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Psychometric properties of the French version of the Karasek Job Content Questionnaire: a study of the scales of decision latitude, psychological demands, social support, and physical demands in the GAZEL cohort

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Abstract Objectives: The objective of this study was to explore the psychometric properties of the French version of the Karasek Job Content Questionnaire (JCQ) for the recommended scales of psychological demands, decision latitude, social support, and physical demands. Internal consistency, factorial validity, and convergent validity were examined in a large occupational cohort of men and women. **Methods:** This study was based on the GAZEL cohort composed of workers aged 40–50 years for men and 35–50 years for women employed by the French national electric and gas company Electricité De France-Gaz De France (EDF-GDF) in 1989. This cohort has been followed up since 1989 by means of yearly self-administered questionnaires and by the collection of data provided by the company. **Results:** The study population included the 11,447 GAZEL subjects, 8,277 men and 3,170 women, who were working and who answered the French version of the JCQ in 1997. Cronbach's alpha coefficients higher than 0.65 supported the internal consistency of the JCQ scales and subscales. The results of exploratory factor analysis were consistent with the expected dimensions. Physical demands, supervisor support, and co-worker support were clearly found. However, for decision latitude, 'repetitive work' and 'learn new things' displayed low factor loadings. For psychological demands, low factor loadings were observed for 'conflicting demands', 'wait on others', and 'no excessive work'. Confirmatory factor analysis supported the instrument construct in six latent factors: psychological demands, skill discretion, decision authority, supervisor support, co-worker support, and physical demands, although the items mentioned earlier displayed low standardized factor loadings. The associations between the JCQ scales and gender, age, educational level, occupational grade, and job satisfaction

were explored using analysis of variance and chi-square test, and supported the convergent validity. **Conclusion:** Although our results of factor analysis could invite the revision of the two scales of decision latitude and psychological demands, this study provided evidence of the validity of the French version of the four JCQ scales of psychological demands, decision latitude, social support, and physical demands among a large population consisting of French working men and women.

Keywords Psychosocial factors at work · Karasek's model · Psychometric scales · Validity · Questionnaire

Introduction

The Karasek Job Content Questionnaire (JCQ) is very widely used to evaluate psychosocial factors at work. Since this model was first formulated by Karasek in 1979 (Karasek 1979), various studies have shown that these factors are important determinants of health, in particular cardiovascular health (Karasek et al. 1981, 1988; Karasek and Theorell 1990; Schnall et al. 1994; Theorell and Karasek 1996; Niedhammer and Siegrist 1998; Peter and Siegrist 2000). Numerous studies have explored the predictive effects of these factors on health outcomes, and the validity of the JCQ in various languages has been assessed in some recent works. The stage of validation seems crucial for the examination of the psychometric properties of an instrument and allow international comparisons between studies. The validity of the JCQ has mainly been studied in its English, Dutch, and Japanese versions (Karasek et al. 1998). As regards the French version, the two scales of decision latitude and psychological demands were examined and validated in two studies conducted in the region of Quebec. One was based on a sample of white-collar workers (Brisson et al. 1998) and the other on a representative sample of the Quebec working population (Larocque et al. 1998). These studies were focused on the two dimensions of psychological demands and decision

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latitude, and/or on specific homogeneous working populations. A work by Karasek et al. (1998) summarized these results, in order to place them in an international perspective. Furthermore, a workshop co-ordinated by Karasek (2000) took place during the sixth International Congress of Behavioral Medicine in 2000.

The aim of the present study was to evaluate the psychometric properties of the French version of the JCQ. The term 'validity' refers to the ability of a method of measurement to measure what it is intended to measure, as defined by Coste et al. (1995). Here, the validity of the JCQ was explored by studying the construct validity of the instrument, both internally (internal consistency and factorial validity) and externally (convergent validity). The JCQ standard version recommended by Karasek (1985) was used for the scales of decision latitude, psychological demands, social support, and physical demands. The study was conducted in the GAZEL cohort consisting of men and women employed in a large range of occupations by the French national electric and gas company Electricité De France-Gaz De France (EDF-GDF). The JCQ was tested for men and women to assess potential differences by gender.

Population and methods

Study population

The GAZEL cohort was established in 1989 and originally included 20,624 subjects working at EDF-GDF, comprising men aged 40–50 years and women aged 35–50 years at baseline (Goldberg et al. 1990a, 1990b). Since 1989, this cohort has been followed up by means of yearly self-administered questionnaires and by the collection of data from the personnel and medical departments of the company. Research on psychosocial factors at work and health has been conducted in this cohort since 1995, and several studies have already shown the predictive effects of these factors on sickness absence, depressive symptomatology, and cardiovascular risk factors (Niedhammer et al. 1998a, 1998b and 1998c, 2000).

Materials

The full recommended scales of decision latitude, psychological demands, social support, and physical demands of the JCQ were included in the self-administered questionnaire of the GAZEL cohort for the year 1997. The version used here has already been used by the team from Laval University in Quebec (Brisson et al. 1998; Larocque et al. 1998) and by the teams from Belgium and France participating in the European BIOMED project called JACE (Houtman et al. 1999). Decision latitude and psychological demands each comprised nine items, social support, eight items, and physical demands, five items. Response categories were presented on a 4-level Likert-type scale, as follows: 'totally disagree' (coded 1), 'disagree' (2), 'agree' (3) and 'totally agree' (4). The abbreviated list of items is given in Table 4.

Five other variables were used in this study: gender, age, educational level, occupational grade, and job satisfaction. For gender, age, and job satisfaction, data were extracted from the answers to the self-administered questionnaire, and for educational level and occupational grade, they were supplied by the personnel department of the company. Age was divided into three 5-year groups for men and four 5-year groups for women. Six categories were defined for educational level, ranging from primary education to university level. Occupational grade included eight categories for men and five

for women. Job satisfaction was based on an 8-level scale ranging from 'very dissatisfied' (A) to 'very satisfied' (H). Job dissatisfaction was defined by the lower tertile of the distribution among the total study population, i.e. from A to D.

