Perceived Job Stress and Incidence of Coronary Events: 3-Year Follow-up of the Belgian Job Stress Project Cohort

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Psychosocial characteristics have been linked to coronary heart disease. In the Belgian Job Stress Project (1994–1999), the authors examined the independent role of perceived job stress on the short-term incidence of clinical manifest coronary events in a large occupational cohort. A total of 14,337 middle-aged men completed the Job Content Questionnaire to determine the dimensions of the extended job strain model, job demands, decision latitude, and social support. Jobs were categorized into high strain, low strain, active jobs, and passive jobs. During the 3-year follow-up, 87 coronary events were registered. At baseline, 17% of workers experienced high strain. Job demands and decision latitude were not significantly related to the development of coronary heart disease after adjustment for covariates. The 38% risk excess among subjects classified in the high-strain category did not reach statistical significance. However, coronary heart disease incidence was substantially associated with the social support scale independently of other risk factors, with an adjusted hazard ratio of 2.4 (95% confidence interval: 1.4, 4.0) between extreme tertiles. No convincing evidence for an association of job demands, decision latitude, or job strain with the short-term incidence of coronary heart disease was found. However, our study underscores the importance of a supportive social work environment in the prevention of coronary heart disease.

coronal disease; risk factors; stress, psychological

Remarkable differences in the incidence of coronary heart disease across occupational cohorts have been observed for many years (1). Given the considerable heterogeneity in empirical evidence from several epidemiologic studies, the question of to what extent chronic psychosocial stress at work contributes to these differences remains rather open. The discrepancies among study outcomes found in the literature may not be attributed solely to the use of inadequate and underpowered study designs for evaluating causality and independency of the putative association but, to a major extent, also to inherent methodological difficulties in measuring work-related stressors in a precise and standardized way (2). In a recent systematic review of 13 prospective cohort studies dealing with psychosocial work characteristics and the development of coronary heart disease (3), the discordance in results was confirmed, as three studies found a lack of association while only five studies were convincingly supportive for a positive association, although for three of the latter the effect was limited to either particular psychosocial work characteristics or women only.

The conceptual models most often used in epidemiologic studies of work-related stress are the “job strain model” developed by Karasek and Theorell (4) and the “effort-reward imbalance model” by Siegrist et al. (5), with the first appearing more preponderantly in the literature because of good psychometric properties (6). In the job strain model, subjects perceiving high job demands along with low job control are classified as “high strain” employees, an exposure category which is expected to be at higher risk for experiencing health-related problems resulting in higher sickness absenteeism. Given the well-documented adverse effects of social isolation outside the workplace on health, rather few

Abbreviations: BELSTRESS, Belgian Job Stress Project; ISCO, International Standard Classification of Occupations.

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prospective studies have dealt with the third component of
the model, social support at work, either separately or as a
buffering element in the so-called “isostrain” hypothesis.
This concept refers to the synergistic role of low social
support in combination with high demands and low job
control (7–9).

The aim of this prospective cohort study was to assess the
association between work-related psychosocial stress as
measured by Karasek’s Job Content Questionnaire and the
incidence of clinically manifest coronary heart disease over
a period of 3 years in a large cohort of middle-aged working
men free from overt coronary heart disease at baseline. The
predictive impacts of the three subscales, including the
social support component, as well as the job strain and iso-
strain constructs, are studied independently of conventional
coronary risk factors.

