

IS THE DEMAND-CONTROL MODEL STILL A USEFUL TOOL TO ASSESS WORK-RELATED PSYCHOSOCIAL RISK FOR ISCHEMIC HEART DISEASE? RESULTS FROM 14 YEAR FOLLOW UP IN THE COPENHAGEN CITY HEART STUDY

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Abstract

Objectives: To test the usefulness of the Demand-Control Model as predictor for ischemic heart disease (IHD).

Materials and Methods: One thousand one hundred forty six actively employed men and women from the general population of Copenhagen participated at baseline in 1993–1994. They filled in questionnaires on the Demand-Control Model, job title, work place, civil status, family income, leisure time activity, smoking, medication, social support, social relations, conflicts, job responsibility, satisfaction, and insecurity and went through a medical examination, including measurements of coronary risk factors. All deaths and hospital admissions due to IHD, including first myocardial infarction (MI) in the cohort were traced in the Danish registries of deaths and hospital admissions to June 2007. **Results:** 104 cases of first time hospitalisation or death due to IHD including 49 cases of MI occurred during 14 years follow up. Odds ratio (OR) compared to the relaxed group was 1.1 (0.1–3.1) among women and 1.6 (0.4–4.9) among men after confounder adjustment. Neither demands nor control were significantly associated with IHD. Among men 50 years of age or more, the risk for IHD was, however, elevated in the job strain group and the active group (OR = 3.5 and 3.2 respectively). Job insecurity was, however, strongly associated with IHD in men (OR = 2.7 (1.1–5.6)) after all adjustments. The risk was increased for MI too (OR = 2.7 (1.2–6.1)). Among women, the only significant association with IHD was for job dissatisfaction (OR = 3.0 (1.2–7.6)). **Conclusion:** In this population and in a period and society characterized by relative wealth and increasing employment rates, the Demand-control Model did not predict IHD. However, the feeling of job insecurity predicted both IHD and MI among men and job dissatisfaction predicted IHD among women.

Key words:

Ischemic heart disease, Myocardial infarction, Job strain, Psychological demands, Job satisfaction, Job insecurity

INTRODUCTION

During the last 30 years, epidemiological studies have provided growing evidence that work-related psychosocial factors play an important role in the development of ischemic heart disease (IHD) [1,2]. Most studies have been on the relationship between the Demand-Control

Model and IHD [3]. Several studies of cohorts in the 1970's and 80's found an increased risk for IHD among men who reported high psychological demands and low degree of control in their job [4–7]. In women similar findings have not been reported [8–10]. The early studies showed an association between control and IHD [11,12], while more

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This Study complies with the Declaration of Helsinki. The research protocol of the Copenhagen City Heart Study has been approved by the locally appointed ethics committee.

recent studies found association between high demands and IHD [13,14]. Use of job title as an exposure assessment in US and Sweden has been conducted without significant results [12,15–17]. Recent studies found no association between either demands or control or the combination of these and IHD [2,18]. In a recent review we concluded that the found associations could fully be explained by the association between demands and disease risk. In addition we found insufficient evidence for a relationship between IHD and effort-reward imbalance, injustice, job insecurity or long working hours [2].

As the labour market demands have changed, there is a possibility that the perceived psychological strains which formerly were associated with IHD have changed too, which might result in that the Demand-Control Model is no longer a reliable tool to measure psychosocial risk factors for IHD [19]. Therefore, in this study we have chosen to deal also with other measures in analysing data from a cohort of employed urban citizens in relation to ischemic heart disease. Data from baseline has been reported earlier [20].

Participants

The study was carried out within the framework the Copenhagen City Heart Study [21]. The third round in the Copenhagen City Study was conducted from January 1, 1992 to June 13 1994. Participants were 63% of all invited persons living in an area of central Copenhagen. Those who participated in the period January 1993 to June 1994, aged 30 or more and at the same time were occupationally active were included in the study. In total, 595 women and 551 men were included. Their basic characteristics are shown in Table 1.