Methods

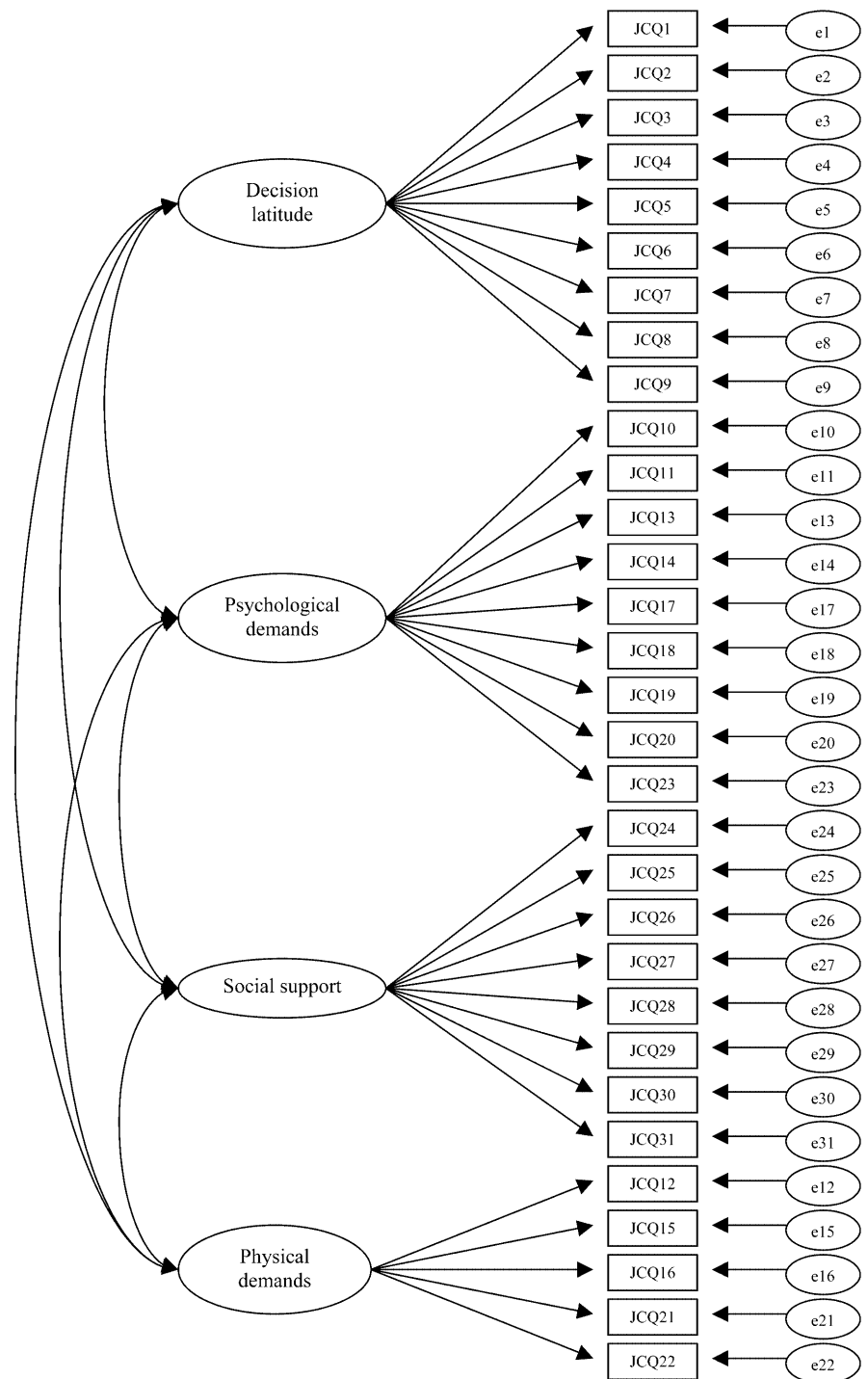
For each of the four scales of decision latitude, psychological demands, social support, and physical demands, scores were calculated using Karasek's recommendations (Karasek 1985). The decision latitude scale comprises two subscales: skill discretion (six items) and decision authority (three items). The social support scale is also composed of two subscales: supervisor support and co-worker support (four items each). Thus, four scales (decision latitude, psychological demands, social support, and physical demands) and four subscales (skill discretion, decision authority, supervisor support, and co-worker support) were explored in this study. As the objective was to validate the French version of the JCQ, missing values were excluded from the analyses. The scores for decision latitude, psychological demands, and social support were dichotomized at the median of the total sample, to create 2-level variables (low/high) for each scale. Job strain was defined by the combination of high levels of psychological demands and low levels of decision latitude, and iso-strain (i.e. social isolation and job strain), by the combination of high levels of demands, low levels of latitude, and low levels of social support, according to the definition of Johnson et al. (1989).

Internal consistency was evaluated by Cronbach's alpha coefficients (Cronbach 1951) for each scale and subscale. The factorial validity of the instrument was first studied by exploratory factor analysis using squared multiple correlations as prior communality estimates. The maximum-likelihood method was used to extract the factors, and this was followed by a promax (oblique) rotation. A scree test was used to determine the number of meaningful factors to be retained for rotation. In interpreting the rotated factor pattern, an item was said to load on a given factor if the factor loading was 0.40 or greater for that factor, and was less than 0.40 for the others (Hatcher 1994).

Confirmatory factor analysis was also performed to examine the factorial validity of the JCQ (Hatcher 1994). Confirmatory factor analysis was used to test the fit of three models. Model 1 (Fig. 1) predicted the existence of four latent factors representing decision latitude, psychological demands, social support, and physical demands; model 2 (Fig. 2) consisted of five latent factors distinguishing supervisor from co-worker support; and model 3 (Fig. 3) was composed of six latent factors dividing decision latitude into skill discretion and decision authority. The models were compared using the chi-square difference test. For each model the most common goodness-of-fit indices were calculated: the chi-square test, the chi-square/df ratio, the Bentler's comparative-fit index (CFI), the Bentler-Bonett non-normed index (NNFI), the root mean squared error approximation (RMSEA), the goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), and the root mean square residual (RMR). The study of the instrument structure was deepened by Pearson's correlation coefficients, which were calculated between scales and subscales.

