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VALIDITY TEST OF THE IPD-WORK CONSORTIUM APPROACH FOR CREATING COMPARABLE JOB STRAIN GROUPS BETWEEN JOB CONTENT QUESTIONNAIRE AND DEMAND-CONTROL QUESTIONNAIRE

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Abstract

Objectives: This study aims to test the validity of the IPD-Work Consortium approach for creating comparable job strain groups between the Job Content Questionnaire (JCQ) and the Demand-Control Questionnaire (DCQ). **Material and Methods:** A random population sample (N = 682) of all middle-aged Malmö males and females was given a questionnaire with the 14-item JCQ and 11-item DCQ for the job control and job demands. The JCQ job control and job demands scores were calculated in 3 different ways: using the 14-item JCQ standard scale formulas (method 1); dropping 3 job control items and using the 11-item JCQ standard scale formulas with additional scale weights (method 2); and the approach of the IPD Group (method 3), dropping 3 job control items, but using the simple 11-item summation-based scale formulas. The high job strain was defined as a combination of high demands and low control. **Results:** Between the 2 questionnaires, false negatives for the high job strain were much greater than false positives (37–49% vs. 7–13%). When the method 3 was applied, the sensitivity of the JCQ for the high job strain against the DCQ was lowest (0.51 vs. 0.60–0.63 when the methods 1 and 2 were applied), although the specificity was highest (0.93 vs. 0.87–0.89 when the methods 1 and 2 were applied). The prevalence of the high job strain with the JCQ (the method 3 was applied) was considerably lower (4–7%) than with the JCQ (the methods 1 and 2 were applied) and the DCQ. The number of congruent cases for the high job strain between the 2 questionnaires was smallest when the method 3 was applied. **Conclusions:** The IPD-Work Consortium approach showed 2 major weaknesses to be used for epidemiological studies on the high job strain and health outcomes as compared to the standard JCQ methods: the greater misclassification of the high job strain and lower prevalence of the high job strain.

Key words:
Epidemiological studies, Malmö, Sensitivity, Specificity, Scoring methods, Misclassification

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INTRODUCTION

The Job Content Questionnaire (JCQ) [1,2] and the Swedish version of the JCQ, called the Demand-Control Questionnaire (DCQ) [3], have been widely used in occupational epidemiological studies, particularly on the job strain and cardiovascular disease (CVD) [4–6]. Despite that the 2 questionnaires were built on the same work stress model, the Demand-Control Model [7,8], they are different in terms of the number of items, item wording, scale formula, and item response set [9] (Table 1).

Creating comparable exposure of the job strain groups (a combination of the job demands and job control: in a dichotomous definition of the job strain, the high job strain means the combination of the high job demands and low job control, and the low job strain means the other 3 possible combinations) between the JCQ and JCQ-like questionnaires (e.g., the DCQ) has been an important challenging methodological issue in work stress epidemiological studies [9]. Those differences between the JCQ and the DCQ have been pointed out as a barrier to drawing strong conclusions about the correlation between the high job strain and health outcomes in typical and individual-participant-data meta-analyses that use either the JCQ or the DCQ [4–6,10,11] and for calculating population attributable risks (PARs) of the high job strain for health outcomes, including the CVD [12–16].

Only 1 study [9] has examined the comparability of the job strain groups between the JCQ and the DCQ using the data set available from the random Swedish (Malmö) population survey that included the 2 questionnaire items for the job control and job demands. In the study, Karasek et al. [9] developed and tested a 4-step comparability–facilitating algorithm and a regression equation based on the information from the population sample in order to convert the DCQ scale scores into the most equivalent JCQ scale scores. In the study [9], the sensitivity to the high job strain improved to some extent when the high job strain group was defined based on the tertiles or quartiles of the job control and job demand scores without the group of workers around the medians of the job control and job demand scores that are the most vulnerable to misclassification of the high job strain [9]. Thus Karasek et al. [9] recommended using the tertile- or quartile-based job strain definitions for increasing the reconciliation levels of the job strain groups between the JCQ and the DCQ, in particular when greater sensitivities to the high job strain between the 2 questionnaires are needed in epidemiological studies.