METHODS

All participants filled in a self-administered questionnaire regarding health and working conditions and went through a medical examination including measurements of height, weight, lung function, ECG and blood pressure. Fasting blood samples were tested for total serum chole-

sterol, high-density lipoprotein (HDL), plasma fibrinogen and plasma glucose.

All participants were traced in the Danish Hospitalization Registry and Death Registry from baseline till July 2007, which gives a follow up period between 13 and 14.5 years.

Independent variables

The two dimensions in the Demand-control Model were measured via a series of questions in the questionnaire. The demand dimension was measured with five questions, three of which came from the Whitehall II Study [22]. These three deal with speed, intensity, and time pressure at work (see Table 2). In addition, two questions were asked, one on normal speed of work and the other on alertness. The control dimension was measured with 13 questions, all from the Whitehall II Study, split into decision latitude and skill discretion.

Social relations were elucidated with questions about isolated work and about opportunity to speak to colleagues, while support was measured with four questions about support from colleagues and superiors. The questionnaire included questions on job satisfaction, responsibility and job insecurity as well (Table 2). Job insecurity was measured with a four-item scale.

Social status was defined as suggested by the National Institute of Social Research by using the coded answers in the questionnaire on job title and occupational sector:

Group 1: Self-employed with more than 20 employees, academics and white collar workers with more than 50 subordinates.

Group 2: Self-employed with 6–20 employees and white collar workers with 11–50 subordinates. Furthermore, self-employed and white collar workers with more than 2 years of formal education.

Group 3: self-employed with zero to 5 employees and white collar workers with 1 to 10 subordinates, Furthermore, self-employed and white collar workers with 1 to 2 years of formal education.

Group 4: White collar workers without subordinates and skilled workers.

Group 5: Unskilled workers.

Table 1. Basic characteristics for 595 women and 551 men in the Copenhagen City Heart Study who participated in the work-related data collection January 1993 to June 1994

| Variable | Women (%) | Men (%) |
|---|--------------|--------------|
| Age groups (years) | | |
| 30–39 | 21.8 | 24.3 |
| 40–49 | 33.3 | 32.1 |
| 50–59 | 43.4 | 41.2 |
| 60–67 | 1.5 | 2.4 |
| Civil status | | |
| Married | 64.7 | 75.9 |
| Unmarried | 13.8 | 15.1 |
| Divorced | 16.3 | 8.2 |
| Widow | 5.2 | 0.9 |
| Social status | | |
| Academics, Leader with > 50 subordinates, self-employed: > 20 subord. | 15.6 | 21.1 |
| White collar: 11–50 subord., self-employed 6–20 subord. | 26.8 | 16.8 |
| White collar 1–10 subord., self-employed 0–5 subord. | 24.6 | 20.4 |
| Skilled workers, white collar without subordinates | 19.4 | 30.5 |
| Unskilled workers | 13.6 | 11.2 |
| Weekly working hours | | |
| < 29 | 14.7 | 4.4 |
| 30–37 | 54.1 | 41.7 |
| 38–49 | 29.4 | 28.9 |
| > 50 | 5.4 | 18.7 |
| Leader | 25.2 | 33.4 |
| Size of work place (employed, n) | | |
| < 50 | 49.0 | 46.8 |
| 50–500 | 31.7 | 34.3 |
| > 500 | 19.3 | 18.9 |
| Family income (US\$) | | |
| < 35.000 | 18.3 | 4.2 |
| 35.000–70.000 | 43.2 | 46.3 |
| > 70.000 | 38.5 | 49.5 |
| Physical activity in leisure time | | |
| Passive | 7.7 | 9.4 |
| Light physical exercise 2–4 hours/week | 55.8 | 45.6 |
| Heavy physical exercise 2–4 hours/week or more | 36.4 | 45.0 |
| Smokers | 46.7 | 47.7 |
| Physical measures | Mean (SD) | Mean (SD) |
| BMI (kg/m ²) | 24.4 (4.1) | 26.0 (3.7) |
| Systolic Blood Pressure (mmHg) | 126.5 (16.4) | 135.2 (16.4) |

SD — standard deviation.

