Yara Hahr Marques Hökerberg[I]

Michael Eduardo Reichenheim[II]

Eduardo Faerstein[II]

Sonia Regina Lambert Passos[I]

Johan Fritzell[III,IV]

Susanna Toivanen[III]

Hugo Westerlund[V]

Cross-cultural validity of the demand-control questionnaire: Swedish and Brazilian workers

Validade transcultural da escala demanda-controle: trabalhadores suecos e brasileiros

[I] Laboratório de Epidemiologia Clínica. Instituto Nacional de Infectologia Evandro Chagas. Fundação Oswaldo Cruz. Rio de Janeiro, RJ, Brasil

[II] Departamento de Epidemiologia. Instituto de Medicina Social. Universidade do Estado do Rio de Janeiro. Rio de Janeiro, RJ, Brasil

[III] Centre for Health Equity Studies. Stockholm University. Karolinska Institute. Stockholm, Sweden

[IV] Aging Research Center. Karolinska Institute. Stockholm University. Stockholm, Sweden

[V] Stress Research Institute. Stockholm University. Stockholm, Sweden

Correspondence:
Yara Hahr Marques Hökerberg
Laboratório de Epidemiologia Clínica
Instituto Nacional de Infectologia
Fundação Oswaldo Cruz
Av. Brasil, 4036 sala 201-A Manguinhos
21040-361 Rio de Janeiro, RJ, Brasil
E-mail: yarahahr@ipec.fiocruz.br

Received: 9/6/2013
Approved: 4/9/2014

Article available from: www.scielo.br/rsp

ABSTRACT

OBJECTIVE: To evaluate the cross-cultural validity of the Demand-Control Questionnaire, comparing the original Swedish questionnaire with the Brazilian version.

METHODS: We compared data from 362 Swedish and 399 Brazilian health workers. Confirmatory and exploratory factor analyses were performed to test structural validity, using the robust weighted least squares mean and variance-adjusted (WLSMV) estimator. Construct validity, using hypotheses testing, was evaluated through the inspection of the mean score distribution of the scale dimensions according to sociodemographic and social support at work variables.

RESULTS: The confirmatory and exploratory factor analyses supported the instrument in three dimensions (for Swedish and Brazilians): psychological demands, skill discretion and decision authority. The best-fit model was achieved by including an error correlation between work fast and work intensely (psychological demands) and removing the item repetitive work (skill discretion). Hypotheses testing showed that workers with university degree had higher scores on skill discretion and decision authority and those with high levels of Social Support at Work had lower scores on psychological demands and higher scores on decision authority.

CONCLUSIONS: The results supported the equivalent dimensional structures across the two culturally different work contexts. Skill discretion and decision authority formed two distinct dimensions and the item repetitive work should be removed.

DESCRIPTORS: Questionnaires. Working Conditions. Stress, Psychological. Cross-Cultural Comparison. Validation Studies. Factor analysis, Statistical.

RESUMO

OBJETIVO: Avaliar a validade transcultural da escala demanda-controle, comparando o questionário original sueco com a versão brasileira.

MÉTODOS: Foram comparados os dados de trabalhadores de saúde, 362 suecos e 399 brasileiros. Foram utilizadas análise fatorial confirmatória e exploratória para avaliar a validade estrutural, usando o estimador robusto de mínimos quadrados ponderados ajustados para média e variância (WLSMV). A validade de construto via teste de hipóteses foi avaliada pela inspeção da distribuição dos escores médios das dimensões da escala segundo as características sociodemográficas e níveis de apoio social no trabalho.

RESULTADOS: A análise fatorial confirmatória e exploratória corroborou o instrumento em três dimensões (suecos e brasileiros): demandas psicológicas, uso de habilidades e autonomia para decisão. O modelo de melhor ajuste foi obtido após incluir uma correlação de resíduos entre os itens trabalho rápido e trabalho intenso (demandas psicológicas) e remover o item trabalho repetitivo (uso de habilidades). O teste de hipóteses mostrou que trabalhadores com nível universitário apresentaram maiores escores em uso de habilidades e autonomia para decisão e aqueles com grau elevado de apoio social no trabalho obtiveram escores menores em demandas psicológicas e maiores em autonomia para decisão.

CONCLUSÕES: Os resultados confirmaram a equivalência da estrutura dimensional em dois contextos laborais culturalmente diferentes. Uso de habilidades e autonomia para decisão formaram duas dimensões distintas e o item trabalho repetitivo deveria ser removido da escala.

DESCRITORES: Questionários. Condições de Trabalho. Estresse Psicológico. Comparação Transcultural. Estudos de Validação. Análise Fatorial.

INTRODUCTION

The demand-control model states that workers exposed to high levels of job strain – a combination of high psychological demands and low job decision latitude – have an increased risk of ill health compared to those exposed to low job strain.[16] Social support at work was added later as a dimension that would potentially buffer the effect of high strain on stress-related illness.[13] The model has been tested mostly in relation to cardiovascular diseases and related risk factors.[3,32]

The Job Content Questionnaire (JCQ) is a 49-item instrument, originally proposed to measure job strain dimensions.[14] Abridged versions were proposed for multidimensional studies, such as the Swedish demand-control-support and the Whitehall Job Characteristics questionnaires.[19] The demand-control-support questionnaire (DCSQ) includes 17 items grouped into three main dimensions: psychological demands (work fast, work intensely, work effort, enough time, and conflicting demands), decision latitude – subdivided into skill discretion (learning new things, skill level, take initiative, repetitive work) and decision authority

