Testing the Job Demand–Control–Support model with anxiety and depression as outcomes: The Hordaland Health Study

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**Aim**
To test the strain/iso-strain, interaction and buffer hypotheses of the Job Demand–Control–Support model in relation to anxiety and depression.

**Methods**
Five thousand five hundred and sixty-two workers with valid Demand–Control–Support Questionnaire (DCSQ) scores were examined with the sub-scales of the Hospital Anxiety and Depression Scale as outcomes. Multiple statistical methods were applied.

**Results**
The strain and iso-strain hypotheses were confirmed. Generally, additive and non-interaction effects were found between psychological demands, control and social support. The buffer hypotheses were refuted. Results from analyses testing different interaction operationalizations were complementary.

**Conclusions**
High demands, low control and low support individually, but particularly combined, are risk factors for anxiety and depression. Support is the DCSQ index most strongly associated with anxiety and depression in women. Assessment of psychosocial work environment may identify workers at risk, and serve as a basis for job-redesign.

**Key words**
Anxiety; depression; Demand–Control(–Support) Questionnaire; Hospital Anxiety and Depression Scale; Job Demand–Control(–Support) model.

**Introduction**
The Job Demand–Control(–Support) (JDC(–S)) model has dominated research on occupational stress for more than 20 years [1]. The JDCS model has three major components describing workplace qualities: (psychological) demands, control (or decision latitude) and (social) support. According to the *strain hypothesis*, high demands combined with high control (‘active’ jobs) lead to psychological strain due to the exposure to high demands [2, pp. 31–36]. However, because of high control, the strain level of ‘active’ workers is predicted to be average. Also employees in ‘passive’ (i.e. low demands/low control) jobs will obtain intermediate scores, while workers in ‘high strain’ jobs (high demands/low control) will experience the most adverse reactions of psychological strain (fatigue, anxiety, depression and physical illness). Workers in ‘low strain’ jobs (low demands/high control) ‘are... made both happier and healthier than average by work’ [2, p. 36].

One of the most controversial issues of the strain hypothesis concerns whether the association between demands and control represents an additive effect or a (multiplicative) interaction [1,3,4]. Regarding the latter, the literature sometimes postulates a synergistic effect, and sometimes a buffering effect [4]. The *buffer hypothesis* states that a high control level (i.e. above a certain threshold) prevents demands from increasing the risk of illness [1,4].

In the 1980s social support was added to the Job Demand–Control model, resulting in the JDCS model [5]. Correspondingly, the *iso-strain hypothesis* expands the strain hypothesis, predicting the most negative outcomes in jobs characterized by high strain combined with low support or social isolation (‘iso-strain’ jobs). The corresponding buffer hypothesis states that a support level above a certain threshold protects against the negative impact of high strain [1,6].
Different interpretations of the interaction concept have led to different ways of ‘operationalizing’ the possible interactions between demands and control and between strain and support, as summarized by Landsbergis and Theorell [7] and briefly explained under Statistics.

Both longitudinal and cross-sectional studies lend some support to the strain and iso-strain hypotheses [1,8]. Conclusions regarding the interaction/buffer hypotheses are still unsettled [1].

Adverse job conditions may lead to the development of anxiety and depressive symptoms [2,9–11]. Identification of possible anxio- and depressogenic agents in the work environment followed by appropriate interventions might have important clinical and economical implications. Most studies that have tested the central hypotheses of the JDCS model with anxiety and depression as outcomes included small sample sizes, concerned only one or a few occupational groups, and/or did not use complete versions of recognized assessment instruments of anxiety and depression. Further, several of the studies used only caseness as outcome. This may be problematic because of an over-representation of healthy individuals among workers [12], which makes it probable that the main part of the variation in symptomatology is found in the sub-clinical area.

Finally, few researchers have systematically examined the different operationalizations of the postulated interactions [7].

The aim of this study was to test the strain, iso-strain and interaction (including buffer) hypotheses, with the sub-scales of the Hospital Anxiety and Depression Scale (HADS) as outcomes, in a large Norwegian population-based study. The following research questions were posed:

(1) To what extent are psychological demands, control and social support in the work place, and the composite indexes strain (demands divided by control) and iso-strain (strain divided by support) associated with levels of anxiety and depression?
(2) Are there interaction effects between demands and control, and between strain and support regarding levels of anxiety and depression?
(3) Is gender a moderator for the possible associations in (1)?
(4) To what extent may the possible associations in (1) be explained by other work related variables, demographics, individual lifestyle and somatic health problems?

