of, respectively, 0.16% (95% confidence interval (CI) 0.07, 0.25), 0.19% (95% CI 0.11, 0.26) and 0.10% (95% CI 0.03, 0.17). The association was heterogeneous among zones, and in some of them, accounting for 26% of the population, it was not statistically significant. The effect was more evident during the cold season and among women.

Conclusion: We explored the relationship between exposure to PM_{10} and cardiovascular prescriptions and we observed a short-term association with the consumption of drugs that are used in the management of mild episodes of hypertensive peaks and exacerbation congestive heart failure, which can be treated at the population level without resorting to hospital facilities. Our study confirms that drug prescriptions can trace moderate cardiovascular events that do not cause hospitalisation or death, and that administrative databases are a feasible data source that should be screened for new outcomes in the field of environmental epidemiology.

Measuring psychological and social working conditions in a continuously changing framework

Trends in work characteristics, 2002–2014: preliminary findings from the US National NIOSH quality of work life surveys

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Aim: Major technological, political, economic and labour market changes have likely had an impact on the organisation of work and psychosocial job characteristics related to cardiovascular disease (CVD) in many countries, including the United States. Tausig et al. studied data from representative samples of US workers (the 1972 and 1977 quality of employment surveys and the 2002 National Institute for Occupational Safety and Health (NIOSH) quality of work life (QWL) survey) and found mixed trends of workers' exposure to job stressors, which varied by worker and work characteristics. However, recent trends in job characteristics in the USA have not been assessed. Therefore, in order to determine whether job and work schedule characteristics are becoming more stressful and potentially increasing CVD risk in the USA, we examined data from the NIOSH QWL surveys in 2002, 2006, 2010 and 2014. We hypothesise that the prevalence of stressful job and work schedule characteristics has been increasing over this 12-year time period and has been increasing to a greater extent among workers with low socioeconomic status (SES) than those with high SES. We also hypothesise that the major recession in 2008 reduced job demands and increased job insecurity.

Methods: The QWL was included in the general social survey (GSS), which was administered to households across the United States during a face-to-face, 90-minute interview of a randomly selected sample of non-institutionalised, English-speaking adults aged 18 or older. GSS survey response rates for the four surveys analysed were 70%, 71%, 70% and 69%. The QWL surveys were only given to GSS respondents who were employed for pay during the week prior to the survey or temporarily not working due to vacation, sickness or strike. Eligibility criteria for our analysis will be employment in the civilian labour force for at least 20 hours per week. Survey sample sizes were 1796 in 2002, 1734 in 2006, 1187 in 2010 and 1246 in 2014. Occupational and industry codes for the entire datasets were updated to reflect the 2010 census occupation and the 2007 North American industry classification system (NAICS) codes. We will graph trends in job and work schedule characteristics across the four surveys (2002–2014) to examine whether trends are linear. Linear regression will be used to examine whether each psychosocial job and work schedule characteristic has been increasing, decreasing or unchanged over the 12-year period. An additional step in the analysis will be to examine trends adjusting for time varying covariates – characteristics of the sample (age, gender, education, occupational category and work hours) and of the business cycle (unemployment rate), which may affect these job exposure variables. Pairwise comparisons between time points will also be conducted with correction for multiple comparisons. An interaction term of psychosocial job and work schedule characteristic by occupational category (management/professional, service, sales, blue collar) will be added as a final step in the model to assess whether trends vary by occupational category. All analyses will be conducted using SPSS version 24.