Recently the European individual-participant-data (IPD) meta-analysis of working populations Consortium (called hereafter the IPD-Work Consortium) [10] has developed another approach for creating comparable job strain groups between the 2 questionnaires as a part of the harmonization process of the job strain measures across the 17 cohort data sets used in the IPD-Work Consortium studies:

1. They dropped 3 job control items ("variety," "develop own abilities," and "allow for own decisions") from some of their cohort data (e.g., data from the Belstress study (Belgian job stress study) [17] and the GAZEL Cohort Study (GAZ and ELectricité) [18]), in which the job control had been assessed with the standard 9 JCQ control items (Table 1) in order to make the same number of items for the job control as in the DCQ.
2. They used simple summation-based scale scoring formulas rather than the standard JCQ scale scoring formulas for calculating the JCQ scale scores as they did for calculating the DCQ scale scores.
3. They defined the high job strain based only on the medians of the job control and job demand scores.

The IPD-Work Consortium approach has been assumed by the IPD-Work Consortium to be free of major errors in their recent meta-analyses about the high job strain and several health outcomes such as coronary heart disease, obesity, cancer, and health-related behaviors [14,19–22]. However, the validity of the aforementioned IPD-Work Consortium approach has never been

Table 1. The comparison of the Job Content Questionnaire (JCQ) and the Demand-Control Questionnaire (DCQ) in terms of the number of items, item wording, scale formula, and item response set

Category	Scale	Subscale	JCQ (14 items)	DCQ (11 items)
Item wording	job control	skill discretion	JQ1: "learn new things" JQ2: "repetitive work" JQ3: "require creative" JQ4: "high skill level" JQ5: "variety" JQ6: "develop own abilities"	DQ1: "learn new things" DQ2: "repetitive work" DQ3: "require creative" DQ4: "high skill level"
		decision authority	JQ7: "allow own decisions" JQ8: "little decision freedom" (decide how to do my work) JQ9: "lot of say"	DQ5: "decide on how you do your work" DQ6: "decide on what you do in your work"
	job demands		JQ10: "work very fast" JQ11: "work very hard" JQ12: "no excessive work" JQ13: "enough time" JQ14: "conflicting demands"	DQ7: "work very fast" DQ8: "work very hard" DQ9: "too much demand" DQ10: "enough time" DQ11: "conflicting demands"
Response set			strongly disagree (1), disagree (2), agree (3), and strongly agree (4)	never (1), seldom (2), sometimes (3), and often (4)
Scale formula	job control		= skill discretion [JQ1 + (5 – JQ2) + JQ3 + JQ4 + JQ5 + JQ6] × 2 + decision authority [JQ7 + (5 – JQ8) + Q9] × 4	= DQ1 + (5 – DQ2) + DQ3 + DQ4 + DQ5 + DQ6
	job demands		(JQ10 + JQ11) × 3 + [15 – (JQ12 + JQ13 + JQ14)] × 2	= DQ7 + DQ8 + [15 – (DQ9 + DQ10 + DQ11)]

JQ – Job Content Questionnaire; DQ – Demand-Control Questionnaire.

tested with an appropriate data set in comparison to the standard JCQ scale scoring methods. In addition, there has been a strong on-going debate between the IPD lead researchers and other researchers on the validity of the interpretations and conclusions in the publications based on the harmonization process of the job strain measures across the 17 European cohort data by the IPD-Work Consortium [11,13,23–32]. Nonetheless, the methodological validity of the aforementioned IPD-Work Consortium approach has been rarely questioned [13].

The objective of this study is to investigate the validity of the IPD-Work Consortium approach for creating comparable job strain groups between the JCQ and the DCQ in comparison to the standard JCQ scale scoring methods, using the same Swedish (Malmö) data as in the previous study by Karasek et al. [9].