Materials and methods

The Hordaland health study 1997–1999 (HUSK) was conducted as a collaboration between the National Health Screening Service, the University of Bergen and local health services. The study population included the 29 400 individuals born in 1953–1957 residing in Hordaland County, Western Norway, December 31, 1997. A total of 8598 men and 9983 women participated, yielding a participation rate of 57% for men and 70% for women.

Data collection in HUSK was performed in two steps. The first, identical for all participants, included a self-administered questionnaire and a brief health examination. In the second step, questionnaires that included the Swedish Demand–Control–Support Questionnaire (DCSQ) were randomly given to about half of the men and 75% of the women (the motivation for the oversampling of women was not related to DCSQ). The present study encompassed only workers (defined as having worked at least 100 income-giving hours the preceding year) who had valid DCSQ and HADS ratings and valid responses on the other variables used here. This comprised 2463 men and 3099 women, constituting 60 and 63%, respectively, of the male and female workers who were given the DCSQ (descriptive characteristics of the participants are given in Table 3).

Levels of anxiety and depression were assessed by HADS, which has been found to perform well in assessing symptom load of anxiety and depression in both somatic, psychiatric and primary care patients as well as in the general population [13].

Each HADS item is scored on a four-point scale from zero to three, and the item scores are added, giving sub-scale scores from 0 (minimum symptom level) to 21 (maximum symptom level) [14].

Psychological demands, control and social support in the work place were assessed by DCSQ (Table 1), a 17-item questionnaire developed by Theorell et al., based on the Demand–Control–Support model [2,5,7,15]. The demands and control sub-scales represent a shortened and modified version of Karasek’s Job Content Questionnaire [7]. The support items are oriented toward the atmosphere at the work-site.

Because of a translation error from Swedish into Norwegian, one of the control items had to be excluded (‘Does your work require skills?’). However, the psychometric properties of the 16-item Norwegian version of the DCSQ have been found to be satisfactory [16].

Each DCSQ item is scored on a four-point scale from one to four, and the item scores are added, giving sub-scale scores from 5 (minimum level) to 20 (maximum level) for demands, and from 6 to 24 for support. Because of the excluded control item, control scores were multiplied with 6/5, giving scores from 6 to 24.

Main occupation was manually classified according to Standard Classification of Occupations [17], whose structure is based on skill level, i.e. which technical and formal skills that are normally required [18]. Other
possible confounders included were: number of paid work hours per week; shift work, night work or duties (yes/no); level of physical activity at work; educational attainment; annual household income; marital status; children (yes/no), daily smoking (yes/no), alcohol consumption; level of leisure time physical activity; body mass index; musculo-skeletal problems (pain and/or stiffness of at least 3 months’ duration in the last 12 months, resulting in reduced work capacity or sick leave); chronic somatic diseases (having (had) myocardial infarction, angina pectoris, hypertension, stroke, asthma, chronic bronchitis, diabetes mellitus or multiple sclerosis); and the physical composite score of the SF-12 Quality of Life Schedule.

The continuous variables strain (demands divided by control) [7] and iso-strain [19] (strain divided by support) were constructed. Analyses were stratified by gender because of significant interactions between gender and each of the indexes demands, strain and iso-strain regarding levels of anxiety and depression.

Standardized regression coefficients (SRCs) and adjusted explained variances ($R^2$’s) were used to examine the direction and strength of the associations between DCSQ indexes and mean HADS scores (Table 4). More precise dose–response relationships of these associations were examined by Generalized Additive Model (GAM) curves [20] (Figure 1).

Possible interactions between demands and control were examined according to Landsbergis and Theorell [7]:

1. examination of the associations between the composite strain index and the outcome variables (Table 4);
2. the ‘quadrant approach’ (Table 5);
3. demands and control trichotomized—a graphical approach (Figure 2); and
4. the multiplicative interaction term ‘demands £ control’. The significance level of this product term was estimated in analysis of variance, with both variables dichotomized [21].

For possible interactions between job strain and social support we examined:

1. the associations between the composite iso-strain index and the outcome variables (Table 4);
2. whether socially isolated, high-strain work carried the highest risk for anxiety and depression;
3. demands, control and support dichotomized by their medians (Table 6, Figure 3); and
4. the multiplicative interaction term ‘strain £ support’, examined as described for ‘demands £ control’ [7,19].