(how to do the work and what to do at work) – and social support at work (pleasant atmosphere, relationships at work, coworkers' support, helpful coworkers, relationship with supervisors and friendly workers). According to the psychometric literature, dimension represents the latent variable (not observed), which summarizes the original set of observed variables (e.g., items).[4,11,30]

Validation studies have been conducted using different versions of the JCQ;[2,5,6,17,20,25,26,28] five studies using the DCSQ were identified:[10,12,22,27,31] one was restricted to an internal consistency analysis[31] and four evaluated dimensional validity using factor analysis.[10,12,22,27]

Mase et al[22] (2012) evaluated the Japanese version of DCSQ applied to 212 workers from 19 day nurseries and nursery schools. The exploratory factor analysis showed a three-factor solution, which did not corroborate the hypothesized theoretical model since psychological demands and skill discretion were combined to form a single dimension. Sanne et al[27] (2005) conducted an exploratory factor analysis on data obtained from Norwegian workers and found a three-factor solution,

namely, psychological demands, decision latitude, and social support at work. The authors found that for white-collar men and blue-collar women, decision latitude was split into skill discretion and decision authority in a four-factor solution.

The best fit model of a Brazilian version of DCSQ[12] assessed through confirmatory factor analysis (CFA) was achieved when psychological demands, skill discretion and decision authority were considered in a three-factor solution, after the exclusion of social support at work. Moreover, a correlated error measurement between the items *work fast* and *work intensely* (psychological demands) was observed and the item *repetitive work* evidenced low and non-statistical significant loadings on all dimensions. Another Brazilian study[10] also found correlated residuals (measurement errors) when fitting a one-dimensional confirmatory model on psychological demands. Unfortunately, the second order solution modeled for decision latitude could not be estimated.

Consistently with the DCSQ findings,[12,27] some JCQ studies concluded that Decision Latitude should be better operationalized as two separate dimensions.[17,26,28] Thus, using decision latitude score as a whole, when combined with demands for the Karasek's quadrant terms, may be unable to distinguish risk factors and outcomes related to each (sub) dimension. Additionally, *repetitive work* has consistently appeared as the most troublesome item.[5,14,20,26]

According to the Consensus-based standards for the selection of health status measurement instruments – the COSMIN checklist –, cross-cultural validity should be assessed in addition to structural validity and hypotheses testing as part of the construct validity domain.[23] CFA is one of the recommended statistical techniques to evaluate how equivalent the performance of items and dimensions are, in both the original and culturally adapted version of the instrument.[23] However, rarely, the DCSQ studies applied the CFA approach to a heterogeneous sample, which enables to evaluate correlated items and factorial convergent and discriminant validity – crucial information to allow scale improvements.

Thus, the purpose of this study is to further explore the DCSQ cross-cultural validity using the CFA approach in two culturally distinct contexts: Sweden, a high income country where the questionnaire was originally developed; and Brazil, a middle income country where work opportunities and job related social policies and rights are more unevenly distributed.

METHODS

Health workers were considered for this study because they represent a relatively high status occupational class, albeit with some internal sociocultural heterogeneity. Brazilian and Swedish databases covering the same time period, of similar sample size and including relevant variables for the present analysis were available.

Brazilian data (BR) originated from a cross-sectional multidimensional study (2004-2005) investigating all workers in a public health research institute in Rio de Janeiro city, Southeastern Brazil. Of 497 estimated active workers, 424 agreed to participate and 399 (80.3%) completed the self-administered DCSQ at the workplace. Workers less than 18 years of age, and those either on a leave of absence or retired, or who had worked for less than two years, were excluded.

Swedish data (SW) were drawn from the Swedish Longitudinal Occupational Survey of Health (SLOSH), a nationally representative cohort of the Swedish working population, in a follow-up of the Swedish Work Environment Survey, conducted by Statistic Sweden in 2003. For the present study, we analyzed data from the first follow-up wave carried out in 2006. The self-administered questionnaires were sent to the participants by mail. We selected workers with occupational characteristics similar to those of the Brazilian sample and included workers from specialized health centers, general hospitals, laboratories, ambulance crews, and veterinary staff. Of the 391 health workers who were followed up in 2006, 362 (92.6%) completed the DCSQ.

The cross-cultural adaptation process of the DCSQ Brazilian version was described elsewhere.[1] Briefly, conceptual, item, semantic and operational equivalences were evaluated. Measurement equivalence was restricted to test-retest reliability and internal consistency.

DCSQ dimension scores were calculated by summing up the unweighted item scores by dimension; for psychological demands scores ranged from five to 20, and for decision latitude scores ranged from six to 24. The four-point response options varied from "often" (four points) to "never/almost never" (one point).

Social Support at Work consists of six items answerable by a four-point-Likert scale ranging from "strongly agree" to "strongly disagree" (scoring from six to 24). This dimension is applied to respondents as part of the DCSQ, but is hypothesized to buffer the association between job strain and stress-related disorders.[13]

Sociodemographic characteristics included age, sex and education level (< high school, high school and university degree). Job titles were evaluated according to the major groups of the International Standard Classification of Occupations (ISCO, 1988) and grouped as white-collar (major ISCO groups one to four) and blue-collar workers (major ISCO groups five to nine).