MATERIALS AND METHODS

The Belgian Job Stress Project study cohort

The Belgian Job Stress Project (BELSTRESS) is a multi-
disciplinary, large-scale study focusing on the independent
association of perceived job stress and health (10), and it is
part of the international job stress, absenteeism, and coro-

nary heart disease European cooperative prospective study
(11). The sample consists of middle-aged men and women at
work in 25 large industries or administrations across
Belgium. Among these were 13 large industrial plants, six
bank and insurance companies, four public administrations,
and two hospitals willing to participate in the study. In each
participating company, the employees’ attention to the
project was attracted through information sessions, distribu-
tion of leaflets, and notices on the message boards. All
44,530 employees aged 35–59 years received a personal
invitation letter that included a reply form and a return enve-
lope. Invitation letters were distributed internally under the
supervision of the occupational health service. The self-
administered questionnaires were then distributed among the
interested participants together with a personal invitation for
the medical screening at the workplace. Participants were
asked to complete the questionnaires at home and bring them
to the medical examination, which took place at least a week
later. There were no formal exclusion criteria. A total of
21,419 participants (16,329 men and 5,090 women)
complied with the study (participation rate: 48 percent). Data
collection was conducted in the period between 1994 and
1998. Apart from work-related characteristics, the self-
administered questionnaires were targeting information on
sociodemographic characteristics, lifestyle-related factors
(smoking, alcohol consumption, dietary habits, physical
activity), medical history (diabetes, coronary heart disease,
respiratory problems, family medical history), health percep-
tion, and psychosocial scales for depression and anxiety.

Measurement of perceived stress at work

A detailed description of the methodology for evaluating
perceived job stress in this population was published else-
where (10). In short, stress at work was measured according
to Karasek and Theorell’s expanded demand-control model
(job strain model) validated in different occupational cohorts
(4). The model operates with three dimensions: psycholog-
cal job demand (in terms of quantity of work, mental
requirements, and time constraints), job control or decision
latitude (in terms of job-related decisions and the possibility
of developing skills), and social support at the workplace.
These scales are based on individual items belonging to the
full, recommended version of the Job Content Questionnaire
(12). The job control scale is composed of two subscales,
namely, “skill discretion” and “decision authority,” while
the social support scale is a sum of the two subscales, “super-
visor support” and “coworker support.” Each item has four
response levels scored on a Likert scale varying from “fully
disagree” to “fully agree.” In case of one missing value per
scale, the mean value calculated over the set of remaining
valid scale items for that particular respondent was imputed.
Job Content Questionnaire scales proved to contain accept-
able scale reliability and validity in our BELSTRESS cohort,
with Cronbach’s alpha values between 0.78 and 0.83 for the
three subscales (13). The cross-classification of both job
demands and job control scales according to their sex-
specific median values produces a quadrant scheme with
four exposure categories: “low strain” (low demands + high
control), “active” (high demands + high control), “passive”
(low demands + low control), and “high strain” (high
demands + low control). “Isostrain” refers to high strain in
conjunction with low support defined as a social support
score under the median.

Clinical examination

The clinical examination took place in the medical office
at the workplace and was done in accordance with a manual
of operations by centrally trained paramedics from either the
occupational health service or the research center. Blood
pressure was calculated as the average of two readings
obtained by sphygmomanometry while the subject was in a
sitting position with a 5-minute interval. A nonfasting blood
sample was taken at the worksite at the time of clinical
examination and shipped to a central laboratory for determi-
nation of serum total and high density lipoprotein cholesterol
assayed enzymatically with a Technicon AutoAnalyzer (14).

Follow-up of the BELSTRESS cohort

The male subcohort was followed up until December 31,
1999, for clinical manifest coronary events. The latter were
defined as the occurrence of an acute myocardial infarction,
unstable angina, and hospitalization for coronary artery
bypass grafting or percutaneous transluminal coronary
angioplasty. Regarding the low number of events expected
among women, female employees did not participate in this
short-term prospective study. The incidence of coronary
heart disease was carefully monitored according to the
following procedure. For sickness absence spells of at least 3
weeks reported to the human resources department, the
occupational health service, in close collaboration with the
coordinating research center, contacted the person’s treating
physician or hospital to check for a possible coronary heart
disease diagnosis. In the case of a suspected coronary event, maximum efforts were instituted to accurately ascertain the clinical diagnosis by following a formal diagnostic algorithm of gathering information on cardiac enzymes and electrocardiographic and necropsy findings. Because of organizational reasons, follow-up information was not gathered in seven of the smaller companies, resulting in 14,987 male employees for inclusion in our present statistical analysis. Moreover, at the analysis stage, we further excluded 522 men with existing coronary heart disease defined as 1) a history of myocardial infarction or angina pectoris according to the Rose questionnaire, 2) a previous hospitalization for coronary angioplasty or bypass surgery, or 3) showing signs of an old myocardial infarction (major Q/QS waves) on the resting electrocardiogram (15). Apart from the electrocardiogram information, all this information was self-reported in the medical history questionnaire but verified with the paramedics during clinical examination. Finally, another 128 men with all three job-stress subscales missing at baseline were excluded, leaving a cohort of 14,337 men with complete follow-up information. The mean follow-up time was 3.1 years, resulting in a total of 45,210 person-years of observation.