Possible interactions between gender and (1) DCSQ indexes; (2) job characteristics classified according to demands, control and support (Tables 5 and 6) were examined as described for ‘demands £ control’. Because of heterogeneity of variances, log transformation of HADS-A and -D scores was done before significance testing of the multiplicative interaction terms. Possible confounders of the associations between DCSQ indexes and HADS scores were adjusted for in linear regression.

Significance level was set to $P = 0.05$ with two-sided tests. The analyses were performed by means of SPSS for Windows, version 11.0, S-PLUS, version 6.1 and Microsoft Excel 97.

The HUSK study protocol was cleared by the Regional Committee for Medical Research Ethics of Western Norway and approved by the Norwegian Data Inspectorate.

### Table 1. The Swedish Demand–Control–Support Questionnaire (DCSQ)a

<table>
<thead>
<tr>
<th>Subscale name and item number</th>
<th>Item text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological demands (D)</td>
<td>D1 Does your job require you to work very fast?</td>
</tr>
<tr>
<td></td>
<td>D2 Does your job require you to work very hard?</td>
</tr>
<tr>
<td></td>
<td>D3 Does your job require a too great work effort?</td>
</tr>
<tr>
<td></td>
<td>D4 Do you have sufficient time for all your work tasks?</td>
</tr>
<tr>
<td></td>
<td>D5 Do conflicting demands often occur in your work?</td>
</tr>
<tr>
<td>Control (C)b</td>
<td>C1/SD1 Do you have the opportunity to learn new things in your work?</td>
</tr>
<tr>
<td></td>
<td>C2/SD2 Does your job require creativity?</td>
</tr>
<tr>
<td></td>
<td>C3/SD3 Does your job require doing the same tasks over and over again?</td>
</tr>
<tr>
<td></td>
<td>C4/DA1 Do you have the possibility to decide for yourself how to carry out your work?</td>
</tr>
<tr>
<td></td>
<td>C5/DA2 Do you have the possibility to decide for yourself what should be done in your work?</td>
</tr>
<tr>
<td>Social support (S)</td>
<td>S1 There is a quiet and pleasant atmosphere at my place of work.</td>
</tr>
<tr>
<td></td>
<td>S2 There is good collegiality at work.</td>
</tr>
<tr>
<td></td>
<td>S3 My co-workers (colleagues) are there for me (support me).</td>
</tr>
<tr>
<td></td>
<td>S4 People at work understand that I may have a ‘bad’ day.</td>
</tr>
<tr>
<td></td>
<td>S5 I get along well with my supervisors.</td>
</tr>
<tr>
<td></td>
<td>S6 I get along well with my co-workers.</td>
</tr>
</tbody>
</table>

*aThe translation into English from the Norwegian version was done by the authors, and is not authorized.

bDecision latitude. SD: skill discretion; DA: decision authority. The control (skill discretion) item 'Does your job require skills?' was excluded from the study due to a translation error.
Results

Mean anxiety level was higher in women than in men, while the opposite was the case for depression (Table 2). Control scores were considerably higher and demands scores somewhat higher in men, while support scores were highest in women.

Anxiety and depression levels were positively associated with demands, strain and iso-strain scores and negatively associated with control and support scores (Table 4). The associations between HADS-A/HADS-D and the DCSQ indexes were generally linear, with some of the curves slightly curvilinear or S-shaped (Figure 1).

The associations were stronger in men than in women, and stronger for support than for demands and control (Table 4).

The effects of each of demands, control and support on HADS scores were mainly independent of the other two factors (Table 4).

The results confirmed the strain hypothesis: The ‘high strain’ group consistently showed significantly higher HADS scores than the other three groups (Table 5). The ‘active’ and ‘passive’ groups had intermediate scores, while the ‘low strain’ group scored significantly lower than the other groups. Differences between the groups were largest for men ($P < 0.01$ for the interaction terms
Demands and control were divided into tertiles. The following patterns of HADS levels across the resulting nine exposure cells further strengthened the strain hypothesis (Figure 2): the high demands/low control group had the highest, and the low demands/high control group the lowest scores. For all levels of control, HADS scores decreased by decreasing demands levels, and for all levels of demands, HADS scores decreased by increasing control levels. This pattern was consistent for HADS-A in men, while it was weakest for HADS-D in women. The results were not in agreement with a buffer effect of control on demands.