Socioeconomic and occupational inequalities in cardiovascular health

Prevalence and risk factors for asthma, tuberculosis and chronic bronchitis among male tannery workers: a study of Kanpur City, India

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Aim: The aim of this study was to estimate the prevalence and potential risk factors of cardiovascular diseases among male tannery workers.
Methods: Data for the study were obtained from a cross-sectional household survey conducted during the period January–June 2015. The study was conducted in the Jajmau area of Kanpur, and 284 tannery and 288 non-tannery workers were interviewed who were selected using a scientifically developed study design of the probability sampling approach. Asthma was diagnosed if the respondent reported the symptoms 'Have you had wheezing or whistling in your chest at least three months in the last one year' and chronic bronchitis was diagnosed by the symptoms 'Did you cough up phlegm most days or nights for at least three months in the previous year'. Univariate and bivariate analyses were used to assess the prevalence, and logistic regression analysis was used to identify the potential risk factors for cardiovascular diseases.
Results: The overall prevalence of symptomatic asthma and chronic bronchitis was 12% each for tannery workers, and it was 9% for asthma and 6% for chronic bronchitis among non-tannery workers. The prevalence of asthma and tuberculosis diagnosed by the doctors was 2.46% and 2.11% among tannery workers. The study has also posed the evidence of symptoms of asthma. The symptoms were 'Had a flu-like illness with aches and pains, fever, chills, and night sweats in last 12 months' (50–27%), 'Usually have a cough first thing in the morning' (24–11%), 'Usually bring up phlegm from your chest first thing in the morning' (20–14%), 'Usually experience chest contestation' (18–10%), 'Cough up phlegm most days or nights for at least 3 months in the previous year' (12–6%) and 'Woken by an attack of shortness of breath at any time in the last 12 months' (6.3–3.8%) of tannery and non-tannery workers, respectively. Results from the study show the prevalence of symptoms of tuberculosis often experienced in the last year reported by tannery and non- tannery workers in Kanpur City. The symptoms of 'Fatigue' (26–15%), 'Fever'(18–6.6%), 'Excessive sweating, especially at night' (19–9%), 'Breathing difficulty' (14.4–4.2%), 'Weight loss' (14–4.2%), 'Chest pain' (9.2–3.8%) and 'Coughing up blood' (0.4–0.0%) were also present among tannery and non-tannery workers, respectively. The results of logistic regression show that asthma is evidently associated with the education of tannery workers. Tannery workers who have completed high school and above education are less likely to have asthma (odds ratio (OR) 0.43*; 95% confidence interval (CI) 0.08–2.18) in model I. Tannery workers who had working experience of 11–20 years are prone to have asthma (OR 3.10*; 95% CI 0.992–9.693) and chronic bronchitis (OR 3.66**; 95% CI 1.14–11.72) in model II. Odds of chemicals in the air reveal that the tannery workers having moderate/high exposure are 3.7 times (95% CI 0.55–24.41) more likely to have asthma and 2.42 times (95% CI 0.28–1.27) more likely to have chronic bronchitis.
Conclusions: This study exposed that the factors which are consistently associated with cardiovascular diseases among tannery workers are age, education, media exposure, standard of living index, work experience in the current tannery and chemicals in the air.

The changing nature of work and cardiovascular risks in different countries

Is work stress becoming a cardiovascular disease risk? Psychosocial factors involved

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Aim: Previous research has explored the negative effects of work stress on physical health. Performing activities which are increasingly characterised as demanding, constraining and highly stressful elevates blood pressure and other cardiovascular indicators. However, there is no clear evidence of the importance of work stress in coronary heart disease. This research focuses on clarifying the effects of work-related stress on cardiovascular disease risk among men and women exploring the psychosocial factors involved in this relationship.
Method: Two different studies were carried out. In study 1 the sample consisted of 374 participants from the general population (46% men, 54%women) with a mean age of 49.24 years (d.t. = 18.63). They completed a questionnaire about different psychosocial measures such as labour situation, socioeconomic level, educational level, life