Table 2. Odds ratio (OR) for first time hospitalisation or death due to IHD during 13 years follow up for work related exposures

| Variable | Women OR (95% CI) | Men OR (95% CI) |
|---|----------------------|--------------------|
| Social status | | |
| Group 2 / group 1 reference | 0.9 (0.1–5.3) | 2.2 (0.8–6.4) |
| Group 3 / group 1 reference | 2.8 (0.9–8.9) | 2.5 (1.2–5.2) |
| Group 4 / group 1 reference | 4.0 (1.7–9.7) | 1.2 (0.6–2.1) |
| Group 5 / group 1 reference | 2.7 (1.1–6.5) | 2.6 (1.3–5.1) |
| Family income (US\$) | | |
| < 35.000 > 70.000 | 3.6 (0.4–29.9) | 1.1 (0.4–2.9) |
| 35.000–70.000 / > 70.000 | 4.6 (0.6–36.0) | 1.3 (0.6–3.0) |
| Work organisation | | |
| Leader | 1.1 (0.5–2.4) | 1.5 (0.9–2.5) |
| Shift work | 0.4 (0.1–1.7) | 0.8 (0.4–1.6) |
| Private/public sector | 0.7 (0.3–1.4) | 1.6 (0.9–2.7) |
| Weekly working hours | | |
| 30–37 / < 30 | 1.5 (0.5–4.6) | 1.1 (0.3–3.8) |
| 38–50 / < 30 | 1.0 (0.3–3.8) | 1.0 (0.3–3.7) |
| > 50 / < 30 | 0.8 (0.1–7.8) | 0.7 (0.2–2.7) |
| Psychosocial factors at work | | |
| Demands | | |
| How is your work pace? Too high/suitable, low | 1.4 (0.4–5.3) | 0.9 (0.4–2.1) |
| The work needs all attention and concentration: \geq 3/4 of the time/rarely | 0.6 (0.3–1.3) | 1.2 (0.6–2.2) |
| Time enough to do everything, Sometimes or rarely/often | 1.0 (0.5–2.2) | 1.2 (0.7–2.5) |
| You need to work fast; Often/sometimes or rarely | 0.7 (0.3–1.5) | 0.7 (0.4–1.3) |
| Necessary to work very concentrated; Often/sometimes or rarely | 0.9 (0.2–3.2) | 1.1 (0.5–2.3) |
| Decision authority | | |
| Influence on what you do Often/sometimes or rarely | 0.5 (0.2–1.1) | 0.7 (0.5–1.3) |
| Is it necessary to do things over and over again: Sometimes or rarely/often | 1.1 (0.3–3.9) | 0.6 (0.3–1.2) |
| Can you choose between different ways to perform your work: Often/sometimes or rarely | 1.2 (0.3–4.9) | 0.6 (0.2–1.6) |
| I have something to say on decisions: Often/sometimes, rarely | 0.9 (0.3–3.2) | 0.8 (0.3–1.7) |
| Others makes decision about my work: Sometimes, rarely/often | 1.5 (0.2–3.2) | 0.5 (0.2–1.6) |
| Influence on work pace: Often/sometimes, rarely | 0.8 (0.2–3.0) | 0.7 (0.3–1.6) |
| Working time flexible: Often/sometimes, rarely | 0.7 (0.1–3.4) | 0.5 (0.2–1.3) |
| Influence on who I am working with: Often/sometimes, rarely | 0.7 (0.3–5.1) | 0.8 (0.5–2.0) |
| Influence on the work environment: Often/sometimes, rarely | 1.6 (0.4–5.9) | 0.7 (0.3–1.6) |
| I decide when to take a break: Often/sometimes, rarely | 1.2 (0.7–2.5) | 0.9 (0.5–1.6) |
| Skill discretion | | |
| Possibilities to learn new things: Often/sometimes, rarely | 1.5 (0.7–6.9) | 0.6 (0.3–1.4) |
| Does your work need expertise: Often/sometimes, rarely | 0.6 (0.3–1.3) | 1.2 (0.7–2.0) |
| Do you have to take initiative: Often/sometimes, rarely | 1.6 (0.7–3.1) | 0.7 (0.4–1.2) |
| Social relations | | |
| Work isolated: \geq 3/4 of the time / less | 1.3 (0.6–2.8) | 1.0 (0.6–1.7) |
| Have possibility to talk to colleagues during work: \geq 3/4 of the time / less | 1.1 (0.5–2.2) | 1.2 (0.7–1.9) |