The significance levels of the interaction term ‘demands × control’ were estimated after dichotomizing demands and control, (1) by their medians and (2) by their 75th (demands)/25th (control) percentiles. The only significant interaction, a synergistic effect, was found in (1), for HADS-D in men (P = 0.046). Correspondingly, when including the interaction term, the adjusted R² increased from 0.050 to 0.052 (P = 0.046 in F test for R² change).

The combined effect of high demands, low control and low support on HADS scores was examined. In accordance with the iso-strain hypothesis, the higher the demands and the lower the control and support, the higher were the anxiety and depression levels. This pattern was strongest for men. For example, the 92 men and women above the 80th percentile for demands and below the 20th percentile for both control and support, had mean scores of 7.5 and 5.8 on HADS-A and -D, respectively. The corresponding scores for the 35 men were 8.5, which is above the cut-off level for caseness (95% CI: 7.1–10.0), and 7.2 (95% CI: 5.9–8.4).

HADS scores were examined for the eight different combinations of high/low levels of demands, control and support dichotomized by their medians (Table 6, Figure 3). For both genders the iso-strain group had the highest, and the low demands/high control/high support group the lowest HADS scores, thus confirming

### Table 2. Descriptive characteristics of the HADS<sup>a</sup> and DCSQ<sup>b</sup> indexes in The Hordaland Health Study

<table>
<thead>
<tr>
<th>Variables</th>
<th>Men (N = 2463)</th>
<th>Women (N = 3099)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Standard deviation Skewness</td>
<td>Mean Standard deviation Skewness</td>
</tr>
<tr>
<td>HADS-A</td>
<td>4.32&lt;sup&gt;c&lt;/sup&gt; 3.04 0.87</td>
<td>4.60 3.19 0.77</td>
</tr>
<tr>
<td>HADS-D</td>
<td>3.41&lt;sup&gt;c&lt;/sup&gt; 2.83 1.08</td>
<td>2.72 2.67 1.45</td>
</tr>
<tr>
<td>Psychological demands</td>
<td>13.81&lt;sup&gt;c&lt;/sup&gt; 2.72 −0.13</td>
<td>13.40 2.91 −0.16</td>
</tr>
<tr>
<td>Control</td>
<td>18.41&lt;sup&gt;c&lt;/sup&gt; 3.19 −0.81</td>
<td>17.41 3.41 −0.56</td>
</tr>
<tr>
<td>Social support</td>
<td>19.05&lt;sup&gt;c&lt;/sup&gt; 2.84 −0.30</td>
<td>19.45 2.89 −0.36</td>
</tr>
<tr>
<td>Strain&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.77&lt;sup&gt;c&lt;/sup&gt; 0.23 2.23</td>
<td>0.81 0.28 2.00</td>
</tr>
<tr>
<td>Iso-strain&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.04 0.02 4.22</td>
<td>0.04 0.02 2.70</td>
</tr>
</tbody>
</table>

<sup>a</sup>HADS: Hospital Anxiety and Depression Scale; HADS-A: anxiety score, HADS-D: depression score.

<sup>b</sup>DCSQ: the Swedish Demand–Control–Support Questionnaire.

<sup>c</sup>Significant gender differences (independent samples t-test: P < 0.05).

<sup>d</sup>Strain: psychological demands divided by control score.

<sup>e</sup>Iso-strain: strain divided by social support score.