Factor analysis was carried out using Mplus software, version 6, which provides the robust weighted least squares mean and variance-adjusted (WLSMV) estimator,

which is suitable for categorical indicators.[24] In agreement with the theoretical model[13,16] and previous study results,[12] we excluded the Social Support at Work dimension from factor analysis of the DCSQ (to be referred to as DCQ hereafter). Since the DCQ is comprised of 11 four-level ordinal items, polychoric correlation matrices were used.[7]

First, CFA was performed on each sample to corroborate the factor structure proposed by the original demand-control model. Basically, two models were tested: Model 1 predicted the existence of two correlated latent factors representing psychological demands and decision latitude; Model 2 consisted of three correlated latent factors (due to the subdivision of decision latitude in two factors): psychological demands, skill discretion and decision authority. We evaluated the magnitude of the factor loadings, item residuals (or uniqueness), i.e., the portion of an indicator not explained by the latent factor, and factor correlations.[4]

Modification indices were evaluated to inspect potential item cross loadings and item residual (error) correlations. Possible item cross loadings and correlations between item measurement errors involving modification indices values equal to or greater than 10 would be further examined, as well as the magnitude of the corresponding expected parameter changes for freely estimated parameters.[4]

Goodness of fit was evaluated using three indices. The root mean square error of approximation (RMSEA) incorporates a penalty function for poor model parsimony, accounting for sample size vis-à-vis the number of estimated parameters. Values under 0.06 suggest an approximate (good) fit, whereas values above 0.10 indicate a poor fit and that the model should be rejected.[4] The Comparative Fit Index (CFI) and the Tucker-Lewis index (TLI) represent incremental fit indices contrasting the hypothesized model to a more restricted nested baseline model, the "null model". Both range from zero to one, with values > 0.9 considered an adequate fit.[18]

Second, exploratory structural equation modeling (ESEM) was performed on each sample to investigate plausible alternative dimensional structures to be further evaluated through the CFA approach. ESEM has been utilized to additionally evaluate whether the same dimensional pattern replicates across the two samples (factorial invariance). Basically, this procedure consisted of fitting separate and grouped exploratory models (one to four factors) within the CFA framework. We fixed factor variances to a value of one and the latent means to zero in the Swedish and Brazilian samples. For the grouped ESEM analysis we also fixed the item residual variances to a value of one in the Swedish sample only. All loadings are freely estimated and *geomin* oblique rotation is used. ESEM allows implementation of other functions that may otherwise only be accomplished within a CFA framework, such as evaluating error measurement correlation and measurement invariance across groups.[21]

Third, factor-based convergent and discriminant validity were evaluated using the parameters obtained in the CFA models based on the theoretical proposition and outlined in ESEM analysis. Factor-based convergent validity assesses the degree to which items of the same dimension are correlated and is measured by internal consistency and average variance extracted. Internal consistency was measured by composite reliability, since the traditional Cronbach's alpha coefficient tends to underestimate reliability except under restricted assumptions of equal common factor loadings and uncorrelated measurement errors. Composite reliability is defined for each factor by the ratio between the true variance (the squared sum of the standardized factor loadings) and the observed variance (the squared sum of the standardized factor loadings plus the sum of their related uniquenesses, ranging from zero to one. Values ≥ 0.70 indicates acceptable internal consistency.[4,11]

Average variance extracted assesses the amount of variance captured by a common factor in relation to the amount of variance due to random measurement error.[11] Average variance extracted ranges from 0 to 1 and a factor shows convergent validity when ≥ 0.50, indicating that at least 50.0% of the variance in a measure is due to the hypothesized latent factor. If correlated measurement errors were considered in the CFA model, the sum of nonzero error covariances, multiplied by 2, was added to the denominator for average variance extracted and composite reliability.[4] Ninety five percent confidence intervals (95%CI) for average variance extracted and composite reliability were obtained via a bootstrap method with 1,000 replications.

Factor-based discriminant validity assesses the degree to which different dimensions of the same construct are distinct,[18] which is corroborated if the average variance extracted square root of a given factor is above the absolute value of its correlation with any other factor in the model.[8]

External construct validity (hypotheses testing) assessment was evaluated when inspecting mean-score distribution of demand and control dimensions according to sociodemographic characteristics and social support at work levels. T-test and ANOVA were used to evaluate mean differences across two or more independent groups, respectively. We tested the hypothesis that younger and female workers of lower socioeconomic status who reported lower scores of social support at work would perceive higher levels of psychological demands, and lower levels of skill discretion and decision authority. These analyses were performed in Stata SE, version 10.0.

The Brazilian study was approved by the Research and Ethics Committee of the *Instituto de Pesquisa Clínica Evandro Chagas* (Protocol 0024.0.009.000-03). The SLOSH was approved by the Regional Research Ethics Board in Stockholm. All participants signed the informed consent form.

RESULTS

The Brazilian sample was younger, had a lower proportion of women, had fewer years of formal education and a lower proportion of blue-collar workers (Table 1). White-collar workers included mostly clerks and professionals, respectively, in the Swedish and Brazilian samples. Health professionals (SW = 60 and BR = 78) were predominantly medical doctors (SW = 27 and BR = 38), nurses (SW = 30 and BR = 12) and psychologists (SW = 5 and BR = 14). Technicians (SW = 132 and BR = 82) included more nurse assistants (SW = 75 and BR = 21) and lifescience technicians (SW = 25 and BR = 43).