**Statistical methods**

Educational level was considered “high” for subjects who had completed at least some years in high school or university. “Low education” was defined as education at the primary school level only. Current smoking refers to the use of cigarettes, cigars, or pipes. Body mass index was calculated as weight (kg)/height (m)². According to World Health Organization criteria, “overweight” was defined as a body mass index between 25 and 29 kg/m² and “obesity” as a body mass index of 30 kg/m² or higher. Job titles were grouped into eight categories according to the International Standard Classification of Occupations (ISCO) (16). Each of the three job stress scales was categorized into low, medium, and high scores according to their tertiles. Based on an observed coronary heart disease incidence of 2.5 per 1,000 person-years in a middle-aged male working population from a previous large Belgian study, power calculations revealed that a sample of 15,000 men was sufficient for demonstrating relative risks of at least 1.8 between extreme tertiles with 80 percent power at the α = 0.05 significance level (17). Hazard ratios, as estimates of relative risks associated with tertiles of the different stress subscales as well as the strain constructs, were obtained through Cox proportional hazards modeling. The assumption of proportionality of odds was checked by plotting log[– log(S(t))] against time in the different subgroups, where S(t) represents the Kaplan-Meier survival estimate (18). In these Cox models, p values were obtained using Wald chi-square statistics, while the significance of the interaction term between the job demands and job control tertile classifications was evaluated by comparing model log-likelihoods. In these Cox models, adjustment for confounding factors was done serially in three steps. Hazard ratios were adjusted for age; for age and ISCO code; and finally for age, education, body mass index, smoking, diabetes, systolic blood pressure, serum total cholesterol, and company. All statistical analyses were performed using SAS, version 6.12, software (19).

**RESULTS**

During the follow-up period of 3.15 years on average, 87 coronary events were registered including 20 cases of fatal myocardial infarction. The incidence of new coronary events in this male population free from overt coronary heart disease was 1.93 per 1,000 person-years of observation. Half of the events (n = 44) were cases of acute myocardial infarc-
tion, while percutaneous transluminal coronary angioplasty and coronary artery bypass grafting surgical procedures were performed in nine men and six men, respectively. The remaining 28 events were cases of unstable angina. Table 1 provides descriptive characteristics of the men at baseline. In general, the coronary risk profile is in line with expectation for a male Belgian working population of that age range, with 30 percent current smokers, 3 percent diabetics, and 14 percent being obese. According to Karasek’s quadrant definitions of job strain, 26 percent of the employees could be labeled as experiencing low strain, while 17 percent were classified in the high-strain category. A high job strain exposure combined with a low level of social support, coined the “isostrain” definition, was found in 11 percent of the subjects.

In Table 2, the distribution of events over the tertile groups of the separate perceived job stress subscales, as well as the job strain categories, is presented. According to the adjusted hazard ratios and their accompanying 95 percent confidence intervals, the probability of a coronary event was not significantly associated with the decision latitude scale. Higher job demands were systematically related to higher coronary heart disease rates, but the hazard ratios were not statistically significant after adjustment for age, body mass index, smoking, educational level, diabetes mellitus, systolic blood pressure, total serum cholesterol, company, and the ISCO professional score. For the social support scale however, we observed significantly different hazard ratios, graded and independently of other risk factors. Lower social support at work was found to be associated with a greater risk for experiencing a coronary event during the period of observation, with a more than twofold risk for employees classified in the lowest tertile in comparison with employees classified in the highest tertile.