Table 2. Odds ratio (OR) for first time hospitalisation or death due to IHD during 13 years follow up for work related exposures — cont.

| Variable | Women OR (95% CI) | Men OR (95% CI) |
|---|----------------------|--------------------|
| Social support | | |
| How often do you get help and support from colleagues: Often/sometimes, rarely | 0.4 (0.1–1.1) | 1.0 (0.5–1.9) |
| How often are your colleagues willing to listen to your problems with work: Often/sometimes, rarely | 0.5 (0.3–1.0) | 0.8 (0.5–1.4) |
| How often do you get help and support from your nearest superior: Often/sometimes, rarely | 0.7 (0.3–1.7) | 0.8 (0.4–1.7) |
| How often are your nearest superior willing to listen to your problems with work: Often/sometimes, rarely | 0.9 (0.4–1.8) | 1.0 (0.6–1.7) |
| Job satisfaction | | |
| Thought of seeking another job, Yes/no | 0.8 (0.3–2.1) | 0.6 (0.2–1.2) |
| Are you satisfied with your work: No, to a lesser degree / yes, very much, to some extent | 3.8 (1.5–9.4) | 0.7 (0.2–2.4) |
| Insecurity | | |
| Are you worried for that | | |
| You become unemployed: Yes/no | 1.0 (0.5–2.7) | 1.0 (0.6–1.7) |
| You are transferred to other job: Yes/no | 2.0 (0.9–4.3) | 0.7 (0.3–1.6) |
| You become superfluous due to new technology: Yes/no | 1.4 (0.5–3.7) | 1.8 (0.9–3.6) |
| You have difficulties to find a new job if unemployed with the qualifications you have: Yes/no | 1.7 (0.8–3.4) | 2.4 (1.4–4.1) |
| Responsibility | | |
| Do you have sufficient responsibility in your work: Too much / yes, too little | 0.9 (0.1–6.6) | 1.5 (0.5–5.3) |
| Risk for health or costs for you or others if you make mistakes: 3/4 of the time / less | 0.9 (0.4–1.9) | 0.6 (0.4–1.1) |

Statistical analyses

Of the 1,146 participants, 70 men and 34 women contracted IHD during the follow up period (ICD 8 410–414, ICD 10 I20–I25). This outcome was used in the analyses, and no distinction was made between death and hospitalisation due to IHD. Furthermore, the 38 cases of MI (ICD 8 410, ICD 10 I20) among men and 11 among women were analysed in relation to the significant independent variables found in the former analyses. All analyses were carried out for each gender separately.

In the statistical analyses, we used the Chi²-test for discrete variables and Student's t-test for continuous variables in bivariate analyses. Adjustment for confounders was carried out using logistic regression analyses, where the adjustment factors were forced into the model.