MATERIAL AND METHODS

A Malmö (Sweden) data set

In order to create the comparable scale scores of the job control and job demands between the JCQ and the DCQ, a separate study was undertaken in 1997 by the Malmö Center of the Job Stress, Absenteeism and Coronary Heart Disease European Cooperative Study (JACE study) [33]. A random population sample of all Malmö (Sweden) males and females (N = 682) aged 52–58 years was given a new test questionnaire, which included both the DCQ questions and the JCQ questions for the job control and job demands (the response rate of the survey = 85%) in 1997 [9].

The 14 JCQ and 11 DCQ questions for job control and job demands

The 14-item JCQ and the 11-item DCQ for the job control (skill discretion and decision authority) and (psychological) job demands (Table 1) were included in the above Malmö survey questionnaire. Six hundred fifty-one out of the 682 survey participants responded to all of the JCQ and DCQ items (31 participants did not respond to at least 1 of the 25 items). Only the responses of the 651 survey participants were used for analyses in this study.

Three different scoring methods for the JCQ job control and job demands scales

In this study, we used 3 different scoring methods for the JCQ job control and job demands scales. The 1st method (method 1, Table 2) was using the current standard JCQ scale formulas for the job control and job demands with the full set of the 14 JCQ items (9 – for the job control items and 5 – for the job demands items). The 2nd method (method 2) was also using the standard JCQ scale formulas for the job control and job demands, but with the partial set of the 11-item JCQ (6 job control items and 5 job demands items). However, in this method, some adjusting scale weights were applied to the standard scale formulas in order to compensate for the reduced number of the job control items (JQ5, JQ6, and JQ9 were dropped, Table 1). In fact, this was a part (step III) of the 4-step comparability-facilitating algorithms introduced in the paper by Karasek et al. [9].

The 3rd method (method 3) was the approach of the IPD-Work Consortium [10], that is, using the simple summation-based scale formulas for the job control and job demands with the partial set of the 11 JCQ items (6 for the job control items and 5 for the job demand items). The IPD-Work Consortium further averaged the summated scale scores based on the number of items for each of the job control and job demands. However, since the additional averaging procedure (i.e., dividing the summated scale scores for the job control and job demands by 6 and 5, respectively) does not affect the correlations of the scale scores and the job strain prevalence with the scale scores, we used the summation-based scale scores for simplicity of analyses and comparisons in the current study.

Table 2. The 3 different scoring methods for the JCQ job control and job demands scales for the comparison with the DCQ scores

Scale	Method 1 (14 items)	Method 2 (11 items)	Method 3 (11 items)
Job control	= skill discretion [JQ1 + (5 – JQ2) + JQ3 + JQ4 + JQ5 + JQ6] × 2 + decision authority [JQ7 + (5 – JQ8 + JQ9) × 4]	= skill discretion [JQ1 + (5 – JQ2) + JQ3 + JQ4] × 2 × 1.5 + decision authority [JQ7 + (5 – JQ8)] × 4 × 1.5	= skill discretion [JQ1 + (5 – JQ2) + JQ3 + JQ4] + decision authority [JQ7 + (5 – JQ8)]
Job demands	= (JQ10 + JQ11) × 3 + [15 – (JQ12 + JQ13 + JQ14)] × 2	= (JQ10 + JQ11) × 3 + [15 – (JQ12 + JQ13 + JQ14)] × 2	= (JQ10 + JQ11) + [15 – (JQ12 + JQ13 + JQ14)]

Abbreviations as in Table 1.

One scoring method for the DCQ job control and job demand scales

The scores of the DCQ job control (6 items) and job demand scales (5 items) were created based on the current standard DCQ scale formulas (Table 2).

Definition of 2 job strain groups

For a consistent comparison with the methodological paper by the IPD-Work Consortium [10], the high job strain group was defined in the current study as the one having the job control scores below the median of the job control scores and having the job demand scores above the median of the job demand scores. Those who had the other 3 possible combinations of the job control and job demands (the low job control and low job demands; the high job control and high job demands; and the high job control and low job demands) were defined as the low job strain group.