We observed no significant differences in incidences of coronary events between job strain categories according to the quadrant definitions. Although the coronary risk in the high-strain group was found to be 38 percent higher than in its complementary group, the risk elevation did not reach the level of statistical significance after multivariate correction, while the hazard ratio associated with the isostrain classification was significant after adjustment for other risk factors. According to the significance of the interaction term in the Cox model ($\chi^2$ with 4 df = 6.06; $p = 0.19$), we found no

<table>
<thead>
<tr>
<th>Job demands</th>
<th>%</th>
<th>No. of events</th>
<th>No. of subjects</th>
<th>Hazard ratio*</th>
<th>95% confidence interval</th>
<th>Hazard ratio†</th>
<th>95% confidence interval</th>
<th>Hazard ratio‡</th>
<th>95% confidence interval</th>
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<tr>
<td>Low</td>
<td>0.58</td>
<td>28</td>
<td>4,869</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>Medium</td>
<td>0.59</td>
<td>30</td>
<td>5,056</td>
<td>1.14</td>
<td>0.68, 1.90</td>
<td>1.13</td>
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<td>0.73, 2.14</td>
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<tr>
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<td>26</td>
<td>4,146</td>
<td>1.31</td>
<td>0.77, 2.24</td>
<td>1.34</td>
<td>0.76, 2.37</td>
<td>1.43</td>
<td>0.80, 2.57</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>0.61</td>
<td>27</td>
<td>4,406</td>
<td>1.00</td>
<td>0.60, 1.65</td>
<td>0.95</td>
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<td>4,332</td>
<td>0.91</td>
<td>0.55, 1.52</td>
<td>0.87</td>
<td>0.52, 1.47</td>
<td>0.73</td>
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<td>5,469</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>0.92</td>
<td>29</td>
<td>3,167</td>
<td>2.11</td>
<td>1.27, 3.52</td>
<td>2.19</td>
<td>1.30, 3.86</td>
<td>2.36</td>
<td>1.38, 4.01</td>
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<tr>
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<td>4,127</td>
<td>1.36</td>
<td>0.79, 2.32</td>
<td>1.46</td>
<td>0.85, 2.50</td>
<td>1.58</td>
<td>0.91, 2.74</td>
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<tr>
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<td>1</td>
<td>1</td>
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<tr>
<td>Job strain</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Low strain</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive</td>
<td>0.67</td>
<td>24</td>
<td>3,599</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>0.47</td>
<td>18</td>
<td>3,828</td>
<td>0.75</td>
<td>0.41, 1.38</td>
<td>0.71</td>
<td>0.38, 1.33</td>
<td>0.70</td>
<td>0.37, 1.32</td>
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<td>High strain</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0.57</td>
<td>24</td>
<td>4,193</td>
<td>0.99</td>
<td>0.56, 1.75</td>
<td>1.01</td>
<td>0.56, 1.82</td>
<td>1.13</td>
<td>0.61, 2.07</td>
</tr>
<tr>
<td>Yes</td>
<td>0.76</td>
<td>18</td>
<td>2,374</td>
<td>1.35</td>
<td>0.73, 2.49</td>
<td>1.25</td>
<td>0.67, 2.34</td>
<td>1.26</td>
<td>0.66, 2.41</td>
</tr>
</tbody>
</table>

| Isostrain | | | | | | | | | |
| No         | 0.55 | 66 | 11,619 | 1 | 1 | 1 |
| Yes        | 0.95 | 14 | 1,473 | 1.91 | 1.07, 3.41 | 1.87 | 1.04, 3.36 | 1.92 | 1.05, 3.54 |