The convergent validity of the instrument was evaluated by studying the associations of the JCQ dimensions with key variables, which were gender, age, educational level, occupational grade, and job satisfaction. These variables were chosen because they were expected to be related to the occupational aspects defined by the JCQ. First, the mean scores for JCQ scales and subscales were compared by gender, and for each sex, according to age, educational level, occupational grade, and job satisfaction, using analysis of variance. Age-adjusted means were also calculated, but as similar associations with educational level, occupational grade, and job satisfaction were found, these age-adjusted means are not shown. Secondly, the prevalence of job strain and iso-strain was compared according to gender, and for each sex, according to age, educational level, occupational grade, and job satisfaction, using the chi-square test.

Fig. 1 Model 1: four-factor model for the JCQ



SAS statistical software (SAS 1988, 1997) was used for all the statistical analyses, which were performed both for the whole study population, and separately for men and women.

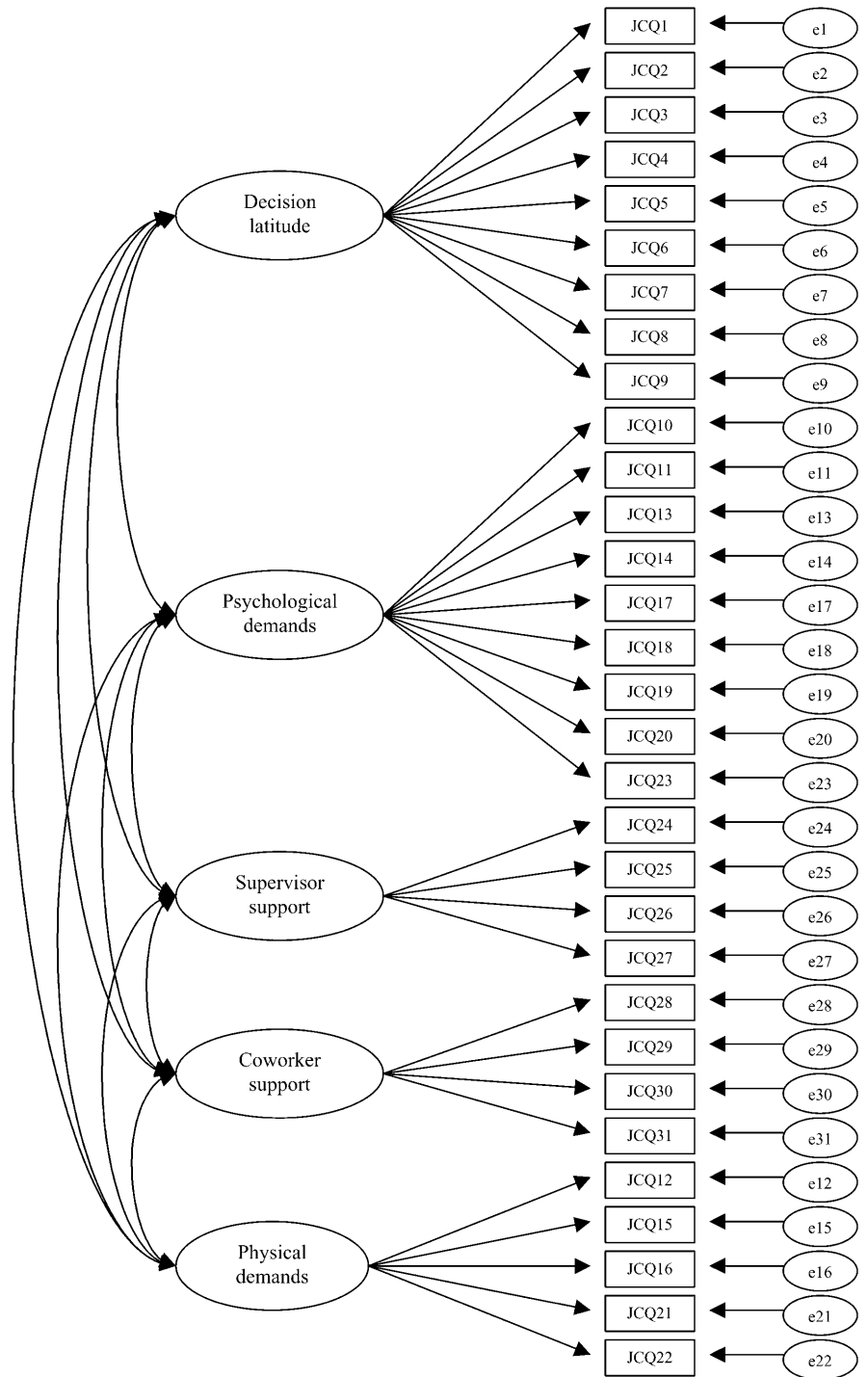
Results

Study population

In 1997, 14,987 subjects in the GAZEL cohort answered the self-administered questionnaire, i.e. 74% of the

20,222 subjects asked to complete it (402 of the 20,624 subjects in the initial cohort were not sent a questionnaire in 1997, because 307 had died and 95 had been lost to follow-up). Of the 14,987 respondents, 11,447 (76.4%) were still working in 1997, 3,344 (22.3%) had retired, 157 (1.0%) were not working because of long illness or disability, and 39 (0.3%) were not working for other reasons (unpaid holidays, compassionate leave, nomination for a future appointment, etc.). The present study is therefore based on the 11,447 subjects, comprising