Statistical analyses

At first, Spearman correlations between the job control and job demands scores from the JCQ and the DCQ were calculated and compared. The prevalence of the high job strain group with the JCQ, the DCQ, or both was then examined. Lastly the reconciliation of the job strain groups (the high and low job strain groups) between the JCQ and the DCQ was examined using several reconciliation statistical indices (specificity, sensitivity, and kappa). The sensitivity and specificity of the JCQ for the job strain against the DCQ were calculated under the assumption that the DCQ was the reference in consideration of the changing JCQ scores by the 3 different scale scoring methods and the constant DCQ scores in the current study. To evaluate the kappa statistics, we followed the conventional guide suggested by Landis and Koch [34]: ≤ 0 = poor, 0.01–0.20 = slight, 0.21–0.40 = fair, 0.41–0.60 = moderate, 0.61–0.80 = substantial and 0.81–1.00 = almost perfect. All of the above analyses were conducted by the 3 different JCQ scale scoring methods for comparisons.

RESULTS

Correlations between job control and job demands from the JCQ and the DCQ

The JCQ job control and job demands scores with 3 different scoring methods were highly correlated with each other (Table 3): ≥ 0.96 for the job control and ≥ 0.99 for the job demands. There was little difference in the correlation between the JCQ and DCQ control scores by the JCQ scoring methods: 0.74–0.75. The correlation between the JCQ and DCQ demand scores was 0.71 regardless of the JCQ scoring methods. The medians of the job control scores with the JCQ or the DCQ were all different from one another (Table 3). The median of the job control scores with the JCQ (the method 3 was applied) was lower than that with the DCQ. The medians of the job demand scores with the JCQ were identical when the method 1 and method 2 were applied. The median of the job demand scores with the JCQ (the method 3 was applied) was higher than that with the DCQ.

Table 3. Spearman correlations of the job control and job demand scores with the JCQ (based on 3 different scoring methods) and the DCQ in a Swedish (Malmö) population sample (N = 651)

Scale	Score Me (range)	Spearman correlations					
		1	2	3	5	6	7
Job control							
DCQ job control	19 (6–24)	1.00	–	–			
JCQ job control (method 1)	74 (24–96)	0.74	1.00	–			
JCQ job control (method 2)	72 (24–96)	0.74	0.98	1.00			
JCQ job control (method 3)	18 (6–24)	0.75	0.96	0.98			
Job demands							
DCQ job demands	13 (5–20)				1.00	–	–
JCQ job demands (method 1)	33 (12–48)				0.71	1.00	–
JCQ job demands (method 2)	33 (12–48)				0.71	1.00	1.00
JCQ job demands (method 3)	14 (5–20)				0.71	0.99	0.99

Method 1 – using the JCQ standard scale formulas for the 14 items (9 control and 5 demands items).
Method 2 – dropping 3 job control items and using the JCQ standard scale formulas with additional scale weights for the 11 items (6 control and 5 demands items).
Method 3 – the approach of the IPD-Work Consortium Group, dropping 3 job control items, but using simple summation-based scale formulas for the 11 items (6 control and 5 demands items).
Me – median. Other abbreviations as in Table 1.

Prevalence of high job strain group

The prevalence of the high job strain with the DCQ was 19.2% (Table 4). The prevalence of the high job strain with the JCQ varied by the scale scoring method: 22.6%, 20.6%, and 15.2% for the methods 1 to 3, respectively (Table 4). The biggest difference in the prevalence of the high job strain between the JCQ and the DCQ was observed when the IPD-Work Consortium approach (the method 3) was applied, while the smallest difference was observed when the method 2 was applied. The number of congruent cases for the high job strain between the JCQ and the DCQ was 79 out of 651 (12.1%, the method 1 was

Table 4. The reconciliation of job strain groups between the JCQ (based on 3 different scoring methods) and the DCQ in a Swedish (Malmö) population sample (N = 651)

Reconciliation indice	High job strain		
	DCQ-JCQ (method 1)	DCQ-JCQ (method 2)	DCQ-JCQ (method 3)
High job strain prevalence (%)			
with the JCQ	22.6	20.6	15.2
with the DCQ	19.2	19.2	19.2
with both the JCQ and the DCQ	12.1	11.5	9.8
Sensitivity[a]	0.632	0.600	0.512
Specificity[a]	0.871	0.888	0.933
Kappa	0.471	0.475	0.484

[a] The reference questionnaire was the DCQ.
Method 1, 2, 3 – as in Table 3.
Abbreviations as in Table 1.

applied) and followed by 75 (11.5%, the method 2 was applied) and 64 (9.8%, the method 3 was applied) (Table 5).