* Adjusted for age.
† Adjusted for age and International Standard Classification of Occupations (ISCO) code.
‡ Adjusted for age, education, body mass index, smoking, diabetes, systolic blood pressure, serum total cholesterol, ISCO code, and company.
TABLE 3. Results of Cox regression analysis for coronary events, Belgian Job Stress Project, 1994–1999

<table>
<thead>
<tr>
<th>Variable</th>
<th>β (SE*)</th>
<th>Wald’s $\chi^2$</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>0.101 (0.023)</td>
<td>18.66</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Current smoking</td>
<td>1.073 (0.233)</td>
<td>21.14</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>0.006 (0.002)</td>
<td>7.19</td>
<td>0.007</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>0.014 (0.007)</td>
<td>4.68</td>
<td>0.03</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>0.067 (0.030)</td>
<td>5.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0.487 (0.476)</td>
<td>1.05</td>
<td>0.30</td>
</tr>
<tr>
<td>Low education</td>
<td>0.234 (0.295)</td>
<td>0.63</td>
<td>0.43</td>
</tr>
<tr>
<td>High education</td>
<td>-0.361 (0.405)</td>
<td>0.79</td>
<td>0.37</td>
</tr>
<tr>
<td>Job demands</td>
<td>0.039 (0.030)</td>
<td>1.77</td>
<td>0.18</td>
</tr>
<tr>
<td>Decision latitude</td>
<td>0.009 (0.011)</td>
<td>0.76</td>
<td>0.38</td>
</tr>
<tr>
<td>Social support</td>
<td>-0.085 (0.033)</td>
<td>6.78</td>
<td>0.009</td>
</tr>
</tbody>
</table>

* SE, standard error.

synergistic effect between job demands and decision latitude. In order to study the impact of an alternative formulation of job strain exposure, we entered the ratio of the job demands scale over the decision latitude scale in an additional Cox regression analysis. The hazard ratio for coronary heart disease in employees in the highest tertile of this ratio scale compared with those in the lowest tertile was 1.37 (95 percent confidence interval: 0.79, 2.40) after multivariate correction.

In our multivariate models, the predictive value of established coronary risk factors, such as age, smoking, total cholesterol, systolic blood pressure, and body mass index, was confirmed. The impact of social support on the development of coronary events follows a linear pattern, with incidence rates over the tertiles of the social support scale being 2.91, 1.86, and 1.45 coronary heart disease events per 1,000 person-years. Modeling social support as a continuous scale confirmed the significance of the inverse association between social support at work and the risk of a coronary event ($p = 0.009$) independently of the other stress scales as well (table 3).

**DISCUSSION**

**Main findings**

Given the diversity in published results on the role of work-related psychosocial characteristics in the development of coronary heart disease, the need for more and better studies as a major challenge for future psychosocial research was formulated in a number of authoritative review articles (2, 3, 20, 21). In our study, no strong association was observed between exposure to high job strain and incidence of coronary events. The graded pattern of the association may, however, suggest some impact of job strain on coronary events, but this remains far from conclusive evidence. For that reason, we are inclined to classify our study among the negative studies regarding the basic hypothesis of the Karasek job demand-control model.

Focusing on the prevalence of job strain, we found that 17 percent of the employees in our study sample were classified in the high-strain category, while 11 percent could further be classified into the isostrain category. These prevalence rates are in close agreement with observations from other studies, such as those published in the latest report from the Whitehall II Study carried out among approximately 10,000 civil servants, with prevalence rates of job strain and isostrain being 21 percent and 11 percent, respectively, among male participants with an age distribution comparable with ours (21).

The lack of a convincing association between exposure to job strain and incidence of coronary events in men tends to confirm earlier reports from the Western Electric Study, the First National Health and Nutrition Examination Survey, and the Honolulu Heart Program (22–24). In a large series of patients undergoing diagnostic coronary angiography, the incidence of cardiac events was not affected by the level of job strain as measured by the Job Content Questionnaire as well, although this latter study was criticized for a number of methodological flaws (20, 25). However, our results are not in line with the results from a very recent comprehensive review on the role of job strain as major source of cardiovascular disease risk. In this review, Belkic et al. (2) conclude that there is consistent evidence that exposure to job strain can be regarded as a major cardiovascular disease risk factor and that the magnitude of the effect is likely to be underestimated since bias to the null was present in nearly all the studies involved.