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### Table 3. Descriptive characteristics of the participants in The Hordaland Health Study (%)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Men (N = 2463)</th>
<th>Women (N = 3099)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmarried</td>
<td>14.4</td>
<td>10.4</td>
</tr>
<tr>
<td>Married, registered partner</td>
<td>75.2</td>
<td>75.2</td>
</tr>
<tr>
<td>Widow/-er, divorced, separated</td>
<td>10.4</td>
<td>14.5</td>
</tr>
<tr>
<td>Level of education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than A-levels/high school</td>
<td>49.5</td>
<td>48.6</td>
</tr>
<tr>
<td>(Equivalent to) A-levels</td>
<td>8.9</td>
<td>12.1</td>
</tr>
<tr>
<td>College/university</td>
<td>41.6</td>
<td>39.3</td>
</tr>
<tr>
<td>Major occupational groups&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–3</td>
<td>56.6</td>
<td>42.9</td>
</tr>
<tr>
<td>4–5</td>
<td>13.1</td>
<td>47.8</td>
</tr>
<tr>
<td>6–9</td>
<td>30.4</td>
<td>9.3</td>
</tr>
<tr>
<td>Number of paid work hours per week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 20</td>
<td>1.5</td>
<td>10.2</td>
</tr>
<tr>
<td>20–49</td>
<td>94.3</td>
<td>89.1</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>4.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Annual household income in NOK&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 200 000</td>
<td>3.9</td>
<td>11.4</td>
</tr>
<tr>
<td>200 000–500 000</td>
<td>68.5</td>
<td>61.1</td>
</tr>
</tbody>
</table>

<sup>a</sup>0–3: The groups with the highest skill levels (0: armed forces, 1: legislators/senior officials/managers, 2: professionals, and 3: technicians/associate professionals).

<sup>b</sup>4–5: The groups with intermediate skill levels (4: clerks and 5: shop/market sales and service workers).

<sup>c</sup>6–9: The groups with the lowest skill levels (6: agricultural/forestry/fishery workers, 7: craft and related trades workers, 8: plant/machine operators, assemblers, and 9: elementary occupations).

<sup>d</sup>In 1999, NOK 200 000 and 500 000 were equivalent to EUR 24 067 and 60 168, respectively.
Table 4. Associations\(^a\) between the HADS\(^b\) and DCSQ\(^c\) indexes in the Hordaland Health Study

<table>
<thead>
<tr>
<th>DCSQ indexes</th>
<th>Men HADS-A</th>
<th>HADS-D</th>
<th>Women HADS-A</th>
<th>HADS-D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SRC(^a)</td>
<td>(R^2)</td>
<td>SRC</td>
<td>(R^2)</td>
</tr>
<tr>
<td></td>
<td>Crude</td>
<td>Adjusted(^d)</td>
<td>Crude</td>
<td>Adjusted(^d)</td>
</tr>
<tr>
<td>Psychological demands</td>
<td>0.22</td>
<td>0.22</td>
<td>0.23</td>
<td>0.05</td>
</tr>
<tr>
<td>Control</td>
<td>-0.14</td>
<td>-0.15</td>
<td>-0.11</td>
<td>0.02</td>
</tr>
<tr>
<td>Social support</td>
<td>-0.28</td>
<td>-0.21e</td>
<td>-0.20e</td>
<td>0.08</td>
</tr>
<tr>
<td>Strain(^f)</td>
<td>0.26</td>
<td>0.22e</td>
<td>0.20e</td>
<td>0.07</td>
</tr>
<tr>
<td>Iso-strain(^g)</td>
<td>0.30</td>
<td>0.28</td>
<td>0.09</td>
<td>0.29</td>
</tr>
</tbody>
</table>

\(^a\)Standardized regression coefficients (SRCs) and adjusted explained variances (\(R^2\)). \(^b\)P < 0.001 for all SRC values.
\(^c\)HADS: Hospital Anxiety and Depression Scale; HADS-A: anxiety score; HADS-D: depression score.
\(^d\)DCSQ: The Swedish Demand–Control–Support Questionnaire.
\(^e\)Adjusted 1: adjusted for other DCSQ sub-scales only (demands adjusted for control and support, control for demands and support, support for demands and control and strain for support). Adjusted 2: adjusted for both other DCSQ sub-scales and other possible confounders (see Materials and methods).
\(^f\)Below lower limit of 95% confidence interval for crude SRC after adjustment.
\(^g\)Strain: psychological demands divided by control score.
\(^h\)Iso-strain: strain divided by social support score.
the iso-strain hypothesis. Differences between the groups were largest for men (\(P < 0.01\) for the interaction terms ‘gender × job characteristics’ regarding anxiety and depression levels). Female groups with low support had significantly higher anxiety and depression levels compared with those with high support.