Fig. 2 Model 2: five-factor model for the JCQ



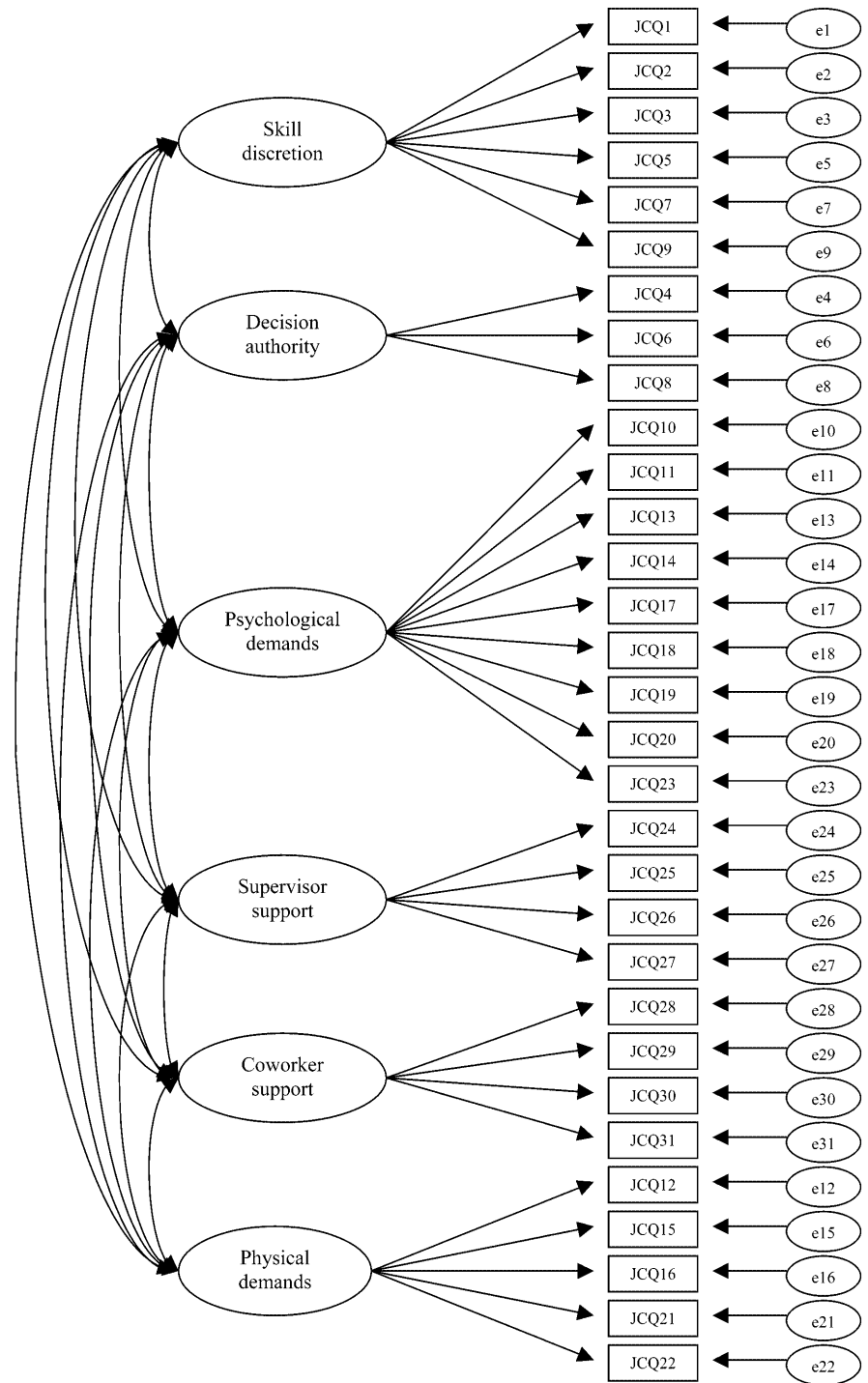
8,277 men and 3,170 women, who were working in 1997 and who answered the questionnaire that year. Further details regarding age, educational level, occupational grade, and job satisfaction are given in Table 1.

Scores of the JCQ

The scores for each scale and subscale were constructed according to Karasek's recommendations (Karasek

1985). The score for psychological demands varied from 9 to 36, for decision latitude, from 24 to 96, for social support, from 8 to 32, and for physical demands, from 5 to 20. The two subscales of skill discretion and decision authority were weighted (respectively 2 and 4) to create the overall score of decision latitude. The distributions of these scores are shown in Figs. 4, 5, 6 and 7 for men and women. Note that the scores for psychological demands, and to a certain extent for decision latitude, approximated normal distribution. For social support,

Fig. 3 Model 3: six-factor model for the JCQ



the mode was 24, which can be interpreted as eight 'agree' responses to the eight items of social support. An asymmetrical distribution was observed for physical demands, as most people did not experience physical constraints. Furthermore, a high proportion of respondents was observed for the 10 value of this score, which corresponds to five 'disagree' responses to the five items of this scale. Means and standard deviations for each score are given for the total sample, and for men and women separately, in Table 2.

Internal consistency

Table 3 shows Cronbach's alpha coefficients for each scale and subscale. All scales and subscales exhibited satisfactory internal consistency, as all the coefficients observed were higher than 0.65. Decision latitude displayed high internal consistency ($\alpha=0.79$), which was higher for the subscale of skill discretion ($\alpha=0.70$) than for the subscale of decision authority ($\alpha=0.65$). Psychological demands, too, displayed high internal

consistency ($\alpha=0.77$). Social support and physical demands displayed the strongest internal consistency (respectively $\alpha=0.80$ and $\alpha=0.85$). The internal consistency

of the two subscales of social support was also high, but was stronger for supervisor support ($\alpha=0.86$) than for co-worker support ($\alpha=0.77$). Similar results were observed for men and women, the largest difference between genders being for physical demands ($\alpha=0.86$ for men, $\alpha=0.80$ for women).