The CFA model results are presented in Table 2. Compared to the two-factor model, the three-factor model showed better item loadings and uniquenesses, particularly related to the items postulated as part of the skill discretion dimension and more evidenced in the Swedish sample. The item *repetitive work* resulted in low loadings and high uniquenesses in both models and samples. The magnitude of factor correlations ranged from 0.10 to 0.44. These models had poor fit for both samples (RMSEA > 0.08), the three-factor model (M2) fit better (CFI/TLI > 0.90) than the two-factor model (M1).

Exploratory models evaluated within a CFA framework (ESEM) were suitable for both samples and confirmed the three-factor structure clearly related to psychological demands, skill discretion and decision authority (Table 3). Consistently with the CFA models, the item *repetitive work* resulted in low loadings (< 0.25) and high uniqueness (> 0.90) in both samples (data not shown) and was therefore deleted from the revised ESEM model. Factor loadings arising from the revised ESEM model were suitable for both samples, with the item *conflicting demands* on psychological demands showing the lowest of all loadings (SW = 0.44 and BR = 0.52). The item *initiative* loaded not only on skill discretion (SW = 0.52 and BR = 0.54), but also on decision authority (0.38) in the Swedish sample and on psychological demands (0.33) in the Brazilian sample. In the Swedish sample, inspection of the modification indices (MI) suggested that freely estimating the item residual correlation between *work fast* and *work intensely* (psychological demands) would decrease the Chi-square of the model by 28.94, with an expected parameter change of 0.52. This item measurement correlation was confirmed in the separate Swedish and Brazilian ESEM models (SW = 0.403 and BR = 0.362) and improved the fit indices: RMSEA = 0.064 (SW) and 0.040 (BR), CFI = 0.985 (SW) and 0.995 (BR) and TLI = 0.960 (SW) and 0.987 (BR). The two-group model considering this item measurement correlation provided a good fit to the data, approximately the same fit as those obtained with separate ESEM models (RMSEA = 0.053, CFI = 0.991, TLI = 0.975). These results support the factorial invariance of the DCQ, which means that the same ESEM model was able to fit data from the Brazilian and Swedish samples.

Table 1. Sociodemographic characteristics of the Brazilian and Swedish hospital workers.

Variable	Sweden N = 362		Brazil N = 399	
	n	%	n	%
Age: Mean (SD)	49.2	9.8	35.7	11.2
Sex				
Male	63	17.4	126	31.7
Female	299	82.6	272	68.3
Education level				
< High school	119	32.9	44	11.2
High school	122	33.7	155	39.3
University	121	33.4	195	49.5
Occupation				
Major ISCO-88 group 1[a]	13	3.6	20	5.5
Major ISCO-88 group 2[b]	73	20.2	146	40.4
Major ISCO-88 group 3[c]	132	36.5	82	22.7
Major ISCO-88 group 4[d]	28	7.7	61	17.0
Major ISCO-88 groups 5 to 9[e]	116	32.0	52	14.4

SD: Standard deviation; ISCO-88: International Standard Classification of Occupations, 1988
[a] Managers and senior officials.
[b] Professionals (medical doctors, nurses, pharmacists, psychologists, social workers).
[c] Technicians and associate professionals.
[d] Clerks.
[e] Mostly service workers and elementary occupations.

Table 2. Confirmatory factor analysis of the demand-control questionnaire: standardized factor loadings (λ), uniquenesses (δ), factor correlations and goodness-of-fit indices.

Variable	Sweden						Brazil					
	M1		M2		M3		M1		M2		M3	
	λ	δ	λ	δ	λ	δ	λ	δ	λ	δ	λ	δ
Item	Psychological demands						Psychological demands					
1. Work fast	0.671	0.550	0.683	0.534	0.624	0.611	0.807	0.590	0.804	0.594	0.735	0.678
2. Work intensely	0.778	0.395	0.765	0.414	0.715	0.489	0.916	0.400	0.913	0.407	0.851	0.526
3. Work effort	0.845	0.285	0.842	0.292	0.872	0.239	0.765	0.644	0.776	0.630	0.816	0.577
4. Enough time	0.636	0.595	0.630	0.603	0.634	0.598	0.648	0.762	0.640	0.769	0.661	0.750
5. Conflicting demands	0.516	0.733	0.539	0.710	0.542	0.706	0.530	0.848	0.534	0.846	0.551	0.835
	Decision latitude		Skill discretion				Decision latitude		Skill discretion			
6. Learning new things	0.098	0.990	0.528	0.721	0.543	0.705	0.510	0.860	0.445	0.896	0.584	0.812
7. Skill level	0.133	0.982	0.726	0.472	0.793	0.372	0.506	0.863	0.597	0.803	0.704	0.710
8. Initiative	0.351	0.877	0.775	0.399	0.669	0.419	0.564	0.826	0.893	0.450	0.620	0.645
9. Repetitive work	0.280	0.922	0.180	0.968	–	–	0.047	0.999	-0.104	0.995	–	–
	Decision authority						Decision authority					
10. How to do	0.924	0.147	0.918	0.158	0.886	0.215	0.692	0.722	0.785	0.620	0.775	0.632
11. What to do	0.806	0.350	0.801	0.358	0.833	0.306	0.745	0.667	0.812	0.584	0.821	0.570
Cross loadings												
DA ⇒ item 8	–	–	–	–	0.310		–	–	–	–	–	–
PD ⇒ item 8	–	–	–	–	–	–	–	–	–	–	0.327	–
Item correlation												
Item 1 ⇔ Item 2	–	–	–	–	0.282	–	–	–	–	–	0.368	–
Factor correlations												
PD ⇔ DL	-0.261		–		–		0.104		–		–	
PD ⇔ SD	–		0.298		0.400		–		0.440		0.229	
PD ⇔ DA	–		-0.339		-0.340		–		-0.129		-0.129	
SD ⇔ DA	–		0.333		0.091		–		0.401		0.472	
GOF indices												
RMSEA	0.148		0.091		0.067		0.134		0.082		0.058	
CFI	0.798		0.926		0.971		0.862		0.951		0.982	
TLI	0.741		0.901		0.956		0.823		0.934		0.972	