The predominant effect of support in women was examined further by repeating the analysis in the female

### Table 5. Job characteristics classified according to psychological demands and control\(^a\), and mean HADS\(^b\) scores (95\% confidence interval). The Hordaland Health Study

<table>
<thead>
<tr>
<th>Job types</th>
<th>Men</th>
<th></th>
<th>Women</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n (%))</td>
<td>HADS-A</td>
<td>HADS-D</td>
<td>(n (%))</td>
</tr>
<tr>
<td>High strain</td>
<td>241 (9.8)</td>
<td>5.95 (5.49–6.40)</td>
<td>5.03 (4.61–5.45)</td>
<td>472 (15.2)</td>
</tr>
<tr>
<td>Active</td>
<td>755 (30.7)</td>
<td>4.74 (4.52–4.95)</td>
<td>3.46 (3.26–3.66)</td>
<td>649 (20.9)</td>
</tr>
<tr>
<td>Passive</td>
<td>551 (22.4)</td>
<td>4.27 (4.01–4.52)</td>
<td>3.71 (3.47–3.95)</td>
<td>977 (31.5)</td>
</tr>
<tr>
<td>Low strain</td>
<td>916 (37.2)</td>
<td>3.59 (3.42–3.76)</td>
<td>2.77 (2.61–2.93)</td>
<td>1001 (32.3)</td>
</tr>
</tbody>
</table>

\(^a\)High and low demands/control scores: above or below median, respectively. ‘High strain’: high demands/low control; ‘active’: high demands/high control; ‘passive’: low demands/low control; ‘low strain’: low demands/high control.

\(^b\)Hospital Anxiety and Depression Scale; HADS-A: anxiety score; HADS-D: depression score.

**Figure 2.** Mean HADS\(^a\) scores according to psychological demands and control tertiles. 1, 2 and 3: high, intermediate and low control scores, respectively. S1, S2 and S3: low, intermediate and high demands scores, respectively. \(^a\)HADS: Hospital Anxiety and Depression Scale; HADS-A: anxiety score; HADS-D: depression score.
sample after dividing support into tertiles. The four groups with the least support had significantly higher HADS-A and -D scores than the other eight groups, while the four groups with the intermediate support levels generally had significantly higher HADS scores than the groups with the most support (data not presented). Thus, the results were not congruent with a buffering effect of support on strain.

The significance levels of the product ‘strain x support’ were estimated after dichotomizing strain and support, (1) by their medians and (2) by their 75th (strain)/25th (support) percentiles. No significant interactions were found.

Gender interacted significantly with demands, strain and iso-strain regarding both HADS-A and -D scores, thus the SRC values for these variables were significantly larger in men than in women.

When the associations between HADS scores and DCSQ indexes were adjusted for possible confounders, none of the SRC values changed significantly, neither when adjusting for the variables one by one, groups based on themes ('demographics', 'lifestyle', etc.), nor for the combination of all variables. However, when adjustment for all variables was combined with adjustment for other DCSQ sub-scales, SRC values for support and strain were generally reduced to below
the lower limit of the 95% CIs for crude SRCs (Table 4).

Discussion

Anxiety and depression levels increased linearly and considerably with increasing demands, strain and iso-strain scores and with decreasing control and support scores. Demands, control and support were each independently associated with anxiety and depression levels. Our results confirmed the strain and iso-strain hypotheses in both genders. There was a significant interaction between demands and control with regard to levels of depression in men, representing a synergistic and not a buffering effect. High strain and iso-strain as risk factors for anxiety and depression were strongest in men. Support was the index most strongly associated with anxiety and depression in women. None of the associations between HADS scores and the DCSQ indexes could be explained by the potential confounders examined.

The most important limitation of the study is its cross-sectional design. Nevertheless, the results consistently show that perceived adverse psychosocial work environment is a risk factor for anxiety and depression. The restricted age range may limit the generalizability of the findings. However, demands, control and support scores have been found to vary little with age [22,23].

The participation rate was moderate. Non-responders to surveys have been found to have a higher prevalence of mental disorders [24,25], and dropout of highly ‘stressed’ individuals is a considerable problem [26]. Thus, in the present study it is probable that anxious, depressed and highly ‘stressed’ individuals are under-represented. This would lead to an underestimation of the associations between negative affects and the DCSQ indexes.

All participants reporting to have worked at least 100 h in the preceding year were defined as workers and included. It may be argued that this number of hours is too low. However, only 37 (1.5%) of the men and 316 (10.2%) of the women worked less than 20 h a week.

The fact that participants select themselves out of high-strain occupations [2,15] may cause an underestimation of the risk associated with high strain.