Table 1 Characteristics of the study population in 1997

Characteristic	Total sample <i>n</i> = 11,447		Men <i>n</i> = 8,277		Women <i>n</i> = 3,170	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Age (years)						
44	286	2.50	—	—	286	9.02
45–49	2,791	24.38	1,375	16.61	1,416	44.67
50–54	6,683	58.38	5,547	67.02	1,136	35.84
55–58	1,687	14.74	1,355	16.37	332	10.47
Educational level						
Primary	548	4.79	347	4.19	201	6.34
Lower vocational	5,712	49.91	4,181	50.53	1,531	48.30
Lower secondary	1,627	14.22	1,027	12.41	600	18.93
Upper secondary	917	8.01	537	6.49	380	11.99
Upper vocational	782	6.83	604	7.30	178	5.61
University	1,859	16.24	1,579	19.08	280	8.83
Occupation						
Managers	1,917	16.80	1,660	20.12	257	8.13
Engineers	2,139	18.74	1,920	23.27	219	6.93
Administrative associate professionals	2,708	23.73	969	11.74	1,739	55.01
Physical, engineering and life science associate professionals	464	4.06	464	5.62	—	—
Foremen	2,781	24.37	2,414	29.25	367	11.61
Clerks	802	7.03	223	2.70	579	18.32
Skilled industrial workers	300	2.63	300	3.64	—	—
Craftsmen	302	2.64	302	3.66	—	—
Job satisfaction						
Dissatisfied	3613	31.95	2,452	29.95	1,161	37.19
Satisfied	7,696	68.05	5,735	70.05	1,961	62.81

Factorial validity

The results for the factorial validity are shown in Tables 4 and 5. Table 4 presents the results for exploratory factor analysis. All the items of the four scales of decision latitude, psychological demands, social support, and physical demands were included in the analysis, making a total of 31 items. Men and women were studied separately. A scree test suggested six meaningful factors for men and women. However, the sixth factor accounted for less than 5% of the common variance, and there were only two items (items 21 and 22 of awkward body and arm positions) with significant factor loadings on this factor. Consequently, five factors were retained for rotation. The first factor was associated with decision latitude: all the items of this scale loaded on this factor (loadings ranging from 0.43 to 0.73) except items 1 ‘*learn new things*’ and 2 ‘*repetitive work*’. The second factor (the fourth for women) was associated with physical demands: all the items of this scale loaded on this factor, with loadings ranging from 0.57 to 0.90. The third factor (the second for women) was associated with psychological demands: all the items of this scale loaded on this factor (loadings ranging from 0.48 to 0.76), except items 17 ‘*conflicting demands*’ and 23 ‘*wait on others*’. Note that item 13 ‘*no excessive work*’ had loadings between 0.30 and 0.40 (0.32 for men and

Fig. 4 Distribution of the score for psychological demands among the working subjects of the GAZEL cohort in 1997 (the higher the score, the greater the psychological demand)

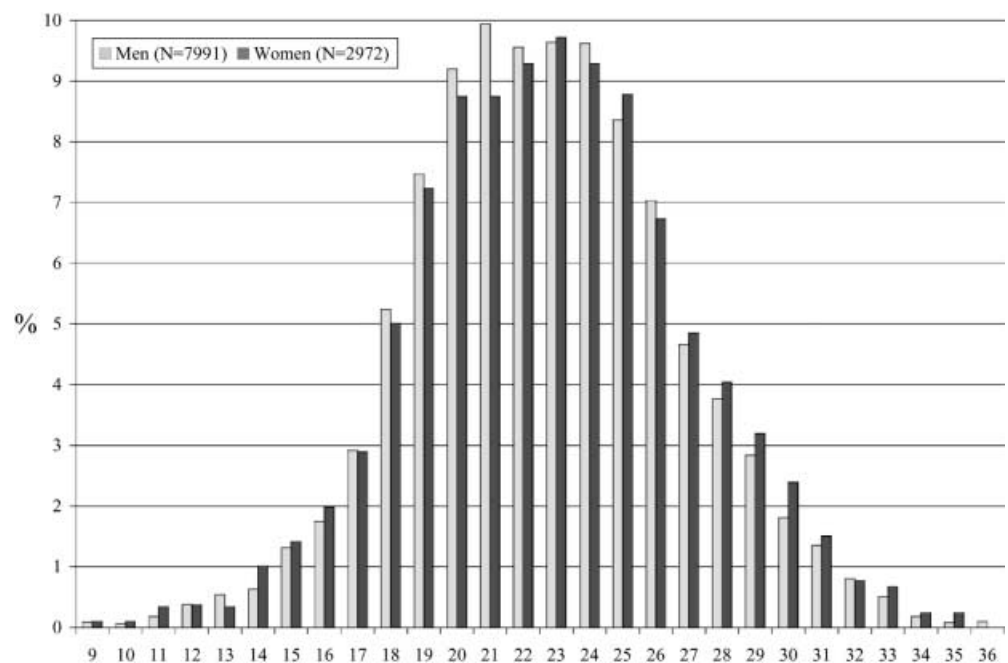
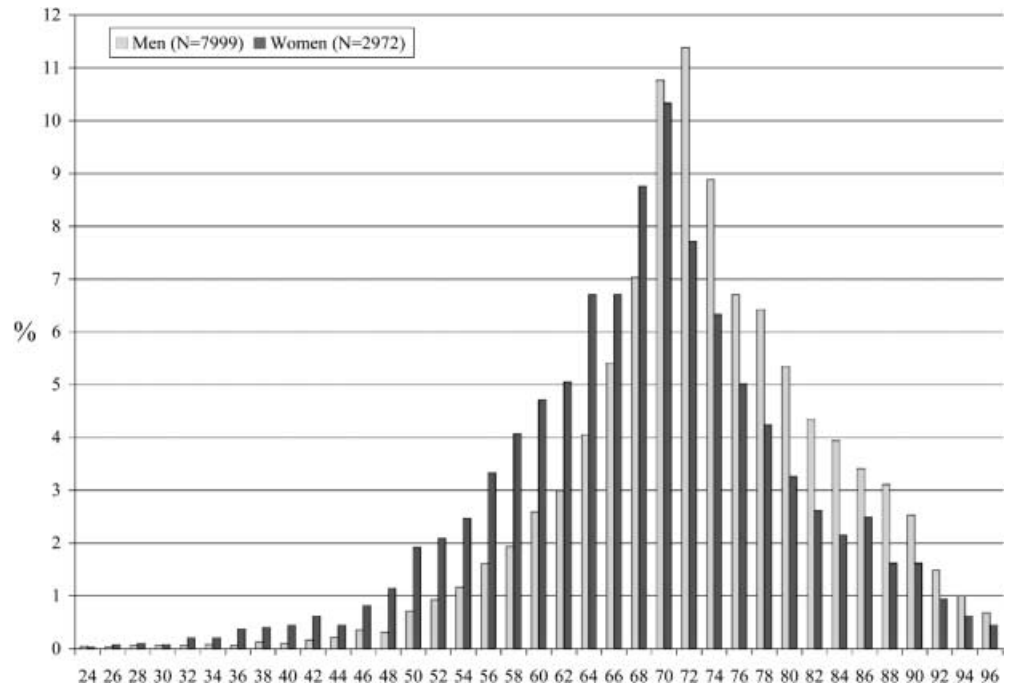