RESULTS

Table 2 gives an overview of the statistical associations between work-related factors and the incidence of IHD during follow up. Social status had a significant association to

outcome as expected in both genders. In women, significantly increased risk was found among workers compared to group 1. Among men, an excess risk was found among unskilled workers and group 3 consisting of small enterprise employers and white collar workers with few subordinates or low degree of education. Family income showed no significant association with IHD, nor did weekly working hours, shift work or employment in the private sector. None of the items on psychological demands showed any significant association with IHD nor did any of the items concerning decision authority or skill discretion. In men, all associations with the items on decision authority were in the expected direction, but still insignificant. In women, the pattern was mixed. Even so, no significant associations between IHD and decision latitude were found for men (OR = 0.7 (0.4–1.2)) even after adjustment for age. However, among men more than 50 years of age, high demands predicted IHD significantly (OR = 2.3 (1.1–4.8)) which led to the significant associations between high strain or belonging to the active group and IHD. Social relations and social support were not associated significantly to IHD.

However, in women, social support from colleagues was borderline associated.

Job dissatisfaction was significantly associated with IHD in women, but not in men. Even though job dissatisfaction was linked to “thoughts of seeking another job”, this last item did not show any association to IHD.

In men, concern about low chances to find a new job if unemployed, given one’s current qualifications, was significantly associated with IHD, while the concern about unemployment was not. The associations between IHD and the psychosocial factors at work are shown in Table 3. After adjustment for social status and coronary risk factors, no significant associations were found except for insecurity among men and low job satisfaction among women. The positive association between IHD and insecurity among men held for MI even after adjustment for all confounders (OR = 3.2 (1.4–7.1)). Due to lack of MI cases among women with low job satisfaction, no relevant statistical tests could be made concerning MI. Among men above 50, high demands were positively associated with IHD, which resulted in significant associations

for IHD for both the active and strained group in the Demand-Control Model.

As social status was the most prominent confounder, the data were split into three strata of social status in order to get a more differentiated picture of the results.

The tendency to increased risk for Job strain was in men almost U-shaped, as there was no excess risk in group 3. It were, however, demands which contributed to the high risk estimate for strain in group 1 and 2 and control in group 4 and 5. Among women, no particular patterns showed. Significantly elevated risk was only found for workers (group 4 and 5), in women for low job satisfaction (OR = 3.2 (1.1–10.0)) and among men for insecurity (OR = 2.7 (1.2–6.3)).

Discussion

This cohort study of employed urban citizens showed no support for the opinion that the Demand Control Model is valuable as a measure of psychosocial risk factors in the work environment for the development of IHD. This is in line with another Danish study conducted 8 years earlier

Table 3. Odds ratio (OR) for first time hospitalisation or death due to IHD during follow up for exposures in the psychosocial work environment