PD: Psychological Demands; DL: Decision Latitude; SD: Skill Discretion; DA: Decision Authority GOF: Goodness-of-fit; RMSEA: Root mean square error of approximation; CFI: Comparative fit index; TLI: Tucker-Lewis index
Models performed using WLSMV mean and variance-adjusted estimator and theta parameterization.
M1: 2-factor solution: PD ⇔ DL; M2: 3-factor solution: PD ⇔ SD ⇔ DA; M3: PD ⇔ SD ⇔ DA, without item 9, with item measurement correlation between item 1 ⇔ item 2 and cross loadings DA ⇒ item 8 (Sweden) and PD ⇒ item 8 (Brazil).

Since these results had been observed in previous CFA-type analyses on the Brazilian sample,[12] we tested and confirmed an alternate model including the above mentioned item residual correlation in both samples (M3, Table 2). As in the previous model the item *initiative* cross-loaded on decision authority and psychological demands in the Swedish and Brazilian samples, respectively. The magnitude of factor correlations ranged from 0.18 to 0.34 and from 0.12 to 0.40 for the Swedish and Brazilian samples, respectively.

Goodness-of-fit indices were suitable for both samples (RMSEA < 0.07, CFI and TLI > 0.90). Modification indices suggested that the item *learning new things* has a negative cross loading on psychological demands in the Brazilian sample.

Although almost all composite reliability coefficients were suitable, the average variance extracted was not (< 0.50), particularly with regard to the Skill Discretion dimension in both samples (Table 4). The

Table 3. Exploratory factor analysis using structural equation models of the Demand-Control Questionnaire: standardized factor loadings (λ_{Fi}), uniquenesses (δ), factor correlations and goodness-of-fit indices.

Variable	Sweden				Brazil			
	λ_{F1}	λ_{F2}	λ_{F3}	δ	λ_{F1}	λ_{F2}	λ_{F3}	δ
Psychological demands								
1. Work fast	0.565[a]	0.237	-0.041	0.723	0.868[a]	-0.171	0.020	0.539
2. Work intensely	0.853[a]	0.009	0.279	0.572	0.910[a]	-0.012	-0.004	0.430
3. Work effort	0.899[a]	-0.008	0.175	0.523	0.705[a]	0.144	-0.182	0.617
4. Enough time	0.656[a]	-0.047	-0.002	0.780	0.632[a]	0.007	-0.048	0.776
5. Conflicting demands	0.444[a]	0.186	0.001	0.844	0.519[a]	-0.011	-0.136	0.837
Skill discretion								
6. Learning new things	-0.092	0.613[a]	-0.027	0.774	-0.139	0.665[a]	0.014	0.772
7. Skill level	-0.104	0.856[a]	0.022	0.628	0.006	0.819[a]	-0.226	0.642
8. Initiative	0.019	0.525[a]	0.382[a]	0.702	0.334[a]	0.540[a]	0.009	0.702
Decision authority								
9. How to do	-0.162	0.007	0.730[a]	0.576	0.055	0.006	0.944[a]	0.375
10. What to do	-0.005	-0.246	0.965[a]	0.373	-0.012	0.205	0.586[a]	0.708
Factor correlations								
PD ⇔ SD		0.333				0.288		
PD ⇔ DA		-0.333				-0.111		
SD ⇔ DA		0.195				0.411		
GOF indices								
RMSEA		0.090				0.048		
CFI		0.968				0.992		
TLI		0.920				0.981		

GOF: Goodness-of-fit; RMSEA: Root mean square error of approximation; CFI: Comparative fit index; TLI: Tucker-Lewis index; PD: Psychological demands; SD: Skill discretion; DA: Decision authority
Model performed using WLSMV estimator, geomin rotation and theta parameterization, without the item repetitive work.
[a] Standardized factor loadings (λ_{Fi}) > 0.30.

square root of average variance extracted of all dimensions (M2 > 0.58 and M3 > 0.65) were above the absolute value of all CFA-based factor correlations, which ranged for the Swedish and Brazilian samples respectively, from 0.30 to 0.34 and from 0.13 to 0.44 for the 3-factor model (M2 = psychological demands ⇔ skill discretion ⇔ decision authority) and from 0.09 to 0.40 and from 0.13 to 0.47 when cross loadings and error measurement correlations were added to alternative models M3 (Table 2).

Table 5 describes the mean score distribution of the demand control components according to sociodemographic variables and Social Support at Work. Since the factor analysis showed that the item *repetitive work* did not belong to the DCQ, it was not computed for the skill discretion score. Workers aged over 30 presented higher scores on psychological demands and decision authority dimensions only in the Brazilian sample. Workers with university degrees had higher scores on job strain components and those with high levels (≥ 21) of social support at work had lower scores for psychological demands and higher scores for decision

authority (p < 0.001). When compared to blue-collar workers, white-collar workers had higher scores on skill discretion in the Swedish ($M_{ISCO1-4} = 10.7$, $SD_{ISCO1-4} = 1.1$ and $M_{ISCO5-9} = 10.1$, $SD_{ISCO5-9} = 1.6$; F = 15.8, p < 0.001) and Brazilian samples ($M_{ISCO1-4} = 10.9$, $SD_{ISCO1-4} = 1.4$ and $M_{ISCO5-9} = 9.2$, $SD_{ISCO5-9} = 2.0$; F = 54.2, p < 0.001) (data not shown).