Table 5. A 2×2 contingency table for job strain groups between the JCQ (based on 3 different scoring methods) and the DCQ in a Swedish (Malmö) population sample (N = 651)

JCQ	DCQ	
	low job strain (N = 526)	high job strain (N = 125)
Method 1		
low job strain	458	46
high job strain	68	79
Method 2		
low job strain	467	50
high job strain	59	75
Method 3		
low job strain	491	61
high job strain	35	64

Abbreviations as in Table 1 and 3.

Sensitivity and specificity to high job strain

There was a noticeable difference in the sensitivity of the JCQ to the high job strain against the DCQ between the 3 different JCQ scale scoring methods. The sensitivity was highest (0.631) when the method 1 was applied and it was lowest (0.512) when the method 3 was applied (Table 4). The difference in the specificities for the high job strain between the 3 JCQ scoring methods were less than that in the case of sensitivities. The specificity of the JCQ for the job strain against the DCQ was highest (0.933) when the method 3 was applied and it was lowest (0.871) when the method 1 was applied. The kappa values for the job strain groups between the 2 questionnaires were very similar: 0.47–0.48 (moderate).

DISCUSSION AND CONCLUSIONS

In this study, we compared the approach of the IPD-Work Consortium (the method 3) and the standard JCQ scale scoring methods (the methods 1 and 2) for creating comparable job strain groups between the JCQ and the DCQ using the unique data set including the information on both the 14-item JCQ and 11-item DCQ for the job control and job demands from a random middle-aged Swedish (Malmö) population sample. Although the reconciliation levels of the job strain groups (the high and low job strain groups) between the 2 questionnaires were very similar (kappas: 0.47–0.48), we observed 2 major weaknesses of the IPD-Work Consortium approach, as compared to the standard JCQ scale scoring methods. Firstly, the IPD-Work Consortium approach missed a much larger portion (49% vs. 37–40%) of the high job strain cases defined with the DCQ. And the number of the congruent cases for the high job strain between the JCQ and the DCQ was smallest (65 vs. 75–79) when the IPD-Work Consortium approach was applied. Secondly, the IPD-Work Consortium approach significantly underestimated the prevalence of the high job strain as compared to the standard JCQ scale scoring methods as well as the DCQ: 5–7% and 4%, respectively.

Implications for epidemiological studies

We would like to discuss here several important implications of the 2 weaknesses of the IPD-Work Consortium approach for epidemiological studies on the high job strain and health outcomes. Researchers [9] have been more interested in finding out more sensitive methods for the high job strain between the 2 questionnaires, given the much greater false negatives for the high job strain than the false positives for the high job strain between the 2 questionnaires. In the current study, false negatives for the high job strain with the JCQ against the DCQ were much greater than false positives: 37–49% vs. 7–13%, respectively. This is generally in line with the results of the previous study with the DCQ against the JCQ [9] (35–39% for false negatives and 12–14% for false positives with the DCQ against the JCQ using the medians of the job control and job demands scores).

The highest false negatives for the job strain with the JCQ (the method 3 was applied in the current study), along with the fewest congruent job strain cases between the 2 questionnaires, is a considerable disadvantage of the IPD-Work Consortium approach, as compared to the standard JCQ scale scoring methods, when researchers seek a more sensitive method for detecting as many cases for the high job strain defined with the DCQ or as many congruent cases for the high job strain between the JCQ and the DCQ as possible, given the well-known associations between the high job strain and several health outcomes, including the CVD and common mental disorders among working populations [5,35–38].