Considering the Karasek dimensions separately, we find emerging evidence in the literature that low decision latitude rather than high psychological demands plays the predominant role in the job strain model, as demonstrated by Bosma et al. (26) using 5-year follow-up data from the Whitehall II Study. In that study, the job demand scale was not associated with the incidence of coronary heart disease, while job control was identified as an independent risk factor. These results are, moreover, in agreement with those obtained in a sample of 12,517 Swedish men and those reported in the First National Health and Nutrition Examination Survey (23, 27). In an earlier publication, Marmot and Theorell (28) even interpreted job control as an essential dimension in explaining the social gradient in cardiovascular morbidity and mortality. In the recent review by Belkic et al. (2), the conclusion was reached that there is compelling evidence of an association between low decision latitude and cardiovascular disease risk. Our data, however, did not confirm the predictive power associated with job control, at least as assessed by the Job Content Questionnaire. Using data of the 11-year follow-up of the Whitehall II cohort, Kuper and Marmot (21) recently published evidence in support of Karasek’s high strain hypothesis rather than a singular job control hypothesis, especially in the prediction of a broader category of coronary heart disease events. A similar conclusion was reached by Kivimäki et al. (29) in a 2002 report of 25-year follow-up findings in a Finnish industrial cohort, where the authors demonstrated a significant relative risk of 2.2 for cardiovascular disease death associated with high strain, while actually none of the separate subscales was significantly associated with cardiovascular disease death after adjustment for cardiovascular risk factors and occupational cohort.

The most striking finding of our study, however, relates to the observed association between the third dimension of the expanded Karasek model, social support at the workplace, and the incidence of clinical manifest coronary events. Men exposed to low social support had a substantially and significantly elevated risk to develop coronary heart disease within 3 years. Excess coronary risk persisted after additional control for potential confounders, adding proof of workplace social support as a nonnegligible risk factor. In view of the emerging interest in psychosocial risk factors in general, the beneficial effects of personal social networks and support have been studied in a broader biobehavioral context. In various earlier prospective studies, greater social integration has been associated with lower mortality rates (9, 30). In a more recent systematic review on aspects of social cohesion in relation to coronary heart disease, five of the eight prospective cohort studies were found to be positive (3). In light of this evidence, it is rather surprising that the relatively scarce studies that have been dealing with levels of social support at the workplace gave rather negative results in the prediction of adverse health effects. The convincing impact of work-related support on coronary heart disease incidence raises the question of whether this is particularly due to low levels of support from coworkers or lack of social support by supervisors. In an additional post hoc analysis, we found that the predictive power associated with self-reported lack of supervisor support was slightly more convincing than for coworker social support. The multivariate-adjusted hazard ratios associated with extreme tertiles were 1.96 (95 percent confidence interval: 1.17, 3.28) for the supervisor support scale and 1.77 (95 percent confidence interval: 0.92, 3.41) for the coworker support scale. To our knowledge, our findings provide the strongest evidence to date of the importance of a coherent social network at the workplace by coworkers and/or supervisors in the prevention of coronary heart disease.

Research findings have suggested that the absence of a coherent social network may lead to an increased cardiovascular reactivity toward psychological stress (31). In agreement with the findings from the recent review by Belkic et al. (2), our observations seem to support the isostrain hypothesis that people employed in high strain jobs and experiencing low social support are at increased risk for coronary events. Among such employees, we observed a risk excess of 92 percent that reached the level of statistical significance despite the relatively low isostrain prevalence. However, given the moderate effect of job strain, this finding may largely reflect the strong singular impact of social support on coronary heart disease in our study. In both 5-year and 11-year follow-ups of the Whitehall II cohort, no evidence of a more pronounced effect of job strain was observed in people reporting low social support (21, 26).