DISCUSSION

Our study corroborated the structural validity of the DCQ, when applied to Swedish and Brazilian hospital workers. The three-factor solution represented by the psychological demands, skill discretion, and decision authority dimensions was also generated in previous studies on Brazilian restaurant workers[12] and on Norwegian male workers in high-status occupations.[27] The same dimensional structure was also identified in at least five studies that used the larger JCQ.[14,17,25,28,29]

In our study, the item *repetitive work* did not belong to any of the factors in the Brazilian or Swedish samples. The same result was observed among Brazilian

Table 4. Composite reliability (95% confidence intervals) and average variance extracted as measured by confirmatory factor analysis of the demand-control questionnaire.

Dimension		Sweden			Brazil		
		Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Psychological demand	CR	0.823	0.824	0.781	0.858	0.858	0.797
	AVE	0.488	0.490	0.423	0.556	0.556	0.412
	√AVE	0.699	0.700	0.651	0.745	0.745	0.642
Decision latitude	CR	0.612	–	–	0.694	–	–
	AVE	0.289	–	–	0.312	–	–
	√AVE	0.537	–	–	0.558	–	–
Skill discretion	CR	–	0.656	0.712	–	0.559	0.671
	AVE	–	0.360	0.457	–	0.340	0.407
	√AVE	–	0.600	0.676	–	0.583	0.638
Decision authority	CR	–	0.851	0.986	–	0.778	0.779
	AVE	–	0.742	0.525	–	0.637	0.638
	√AVE	–	0.862	0.725	–	0.798	0.799

CR: Composite Reliability; AVE: average variance extracted
Models performed using WLSMV estimator and theta parameterization.
Model 1: 2-factor solution: Psychological demands ⇔ Decision latitude; Model 2: 3-factor solution: Psychological demands ⇔ Skill discretion ⇔ Decision authority; Model 3: Psychological demands ⇔ Skill discretion ⇔ Decision authority, without item 9, with item measurement correlation between item 1 ⇔ item 2 and cross loadings Decision authority ⇒ item 8 (Sweden) and Psychological demands ⇒ item 8 (Brazil).

restaurant workers,[12] although not in a large sample of Norwegian workers.[27] Even though this finding has been observed in several JCQ studies,[6,14,25,29] results may not be comparable, since the length and the items' response pattern are different from DCQ.[9,15]

Error measurement correlation between *work fast* and *work intensely* was confirmed for both samples, which may be interpreted as reflecting some redundancy in these items. This finding has been detected among Brazilian restaurant workers,[25] nursing staff[10] and in a study of Canadian hospital workers using the JCQ.[26]

Since the findings showed that the item *initiative* not only loaded on Skill Discretion, as expected, but also on the decision authority and psychological demands factors in the Swedish and Brazilian samples, respectively, we reviewed the item contents across the versions, particularly with regard to semantics and wording. We identified an item wording difference between the Swedish and the English versions ("Does your work require creativity?" and "Does your job require you to take the initiative?", respectively) that might have affected the comparison between the Swedish and the Brazilian versions, since the latter was adapted directly from the English version.[1] Further studies using a qualitative approach could help clarifying the cultural differences regarding the item on 'initiative'. Nevertheless, the evidence that the item consistently cross-loads suggests its unsuitability in both cultures.[4]

Albeit exclusive to the Brazilian sample, the negative cross-loading from *learning new things* on the psychological demands factor identified through the CFA approach failed to materialize when using an exploratory modeling process. This may be because the CFA's strict requirement of zero-loadings on nontarget factors ends up forcing a single spurious negative cross-loading to accommodate information that would otherwise be adequately redistributed over several inconspicuous cross-loadings as implied by the more parsimonious ESEM approach,[21] probably more adequate for latent psychosocial constructs such as the DCQ.

Patterns of mean score distribution for skill discretion (BR) and decision authority (SW and BR) across education levels, for skill discretion (SW and BR) across occupation groups, and for psychological demands and decision authority across social support levels (SW and BR) are in accordance with the theoretical model[16] and with other JCQ validation studies.[14,25]

Our findings need to be evaluated in light of the strengths and limitations of our study. To our knowledge, this is the first comparative study using ESEM and CFA approaches on the structural and cross-cultural validity of the DCQ in two culturally different societies. Other methodological strengths can also be cited. For one, we have explicitly evaluated item residual correlation in a unified context of exploratory and confirmatory analyses, which heretofore had not been investigated in studies on the demand-control model. Moreover, sample sizes by group were in accordance with current

Table 5. Demand-control mean scores (with standard deviations) according to sociodemographic characteristics and level of social support at work: Swedish and Brazilian hospital workers.