| Psychosocial factor | Adjustment for age OR (95% CI) | | Adjustment for age, social status and coronary risk factors OR (95% CI) | | | | | |
|----------------------------|-----------------------------------|---------------|--|---------------|----------------|----------------|---------------|---------------|
| | women | men | < 50 years | | > 50 years | | All | |
| | | | women | men | women | men | women | men |
| Demands, high/low | 0.9 (0.4–1.8) | 1.1 (0.6–1.8) | 1.1 (0.3–4.2) | 0.7 (0.3–1.7) | 0.9 (0.3–2.4) | 2.3 (1.1–4.8) | 1.1 (0.5–1.6) | 1.5 (0.8–2.6) |
| Control, high/low | 0.6 (0.3–1.4) | 0.7 (0.4–1.1) | 1.9 (0.4–9.9) | 1.3 (0.5–3.4) | 0.9 (0.3–2.7) | 0.7 (0.3–1.6) | 1.2 (0.5–3.1) | 0.9 (0.5–1.3) |
| Job strain | | | | | | | | |
| Active | 1.3 (0.7–2.2) | 1.2 (0.8–1.9) | 0.8 (0.1–6.2) | 0.6 (0.2–2.0) | (0.2–6.1) | 3.2 (1.1–9.0) | 1.1 (0.2–4.7) | 1.5 (0.5–3.5) |
| Passive | 0.8 (0.4–1.6) | 0.9 (0.5–1.4) | 0.2 (0.01–1.8) | 0.7 (0.2–2.3) | 1.3 (0.2–7.7) | 1.8 (0.6–5.6) | 0.8 (0.2–3.6) | 1.1 (0.5–2.7) |
| Strain | 1.2 (0.6–2.3) | 1.3 (0.8–2.1) | 0.6 (0.1–3.4) | 0.5 (0.1–1.0) | 1.1 (0.2–6.0) | 3.5 (1.1–10.5) | 1.1 (0.3–4.2) | 1.6 (0.7–3.7) |
| Social support, high/low | 0.6 (0.3–1.2) | 0.8 (0.5–1.4) | 1.0 (0.3–3.4) | 1.0 (0.4–2.3) | 0.7 (0.3–1.8) | 0.7 (0.4–1.5) | 0.9 (0.4–1.4) | 0.8 (0.5–1.4) |
| Social relations, many/few | 1.2 (0.6–3.3) | 1.6 (0.9–2.5) | 1.7 (0.5–5.9) | 1.6 (0.7–3.7) | 0.8 (0.3–2.2) | 1.5 (0.7–2.9) | 1.1 (0.5–2.0) | 1.6 (0.9–2.7) |
| Conflicts | 0.5 (0.3–1.1) | 1.2 (0.7–2.0) | 0.8 (0.2–2.7) | 1.0 (0.4–2.6) | 0.6 (0.2–1.7) | 1.2 (0.6–2.4) | 0.7 (0.2–3.2) | 1.1 (0.6–3.1) |
| Insecurity, high/low | 1.6 (0.7–3.4) | 2.1 (1.2–3.6) | 1.1 (0.3–4.3) | 1.3 (0.5–3.3) | 1.6 (0.6–4.3) | 2.7 (1.2–5.7) | 1.4 (0.5–3.2) | 2.5 (1.1–5.6) |
| Job satisfaction, low/high | 3.7 (1.5–9.1) | 0.9 (0.7–3.2) | 0.8 (0.1–5.4) | 1.8 (0.4–6.9) | 4.0 (1.2–13.1) | – | 3.0 (1.2–7.6) | 0.9 (0.3–3.3) |

– No cases in the low job satisfaction group.

in the suburb of Copenhagen, where we found a clear association between self-reported high psychological demands at work and IHD independently of other coronary risk factors, but no association between the combination of demands and control and IHD [14]. Other recent studies have also failed to support the Demand Control Model hypothesis regarding IHD [18,24], while older studies have shown good predicting of IHD using the model [1,2]. The difference in those findings may be due to the changes in exposures to psychosocial risk factors during the time elapsed between the early and recent studies. In Denmark, the changes in the labour market during the last decade of the last century have resulted in longer working hours, more computerised and highly skilled work and a decrease in numbers of workers with clerical, cleaning and industrial jobs [19]. The study has some intrinsic methodological limitations, as do other similar studies, and this might have affected the results. Firstly, exposure was only measured at baseline, and the relatively long follow-up time means that it must be assumed that a certain number of participants have stopped working and consequently have not been exposed for some time. Further, the exposure intensity might have changed during the follow-up time, and these factors add to an underestimation of the observed associations.

The fact that only 63% of the entire study population participated in the study constitutes a selection bias. We do not know anything about the non-participants' health or working conditions, we only know that their age and gender distribution compared to that of the participants. It is difficult to imagine that information bias could influence the results in any systematic way. The Danish hospitalisation register has a very high degree of validity, and the procedures used in Denmark with regard to diagnosing IHD are considered to be of a high standard [23]. This means that it is unlikely that there are cases of misclassification when it comes to the endpoints.

The confounder control could lead to overcontrol, but the risk estimates were mostly affected by control for social status and not for conventional risk factors.

Consequently, this cohort study partly supports the findings from other studies indicating that job insecurity could

be a major risk factor for IHD [25–27]. This is of importance in the light of the financial crisis which did not affect the results of this study. Further studies are needed in order to determine whether these are isolated findings or perhaps indications of a new trend due to changing working conditions at the modern labour market.

The results also indicate that risk for IHD associated with psychosocial factors at work is unevenly distributed in the labour force.

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