Self-reports on demands, control and support may be biased towards the negative in individuals with poor psychological well-being, particularly the depressed, while workers with good mental health may under-report job stressors [3,27]. Thus, the associations between HADS and the DCSQ indexes may be overestimated, especially between depression and support, as the support items are oriented towards how the worker perceives the atmosphere at the work-place. The problem is also potentially significant with regard to demands, but is probably not important for control because of the high self-report–observer inter-reliability for the latter index [26]. However, studies not using self-report to assess work-place characteristics are generally non-supportive of the JDCS model, suggesting that the way in which the individual experiences work characteristics is crucial to their effects [1].

The exclusion of one of the control items in this study probably did not compromise the psychometric properties of the questionnaire [16].

The higher level of depression in men than in women in our study agrees with the findings from the large Norwegian population-based HUNT study, where the odds ratio for caseness of depression based on HADS was significantly higher in men [28].

The findings of increasing anxiety and depression levels with increasing demands and decreasing control and support are supported by both cross-sectional [6] and longitudinal studies [29–32]. Independent effects of demands, control and support, respectively, are congruent with the low correlation which has been found between the three sub-scales [16]. Also other studies have shown that support is the sub-scale most strongly associated with negative affects [6,33]. Some researchers have hypothesized that the associations between the DCSQ indexes and outcome variables are curvilinear [1,3]. This hypothesis was generally not confirmed by our findings.

The strain hypothesis has been confirmed in the majority of cross-sectional studies examining male or gender-mixed samples related to psychological well-being and distress, while the iso-strain hypothesis has been confirmed in only about half of such studies [1]. Two recent longitudinal studies have confirmed the strain hypothesis regarding depression [34,35].

A small proportion of the studies that have tested the JDCS model with psychological distress as outcome has shown significant (multiplicative) interactions and few of these, in turn, have demonstrated buffer effects [1,8]. This could be due to the tendency to overestimate the strengths of the associations when using self-report measures (most studies) at the cost of underestimating the interaction effects, as well as inadequate specification and operationalization of the psychosocial work environment indexes [36]. Although only one significant interaction was found in the present study, the other operationalizations of the interaction hypotheses showed rather strong associations between negative affects and adverse combinations of demands, control and support. Thus, when examining the interplay between DCSQ sub-scales, estimation of significance levels of multiplicative interaction terms should be complemented with the use of other operationalizations for gaining more detailed information about this interplay.
The use of composite indexes like strain and iso-strain to ‘operationalize’ the examination of possible interactions has been criticized because such indexes make it impossible to tell whether there is a (multiplicative) interaction or not [4]. Although, we agree with this criticism, our results suggest that the use of composite indexes, particularly iso-strain in men, may be a practical method to identify work associated with, and workers at risk for, anxiety and depression.

The stronger association between adverse psychosocial work environment and negative affects in men is congruent with most of the literature [1,15]. The findings indicate that men and women are differently affected by high-strain work, possibly because of a relatively stronger influence of the psychological load at home compared with at work in women [15]. However, some studies have found stronger associations between high job strain and depressive disorders in women compared with men [35, 37]. Nevertheless, these and other findings support the view that men and women should be examined separately [26].

The associations between HADS levels and the DCSQ indexes in HUSK could not be explained by socioeconomic status (income, education and/or occupation), which is in accordance with other studies [2, p. 42,38]. Another possible explanation of these associations is personality traits, which were not assessed in HUSK. However, in the longitudinal GAZEL study, the prediction of depressive symptom worsening by adverse psychosocial work conditions was independent of personality traits [32].

**Conclusion**

The HUSK study confirmed that high demands, low control and low support individually, but particularly combined, represent risk factors for anxiety and depression in the working population. When studying possible interactions between demands, control and support, the use of different operationalizations may give complementary information. Assessing psychosocial work environment by means of the JDCS model may serve to identify workers at risk for anxiety and depression, as well as basis for job redesigning. The latter may prevent new cases, and make it easier for anxious and depressed workers to stay at or return to work. Because no buffering effects of control (on demands) or support (on strain) were observed, it is important both to reduce demands and to increase control and support when called for. Nevertheless, the most important intervention in women is probably to increase social support. General practitioners should be aware of perceived adverse psychosocial work environment as a potential risk factor for anxiety and depression.

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**Conflicts of interest**

None declared.

**References**