Variable	Sweden			Brazil		
	Psychol. Demands	Skill Discretion	Decision Authority	Psychol. Demands	Skill Discretion	Decision Authority
Sex		[a]	[a]		[a]	[a]
Male	13.6 (2.9)	10.1 (1.8)	6.1 (1.4)	12.9 (3.3)	10.4 (1.9)	5.3 (1.6)
Female	13.6 (2.6)	10.6 (1.2)	5.6 (1.5)	13.3 (3.2)	10.8 (1.4)	5.7 (1.6)
Age				[a]		[c]
< 30	13.5 (2.3)	10.4 (1.6)	4.7 (0.9)	12.5 (3.1)	10.5 (1.6)	5.2 (1.5)
30 to 50	13.6 (2.5)	10.5 (1.4)	5.6 (1.4)	13.5 (3.3)	10.8 (1.4)	5.8 (1.5)
≥ 50	13.6 (2.7)	10.5 (1.3)	5.8 (1.5)	13.5 (3.3)	10.4 (1.8)	5.7 (1.7)
Education	[a]	[c]		[b]	[c]	[c]
< High School	13.3 (2.8)	10.0 (1.5)	5.5 (1.5)	13.5 (3.1)	9.5 (1.8)	4.8 (1.8)
High School	13.4 (2.6)	10.6 (1.2)	5.7 (1.5)	12.5 (3.1)	10.4 (1.6)	5.2 (1.5)
University	14.1 (2.4)	10.9 (1.1)	5.8 (1.4)	13.6 (3.3)	11.2 (1.2)	6.0 (1.4)
SSW	[c]		[c]	[c]		[c]
Low (< 17)	15.0 (2.4)	10.3 (1.4)	4.9 (1.4)	14.8 (3.1)	10.8 (1.4)	5.0 (1.6)
Medium	13.5 (2.6)	10.5 (1.4)	5.8 (1.4)	13.8 (3.0)	10.5 (1.6)	5.4 (1.5)
High (≥ 21)	12.8 (2.5)	10.6 (1.2)	6.0 (1.4)	12.2 (3.2)	10.7 (1.6)	5.9 (1.5)

SSW: Social support at work
[a] $p < 0.05$
[b] $p < 0.01$
[c] $p < 0.001$ obtained by student t-test (sex and occupation) or ANOVA prob > F (age, education and social support at work).

recommendations suggested by Montecarlo simulations of CFA- and ESEM-based multiple group analyses[21] and when using the WLSMV estimator for non-normal observational data.[4] In terms of limitations, our samples were restricted to health workers, although there were workers from six of the nine major ISCO groups in both samples.

Our results showed that DCQ has the same dimensional structure in the Swedish and Brazilian hospital workers confirming the cross-cultural validity of this instrument. Consistently with several other DCQ and JCQ studies, the item 'repetitive work' should be removed from the demand control construct at least in our studied work environments. As most items were hypothesized as part of the Decision Latitude dimension, this could indicate the need to revise the content of this dimension, perhaps by contemplating the scrutiny and eventual introduction of new and better items.

Our results suggest that the demand-control model may still be valid in contemporary labor contexts. The DCQ should be operationalized as a three-dimensional instead of a two-dimensional scale and without the item

assessing repetitive work. Since this study additionally sought to compare the Swedish and Brazilian data and thus enables an evaluation across different domains, our results may also be regarded as indicating the instrument's psychometric invariance, be it only provisionally and pending more rigorous analyses.[4,21] International comparative studies on the association of job strain and health-related outcomes would benefit from truly comparable scales. This would help resolve one source of inconsistency of empirical results in this research field. Remaining issues – which argue for revising the model – include how items cover the latent trait in terms of intensity and the reproducibility of these results across a wider spectrum of socio-occupational groups.

ACKNOWLEDGMENTS

REFERENCES

1. Alves MGM, Chor D, Faerstein E, Lopes CS, Werneck GL. Short version of the "job stress scale": a Portuguese-language adaptation. *Rev Saude Publica*. 2004;38(2):164-71. DOI:10.1590/S0034-89102004000200003

2. Araújo TM, Karasek R. Validity and reliability of the Job Content Questionnaire in formal and informal jobs in Brazil. *Scand J Work Environ Health Suppl*. 2008;(6):52-9.

3. Backé EM, Seidler A, Latza U, Rossnagel K, Schumann B. The role of psychosocial stress at work for the development of cardiovascular diseases: a systematic review. *Int Arch Occup Environ Health*. 2012;85(1):67-79. DOI:10.1007/s00420-011-0643-6

4. Brown TA. Confirmatory factor analysis for applied research. New York: The Guilford Press; 2006. (Methodology in the Social Sciences).

5. Edimansyah BA, Rusli BN, Naing L, Mazalisah M. Reliability and construct validity of the Malay version of the Job Content Questionnaire (JCQ). *Southeast Asian J Trop Med Public Health*. 2006;37(2):412-6.

6. Escribà-Aguir V, Más Pons R, Flores Reus E. Validación del "Job Content Questionnaire" en personal de enfermeria hospitalario. *Gac Sanit*. 2001;15(2):142-9. DOI:10.1016/S0213-9111(01)71533-6

7. Finney SJ, DiStefano C. Non-normal and categorical data in structural equation modeling. In: Hancock GR, Mueller RO, editors. Structural equation modeling: a second course. Greenwich: Information Age Publishing; 2006. p.269-314.

8. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. *J Mark Res*. 1981;18(1):39-50. DOI:10.2307/3151312

9. Fransson EI, Nyberg ST, Heikkilä K, Alfredsson L, Bacquer D, Batty GD, et al. Comparison of alternative versions of the job demand-control scales in 17 European cohort studies: the IPD-Work consortium. *BMC Public Health*. 2012;12:62. DOI:10.1186/1471-2458-12-62

10. Griep RH, Rotenberg L, Vasconcellos AGG, Landsbergis P, Comaru CM, Alves MGM. The psychometric properties of demand-control and effort-reward imbalance scales among Brazilian nurses. *Int Arch Occup Environ Health*. 2009;82(10):1163-72. DOI:10.1007/s00420-009-0460-3

11. Hair JF, Black WC, Babin BJ, Anderson RE, Tatham RL. SEM: confirmatory factor analysis. In: Hair JF, Black WC, Babin BJ, Anderson RE, Tatham RL, editors. Multivariate data analysis. 6.ed. Upper Saddle River: Pearson Prentice Hall; 2006. p.770-842.

12. Hökerberg YH, Aguiar OB, Reichenheim M, Faerstein E, Valente JG, Fonseca MJ, et al. Dimensional structure of the demand control support questionnaire: a Brazilian context. *Int Arch Occup Environ Health*. 2010;83(4):407-16. DOI:10.1007/s00420-009-0488-4

13. Johnson JV, Hall EM. Job strain, work place social support, and cardiovascular disease: a cross-sectional study of a random sample of the Swedish working population. *Am J Public Health*. 1988;78(10):1336-42. DOI:10.2105/AJPH.78.10.1336

14. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *J Occup Health Psychol*. 1998;3(4):322-55. DOI:10.1037/1076-8998.3.4.322

15. Karasek R, Choi B, Ostergren PO, Ferrario M, De Smet P. Testing two methods to create comparable scale scores between the Job Content Questionnaire (JCQ) and JCQ-like questionnaires in the European JACE Study. *Int J Behav Med*. 2007;14(4):189-201. DOI:10.1080/10705500701638336

16. Karasek R, Theorell T. Healthy work: stress, productivity, and the reconstruction of working life. New York: Basic Books; 1990.

17. Kawakami N, Fujigaki Y. Reliability and validity of the Japanese version of Job Content Questionnaire: replication and extension in computer company employees. *Ind Health*. 1996;34(4):295-306. DOI:10.2486/indhealth.34.295 10

18. Kline RB. Principles and practice of structural equation modeling. New York: Guilford Press; 2005. (Methodology in the Social Sciences).

19. Landsbergis P, Theorell T, Schwartz J, Greiner BA, Krause N. Measurement of psychosocial workplace exposure variables. *Occup Med*. 2000;15(1):163-88.

20. Li J, Yang W, Liu P, Xu Z, Cho SI. Psychometric evaluation of the Chinese (mainland) version of Job Content Questionnaire: a study in university hospitals. *Ind Health*. 2004;42(2):260-7. DOI:10.2486/indhealth.42.260

21. Marsh HW, Muthén B, Asparouhov T, Lüdtke O, Robitzsch A, Morin AJS, et al. Exploratory structural equation modeling, integrating CFA and EFA: application to students' evaluations of university teaching. *Struct Equ Modeling*. 2009;16(3):439-76. DOI:10.1080/10705510903008220

22. Mase J, Ota A, Inoue K, Iida T, Tsutsumi A, Yatsuya H, et al. Reliability and validity of the Japanese translated version of the Swedish Demand-Control-Support Questionnaire. *Ind Health*. 2012;50(6):467-75. DOI:10.2486/indhealth.MS1282

23. Mokkink LB, Terwee CB, Patrick DL, Alonso J, Stratford PW, Knol DL, et al. The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: an international Delphi study. *Qual Life Res*. 2010;19(4):539-49. DOI:10.1007/s11136-010-9606-8

24. Muthén LK, Muthén BO. Mplus statistical analysis with latent variables: user´s guide. 5.ed. Los Angeles: Muthén & Muthén; 1998-2007.

25. Niedhammer I. Psychometric properties of the French version Karasek Job Content Questionnaire: a study of the scales of decision latitude, psychological demands, social support, and physical demands in the GAZEL cohort. *Int Arch Occup Environ Health*. 2002;75(3):129-144. DOI:10.1007/s004200100270

26. Sale JE, Kerr MS. The psychometric properties of Karasek's demand and control scales within a single sector: data from a large teaching hospital. *Int Arch Occup Environ Health*. 2002;75(3):145-52. DOI:10.1007/s004200100289

27. Sanne B, Torp S, Mykletun A, Dahl AA. The Swedish Demand-Control-Support Questionnaire (DCSQ): factor structure, item analyses, and internal consistency in a large population. *Scand J Public Health*. 2005;33(3):166-74. DOI:10.1080/14034940410019217

28. Schreurs PJG, Taris TW. Construct validity of the demand-control model: a double cross-validation approach. *Work Stress*. 1998;12(1):66-84. DOI:10.1080/02678379808256849

29. Smith CS, Tisak J, Hahn SE, Schmieder RA. The measurement of job control. *J Organ Behav*. 1997;18(3):225-37. DOI:10.1002/(SICI)1099-1379(199705)18:3<225::AID-JOB797>3.0.CO;2-E

30. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 4.ed. Oxford: Oxford University Press; 2008.

31. Theorell T. The demand-control-support model for studying health in relation to the work environment: an interactive model. In: Orth-Gomér K, Schneiderman N, editors. Behavioral medicine approaches to cardiovascular disease prevention. Mahwah: Lawrence Erlbaum Associates; 1996, p.69-85.

32. Toivanen S. Social determinants of stroke as related to stress at work among working women: a literature review. *Stroke Res Treat*. 2012;2012:873678. DOI:10.1155/2012/873678