Fig. 5 Distribution of the score for decision latitude among the working subjects of the GAZEL cohort in 1997 (the higher the score, the greater the decision latitude)



0.34 for women) on this factor. The fourth factor (the third for women) was associated with supervisor support (loadings from 0.72 to 0.85) and the fifth, with co-worker support (loadings from 0.50 to 0.81).

The results for confirmatory factor analysis are presented in Table 5. The comparison between the three models showed that model 2 fitted the data better than model 1, and model 3 better than model 2 for men and women. Consequently, the best model consisted of six latent factors: skill discretion, decision authority, psychological demands, supervisor support, co-worker

support, and physical demands. Nevertheless, the goodness-of-fit indices for model 3 can be considered as low, as the chi-square test was highly significant, the chi-square/df ratio was higher than 5, the CFI and NNFI were lower than 0.90, and the RMSEA was higher than 0.05, suggesting that the model may not provide an acceptable fit. Furthermore, some items displayed low standardized factor loadings: item 2 'repetitive work' (loadings: 0.22 for men and 0.33 for women), item 17 'conflicting demands' (0.24 for men and 0.35 for women), item 23 'wait on others' (0.29 for men and 0.27 for

Fig. 6 Distribution of the score for social support among the working subjects of the GAZEL cohort in 1997 (the higher the score, the greater the social support)

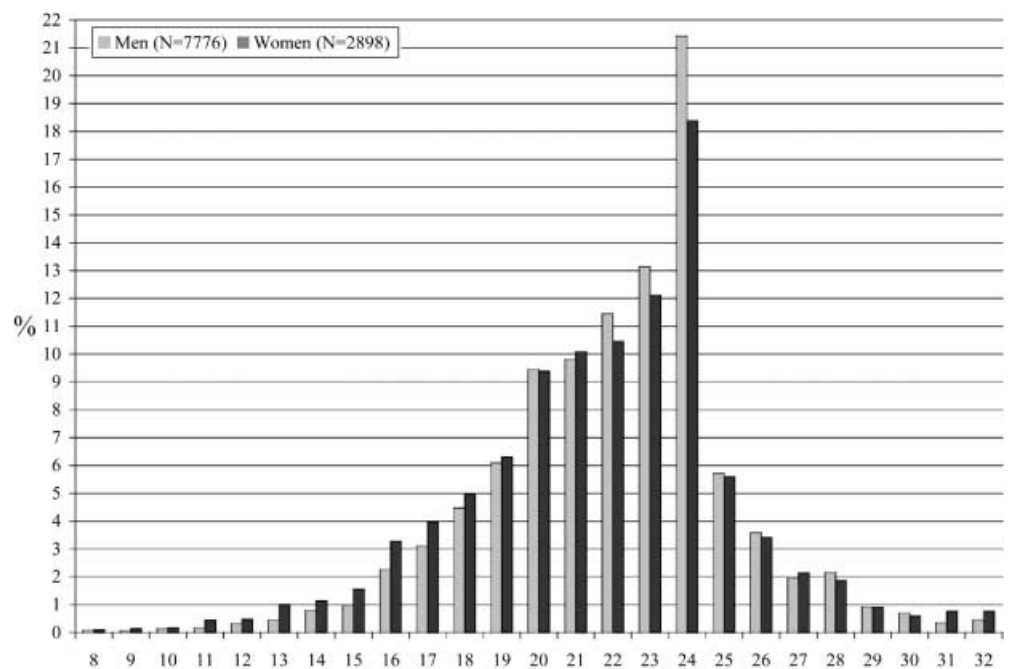
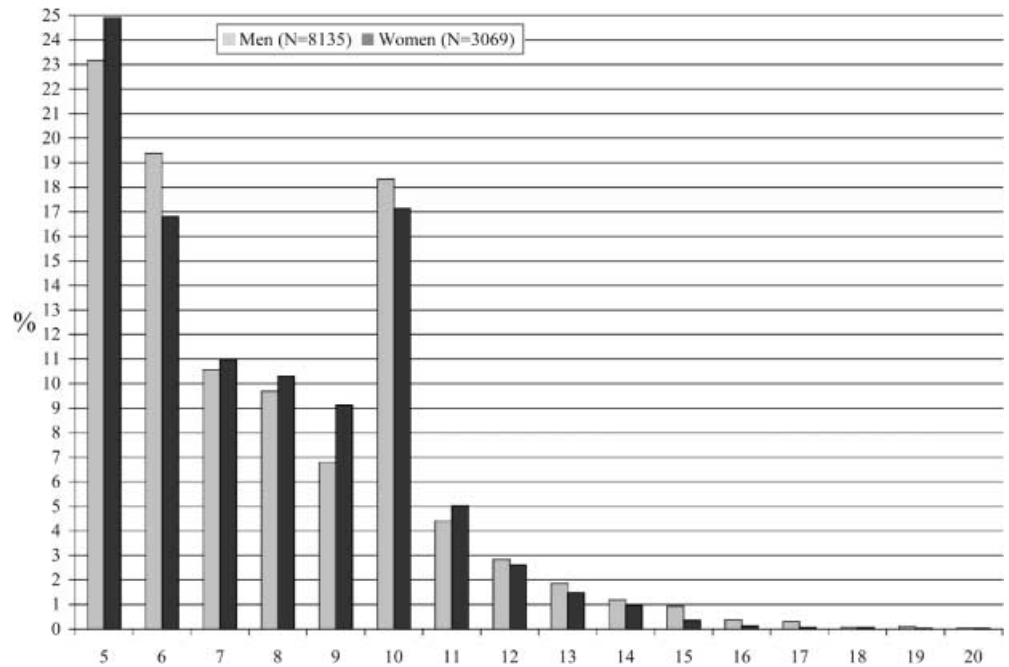