It is also noteworthy that the likelihood of misclassification of the high and low job strain groups between the JCQ and the DCQ was differential in the current study and the previous study [9]. That is, the higher likelihood of misclassification for the high job strain group than for the low job strain group. It implies that the results of the meta-analyses using the job strain data with either the JCQ or the DCQ as in the meta-analyses using the European cohort data by the IPD-Work Consortium are likely to underestimate the correlation between the high job strain and health outcomes due to the differential misclassification of the job strain exposure. This study indicates that using the method 3 rather than the standard JCQ scale scoring methods could further increase the differential misclassification of the job strain exposure (i.e., greater misclassification of the high job strain). This type of underestimation of the correlation between the high job strain and health outcomes has never been discussed explicitly in the publications [14,19–22] by the IPD-Work Consortium, and also in the on-going debate between the IPD-Work Consortium and other researchers acting in the capacity as work stress research field researchers.

The underestimated prevalence of the high job strain is another serious disadvantage of the IPD-Work Consortium approach in comparison to the standard JCQ scale scoring methods. It is very important to obtain accurate information on the prevalence of the high job strain when the main research goal is to estimate the population attributable risks (PARs) of the high job strain for health outcomes accurately [12,15,16]. If the prevalence of the high job strain is underestimated, its PAR for the health outcome will be also underestimated, given the same effect size of the correlation between the high job strain and the health outcome. As a result, worksite policy makers as well as researchers and practitioners are likely misled in thinking that worksite intervention efforts for addressing adverse psychosocial working conditions, including the high job strain, are not so important for improving the health of working populations.

There has been a strong debate between the IPD-Work Consortium and other researchers on whether the prevalence of the high job strain (15%) and its PAR of the high job strain for coronary heart disease (3.4%) reported in the "Lancet" paper by the IPD-Work Consortium [14] were underestimated or not, and whether the interpretation of the "Lancet" paper by the IPD-Work Consortium ("prevention of workplace stress might decrease disease incidence; however, this strategy would have a much smaller effect than tackling standard risk factors, such as smoking, would") is appropriate or not [11,13,23,27,28,39]. In fact, the prevalence of the high job strain in the IPD-Work Consortium European cohort data was much lower than the prevalence of the high job strain in the 2005 European Working Conditions Survey: 23.9% and 26.9% from 7 European countries (Belgium, Denmark, France, Finland, the Netherlands, Sweden and the United Kingdom), which the IPD-Work Consortium cohort data in the "Lancet" paper came from, and all 31 European countries, respectively [15,16]. In addition, the estimated PAR of the high job strain for coronary heart disease in the "Lancet" paper was significantly lower in comparison to the previous study based on a French national representative sample: 6.5–25.5% [40].

In the debate, several methodological issues have been raised and discussed as sources of a possible underestimation of the prevalence of the high job strain and its PARs for health outcomes by the IPD-Work Consortium, for example, the underrepresentation of low socioeconomic status groups in the IPD-Work Consortium cohort data [13,23,41], neglecting a possibly higher occurrence rate of the job strain group in non-responses to a cross-sectional survey [23,42,43] or a follow-up survey [17,25], and the inclusion of some cohort data having unqualified job strain measures into the meta-analyses by the IPD-Work Consortium [23,29,44]. This study implies that the IPD-Work Consortium approach (the method 3 applied in this study) for creating comparable job strain groups between the JCQ and the DCQ may be another source of a possible underestimation of the prevalence of the high job strain, the correlation between the high job strain and health outcomes, and its PARs of health outcomes in the recent meta-analyses by the IPD-Work Consortium.

Possible causes of the 2 weaknesses

Interestingly enough, despite the same number of the JCQ items for the job control and job demands (11 items) between the method 2 and method 3, the lowest sensitivity to and the prevalence of the high job strain with the JCQ was observed only when the method 3 was applied. Whether or not to follow the JCQ standard scale scoring methods including unique differential weights for subscales or items of the JCQ job control and job demands seems critical in creating comparable high job strain groups based on the medians of the job control and job demand scores between the JCQ and the DCQ. The standard JCQ scale scoring method for the job control items is designed to equally balance the 2 components of the job control (skill discretion and decision authority scores), while the JCQ scoring method (the method 3) and the standard DCQ scoring method for the job control intrinsically gives greater weight to skill discretion scores over the decision authority scores.