satisfaction, social support, self-efficacy for emotion regulation, type D personality profile, work-related stress and coping strategies against anxiety. In study 2 the sample consisted of 200 cardiovascular disease patients of the University Hospital Reina Sofia (Cordoba, Spain) who completed the same measures during a medical revision several months after being diagnosed with cardiovascular disease (85.3% men, 14.7% women; mean age 64.3 years, d.t. = .3).
Results: The results of the structural equation model (SEM) allowed us to determine the weight and interaction of the psychosocial factors and work-related stress on life satisfaction of patients compared to the general population. The predictive model explained 35% for patients and 20% for the general population (fit indexes were excellent in both samples using AMOS). The labour situation (self-employed in the case of men, and home-family care in the case of women), age and type D personality profile (especially negative affectivity dimension) determined the level of work stress and, finally, life satisfaction. In the case of patients, work stress indirectly influenced life satisfaction through the level of self-efficacy for emotion regulation.
Conclusions: We concluded that work-related stress and other psychosocial factors may determine perceived quality of life (life satisfaction), predictor of the adherence to healthy behaviours (level of physical activity, type of diet, etc.), which is highly associated with most of cases of cardiovascular disorders. These findings contribute to the current effort of primary prevention of cardiovascular disease by evidencing the psychosocial factors involved. Results point out the need for managing work pressures, promoting social support and adequate coping strategies in order to develop effective prevention programmes.

Women, work and cardiovascular diseases

Mathematical analysis of heart rate changes in women: stockbreeders

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Aim: To identify features of heart rate depending on the working conditions, the degree of mechanisation and the severity and intensity of work.
Methods: The heart rate, indicators of heart rhythm and the arterial pressure were studied during the shift. The mathematical processing program included a variation, gistogramm and autocorrelation analysis. We assessed the arithmetic mean RR (M), the mode (Mo) and its amplitude (AMo).
Results: Twenty female stockbreeders were examined. Group I included nine women (mean age 41 years) who served 80–100 calves from 20 to 100 days. Group II included 11 women (mean age 47.8 years) serving 350 older animals. Group I had partially mechanised work. Group II had more mechanised work. Most workers in group I according to the histogram were identified with a normotensive type of distribution ($M \pm 0.86$). In the dynamics of the shift an increase of vagotonic influence was found ($M = 0.97$). Workers in group II had standard-setting and marked vagotonic distribution types at the beginning of the working day, at the end of work the sympathetic type of distribution dominated ($M = 0.65$). The variance in heart rate in workers in group I was 0.0032 at the beginning and changed at the end of the shift 0.0012; workers in group II: 0.002 and 0.00065. The variance of the mean value (0.0020 ± 0.0002) is most common in elderly healthy workers. Workers in group I had the results of the restructuring of the body to adapt to stress, and the operators of group II indicated voltage regulation systems. Restructuring regulation from sympathetic to parasympathetic is more 'profitable' to the organism in energy supply, because at this time the body has a great potential for aerobic energy production. Some changes were established in quantitative characteristics of the autocorrelation function of a dynamic of RR intervals. The correlation coefficient after the first shift (1K) in group I was 0.64, in the last hour it had decreased to 0.37. The autocorrelation function is characterised by the rapid attenuation ($M0 = 12–9$; $Mo3 = 7.6–2.3$). Group II (1K) and the first hour of work is equal to 0.76, and the end of work −0.74 ($M0 = 22.7–12.1$; $Mo3 = 9.4–5.9$).
Conclusion: In analysing the results, it was found that working conditions affecting the heart rate are ambiguous. Working conditions at the beginning of the working day provided a significantly greater impact on the index of heart rate in the group II workers ($R1 = 0.28$, $R2 = 0.77$). At the end of the shift the proportion of the influence of environmental factors on production decreased to 0.38, group II, group I changed slightly ($R1 = 0.30$). The proportion of the influence factor of gravity and the load of group I was at the beginning 36.1%, and at the end of the shift 41.2%. In group II the proportion of the influence of labour gravity and the load was at the beginning 50%, and at the end of the working day 81.4%. Thus, using the method of mathematical analysis of the heart rate allows us to identify the various states of the body, due to changes in the tone of the autonomic nervous system, and indirectly judges the organism to adapt to the environmental conditions. Based on these results it is possible to judge the effect of gravity on the body of work of employees.