Fig. 7 Distribution of the score for physical demands among the working subjects of the GAZEL cohort in 1997 (the higher the score, the greater the physical demand)



women), and to a lesser extent item 13 ‘no excessive work’ (0.32 for men and 0.31 for women) and item 1 ‘learn new things’ (0.39 for men and 0.37 for women).

Correlations

The study of the JCQ structure was deepened by the calculation of Pearson’s correlation coefficients between scales and subscales. These correlations are given in Table 6. All Pearson’s correlation coefficients except one were significantly different from zero. Although significant, the correlation between decision latitude and psychological demands was weak ($r=0.14$). As expected, the correlation between the two subscales of decision latitude, skill discretion and decision authority, was the strongest ($r=0.61$). Psychological demands were more closely correlated with skill discretion ($r=0.24$) than with decision authority ($r=0.03$). Social support was positively correlated with decision latitude ($r=0.37$) and negatively with psychological demands ($r=-0.17$). The two subscales of social support, supervisor support and

co-worker support, were also positively correlated with decision latitude and negatively with psychological demands, the coefficients being stronger for supervisor support. Supervisor support and co-worker support were moderately correlated ($r=0.29$). Physical demands were positively correlated with psychological demands, and the correlation appeared to be stronger for women

Table 3 Cronbach’s alpha coefficients for the JCQ scales and subscales

Scale/subscale	Total sample		Men		Women	
	n	α	n	α	n	α
Decision latitude	10,971	0.79	7,999	0.78	2,972	0.80
Skill discretion	11,060	0.70	8,054	0.68	3,006	0.72
Decision authority	11,261	0.65	8,170	0.65	3,091	0.65
Psychological demands	10,963	0.77	7,991	0.77	2,972	0.77
Social support	10,674	0.80	7,776	0.80	2,898	0.82
Supervisor support	10,791	0.86	7,846	0.85	2,945	0.87
Co-worker support	11,176	0.77	8,118	0.76	3,058	0.80
Physical demands	11,204	0.85	8,135	0.86	3,069	0.80

Table 2 Means and standard deviations (SD) of the JCQ scales and subscales

Scale/subscale	Total sample			Men			Women		
	n	Means	SD	n	Means	SD	n	Means	SD
Decision latitude	10,971	71.67	10.65	7,999	72.93	10.09	2,972	68.26	11.35
Skill discretion	11,060	34.98	5.24	8,054	35.66	4.94	3,006	33.16	5.59
Decision authority	11,261	36.66	6.62	8,170	37.26	6.34	3,091	35.07	7.06
Psychological demands	10,963	22.72	4.01	7,991	22.69	3.96	2,972	22.81	4.13
Social support	10,674	22.00	3.37	7,776	22.10	3.26	2,898	21.75	3.64
Supervisor support	10,791	10.21	2.49	7,846	10.23	2.44	2,945	10.15	2.62
Co-worker support	11,176	11.80	1.67	8,118	11.87	1.59	3,058	11.60	1.84
Physical demands	11,204	7.77	2.53	8,135	7.80	2.58	3,069	7.68	2.40

Table 4 Exploratory factor analysis: JCQ items and corresponding factor loadings from the rotated factor pattern matrix, decimals omitted, for men ($n=7,401$) and women ($n=2,658$)