Karasek et al. [9] reported a noticeable difference in the response distributions of the 2 items of the skill discretion between the 2 questionnaires (JQ2 and JQ4 in the JCQ; and DQ2 and DQ4 in the DCQ) in the Swedish (Malmö) population sample. That is why Karasek et al. [9] tried to align the different response distributions of the items by introducing an adjustment factor of 0.5 (i.e., JQ2 = DQ2–0.5 and JQ4 = DQ4–0.5) in the step I of the 4-step comparability-facilitating algorithm. Thus, we think that the standard scale scoring methods for the JCQ job control items would be less influenced by the 2 skill discretion items than the IPD-Work Consortium approach. Also, we think that the median of the job control scores of the JCQ (the method 3 based on the summation scoring method) could be lower than that with the DCQ. In fact, the median of the job control scores with the JCQ was less than the one with the DCQ. In a similar way, the standard JCQ scale scoring method for the job demands is designed to equally balance the 2 sub-components of the job demands (J10–J11 and J12–J14) [45,46] so the 1st component (J10–J11) is given relatively more weight than the 2nd component (J12–J14), while the standard DCQ scoring method for job demands lacks such a balancing procedure. Karasek et al. [9] reported a notable difference in the response distributions of 1 item of psychological job demands (JQ12 in the JCQ; and DQ9 in the DCQ) between the 2 questionnaires in the Swedish (Malmö) population sample. We think that the standard scale scoring methods for the JCQ job demands items would be less influenced by the job demand item than the IPD-Work Consortium approach.

Recommendations for epidemiological studies

In conclusion, due to the aforementioned 2 major weaknesses and their implications for epidemiological studies on the high strain and health outcomes, we do not recommend the IPD-Work Consortium approach (the method 3 applied in this study) for creating comparable high

job strain groups between the JCQ and the DCQ. If researchers want to use the median-based job strain definition, we think using the standard JCQ scale scoring methods (the method 1 and method 2 applied in this study) is better than the IPD-Work Consortium approach. If researchers are interested in more sensitive methods for creating comparable high job strain groups between the 2 questionnaires, we continuously recommend the tertile- or quartile-based job strain definitions because their greater sensitivities than the median-based job strain definition were demonstrated [9], providing for no significant changes in specificities. The quartile-based job strain definition was also more strongly correlated with leisure-time physical activity than the median-based job strain definition [47].

We think that the recent meta-analyses on the high job strain and health outcomes by the IPD-Work Consortium [14,19–22], that have been based on the method 3 in this study need to be carefully reviewed because of possible underestimation of the prevalence of the high job strain, the correlation between the high job strain and health outcomes, and its PARs of health outcomes. In addition, due to the aforementioned differential exposure misclassification between the JCQ and the DCQ, it would be desirable for researchers to examine whether their meta-analysis findings about the high job strain and health outcomes, using a pooled database with either the JCQ or the DCQ, differ by the specific instrument for the job strain as Szerencsi et al. [6] did in their recent meta-analysis on the high job strain and the CVD.

This study was based on the data set from a middle-aged Swedish random population sample. Thus for the generalization of the findings of this study, more future studies in different populations are needed. However, to the best of our knowledge, as of now, the Swedish data set used for the purpose of this study is the only and largest one including the information on both the JCQ and the DCQ items for the job control and job demands from the same group of people in a survey. On the other hand, none of health outcome variables was available in the Swedish data set used for the purpose of this current study. If we can have access to health outcomes and link them to the existing Swedish data set in the future, we will be able to further test whether the correlation between the high job strain and health outcomes vary substantially by the measure of the job strain (the JCQ or the DCQ) and the scoring method of the JCQ control and demands scales (3 different methods applied in this study).

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