**Methodological considerations**

A possible explanation for the differences between our findings and those from previous studies may be the relatively short follow-up of 3 years on average. Johnson et al. (27, 32) hypothesized that accumulated exposure to stress may provide a more rigorous evaluation of the job strain hypothesis and that attributable fractions for cardiovascular disease associated with long-term exposure to job stress might be substantially larger than estimated for observed point exposures. The assumption that past exposure conditions are similar to the present occupational environment may particularly be unjustified given the degree of career mobility in modern industrial societies. This also relates to the fact that high-strain employees may disproportionately have switched to other jobs for reasons related to the training conditions. As a consequence, subjects who remain longer in high-strain jobs are the ones "best fitted" to that particular environment, while those who left are the more "vulnerable" (33). Evidence for such an effect was found by Laflamme et al. (34) in female employees, showing that twice as many women exposed to high strain moved to other jobs compared with those exposed to low strain. In our study, such a "high-strain worker effect" may have led to an underestimation of the true association between psychosocial stressors and the occurrence of new coronary events. However, bias through high job turnover is less likely to be a prominent issue in short-term prospective studies such as ours.

A participation rate of 48 percent is rather low, and hence a differential selection bias with respect to personal and job-related characteristics cannot be ruled out. Unfortunately, no information was collected to elicit the effect of nonresponse. A random selection of eligible employees on the payroll list showed, however, that nonrespondents and respondents had comparable distributions of age and gender. Moreover, the cardiovascular risk profile of the middle-aged men involved in our study, as well as their coronary heart disease experience over a period of 3 years, is in line with expectation. Nevertheless, neither the BELSTRESS cohort nor its large subclass of male subjects free of prevalent coronary heart disease can be undoubtedly considered representative of the entire Belgian workforce.

A bias could have resulted from omitting seven smaller companies from our follow-up. It could be hypothesized that job stress is more present in small-scale companies because of higher work pressure and lack of stress counseling at the workplace. Additional analysis revealed, indeed, that the 1,342 employees from these companies reported slightly higher levels of job demands, while levels of decision authority and social support were comparable with those reported by workers from larger companies.

The chance that our study is missing real, existing associations is rather limited. Although the coronary event rate of 1.93 per 1,000 person-years was lower than expected, a post hoc power calculation indicated that our sample was sufficiently large to demonstrate relative risks among tertiles of at least 1.8 with 74 percent power. This fact is strengthened by the observation that established risk factors, such as age, smoking, total cholesterol, blood pressure, and body mass index, prove their prognostic importance for the development of coronary events in our study.

Regarding other self-perceived work-related characteristics, the Karasek Job Content Questionnaire also contains measures of physical exertion and job insecurity. Although in our data both components were significantly associated with high strain, we found in additional analysis that there
was no evidence of an independent relation with the incidence of new coronary events and that these did not affect the lack of a demand/control effect on the development of coronary heart disease.

The issue of whether to adjust for cardiovascular risk factors as potential intermediates in the putative causal association between psychosocial work characteristics and health outcomes remains rather controversial. Many studies have reported positive associations between work-related stress and clinical characteristics, such as casual and ambulatory blood pressure levels, or biochemical factors, such as fibrinogen (14, 35, 36). However, the problem seems of minor importance in our study, as the observed associations were not strengthened with or without adjustment for classical coronary risk factors.

Conclusion

The Expert Working Group of the National Heart Foundation of Australia recently published a summary of systematic reviews on the role of major psychosocial characteristics as independent risk factors for the development and progression of coronary heart disease and acute cardiac events (37). Our results seem in line with their conclusion of no strong or consistent evidence for job control, decision latitude, and high strain as predictors of coronary heart disease. Despite its possible limitations, our study is, however, the first prospective research to demonstrate the major importance of a supportive social environment at the workplace by coworkers and/or supervisors in the prevention of coronary heart disease.

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