Item	Item number ^a	F1	F2	F3	F4	F5	Communality
Men							
Decision latitude							
Learn new things	1	33	0	15	-1	2	15
Repetitive work ^b	2	20	-14	-1	0	-2	7
Requires creativity	3	58 ^c	0	15	1	-4	39
Allows own decisions	4	65 ^c	4	2	1	1	42
High skill level	5	52 ^c	4	23	-7	4	36
Little decision freedom ^b	6	43 ^c	-14	-13	4	-4	24
Variety	7	66 ^c	4	1	-2	2	43
A lot of say	8	73 ^c	-3	-11	-2	-3	50
Develop own abilities	9	68 ^c	2	-5	6	3	49
Psychological demands							
Work fast	10	6	2	64 ^c	6	2	43
Work hard	11	15	-3	69 ^c	6	1	55
No excessive work ^b	13	-3	0	32	-3	-1	10
Enough time ^b	14	-8	-4	65 ^c	0	-6	42
Conflicting demands	17	-18	23	28	-23	-1	29
Intense concentration	18	16	2	48 ^c	-2	0	29
Tasks interrupted	19	-4	-9	58 ^c	-1	1	34
Hectic work	20	-3	0	75 ^c	-1	0	56
Wait on others	23	-5	17	31	-2	-3	13
Supervisor support							
Supervisor concerned	24	-1	3	1	76 ^c	-2	56
Supervisor pays attention	25	9	-4	2	79 ^c	-2	69
Helpful supervisor	26	-6	5	0	82 ^c	0	63
Supervisor good organizer	27	-2	0	2	72 ^c	5	52
Co-worker support							
Co-workers competent	28	-1	-2	-3	-1	55 ^c	30
Co-workers interested in me	29	6	1	5	1	69 ^c	51
Friendly co-workers	30	-3	-2	-4	-6	75 ^c	53
Co-workers helpful	31	-2	4	-1	9	66 ^c	47
Physical demands							
Much physical effort	12	1	57 ^c	7	2	2	32
Lift heavy loads	15	1	67 ^c	-10	1	2	45
Rapid physical activity	16	-1	67 ^c	-2	1	1	45
Awkward body positions	21	-1	90 ^c	-1	0	-1	81
Awkward arm positions	22	-1	88 ^c	0	0	-4	78
Women							
Decision latitude							
Learn new things	1	23	28	7	-5	2	17
Repetitive work ^b	2	33	3	-4	-8	0	12
Requires creativity	3	60 ^c	10	1	5	-1	39
Allows own decisions	4	68 ^c	3	0	3	3	49
High skill level	5	51 ^c	25	-10	1	0	36
Little decision freedom ^b	6	46 ^c	-14	0	-7	1	23
Variety	7	63 ^c	6	1	0	4	44
A lot of say	8	72 ^c	-12	-1	4	-3	48
Develop own abilities	9	67 ^c	3	11	-1	1	53
Psychological demands							
Work fast	10	6	60 ^c	3	4	1	38
Work hard	11	12	69 ^c	3	-2	0	52
No excessive work ^b	13	-8	34	-4	-6	2	11
Enough time ^b	14	-9	63 ^c	-4	-8	-1	38
Conflicting demands	17	-9	25	-24	27	-4	29
Intense concentration	18	19	50 ^c	-6	8	-4	35
Tasks interrupted	19	0	63 ^c	3	1	2	39
Hectic work	20	-2	76 ^c	3	2	0	57
Wait on others	23	4	17	-4	26	-8	14
Supervisor support							
Supervisor concerned	24	0	-2	75 ^c	3	1	56
Supervisor pays attention	25	10	0	81 ^c	-2	-2	72
Helpful supervisor	26	-3	1	85 ^c	2	-2	69
Supervisor good organizer	27	-4	1	77 ^c	0	3	58

Table 4 (Contd.)

Item	Item number ^a	F1	F2	F3	F4	F5	Communality
Co-worker support							
Co-workers competent	28	0	-1	-1	-1	50 ^c	25
Co-workers interested in me	29	7	1	-2	1	80 ^c	66
Friendly co-workers	30	0	0	-5	-2	81 ^c	63
Co-workers helpful	31	-2	0	11	2	68 ^c	51
Physical demands							
Much physical effort	12	6	3	2	58 ^c	1	34
Lift heavy loads	15	10	-17	-2	72 ^c	0	49
Rapid physical activity	16	12	-13	0	80 ^c	-3	60
Awkward body positions	21	-22	11	4	63 ^c	5	49
Awkward arm positions	22	-23	12	3	59 ^c	3	45

^aRefers to the order of the items in the self-administered questionnaire used in this study

^bThe response categories for these items were reversed before exploratory factor analysis

^cLoadings ≥ 0.40

($r = 0.21$) than for men ($r = 0.05$). Physical demands were negatively correlated with decision latitude ($r = -0.21$), and also with the two subscales of decision latitude. These demands were also negatively correlated with social support ($r = -0.11$), and with its two subscales.

Convergent validity

The mean scores for each scale and subscale are given in Table 7 for men and women separately, and for each sex, according to age, educational level, occupational grade, and job satisfaction. The mean scores for skill discretion and decision authority, and consequently for decision latitude, were significantly lower for women than for men. No difference was observed between men and women for psychological demands. The mean score for supervisor support did not differ for men and women, but the one for co-worker support did, leading to a significant difference for the total score for social support, women having a lower mean score for co-worker support and total social support than men. The

scores for physical demands were significantly higher for men than for women.

The association between age and the JCQ dimensions was examined separately for men and women. Age was associated with decision authority for men; the older the subjects, the greater the decision authority. This association was not observed for women. Age was not related to skill discretion or decision latitude for men or women. Age was significantly related to psychological demands for both men and women; psychological demands decreased with age. Social support, as well as supervisor and co-worker support, were not associated with age for men or women. Physical demands displayed gender-specific relations with age, as they decreased with age for men but not for women.

Educational level and occupational grade displayed the same associations with the JCQ dimensions for men and women. Decision latitude, and its subscales, increased with rising educational and occupational levels for both men and women. Note that clerks of both genders had the lowest mean scores for decision latitude, skill discretion and decision authority. Psychological

Table 5 Confirmatory factor analysis: comparison and goodness of fit indices of three models (*L* decision latitude, *D* psychological demands, *S* support, *P* physical demands, *CS* co-worker support, *SS* supervisor support, *SD* skill discretion, *DA* decision authority)

	Model 1: four latent factors L-D-S-P		Model 2: five latent factors L-D-CS-SS-P		Model 3: six latent factors SD-DA-D-CS-SS-P	
	Men	Women	Men	Women	Men	Women
<i>n</i>	7,401	2,658	7,401	2,658	7,401	2,658
χ^2	19,916.52	8,377.22	14,088.31	5,547.82	13,707.00	5,408.49
df	428	428	424	424	419	419
<i>P</i>	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
χ^2/df	46.53	19.57	33.23	13.08	32.71	12.91
CFI	0.76	0.73	0.83	0.82	0.84	0.83
NNFI	0.74	0.70	0.81	0.81	0.82	0.81
RMSEA	0.08	0.08	0.07	0.07	0.07	0.07
GFI	0.83	0.81	0.88	0.87	0.88	0.87
AGFI	0.80	0.78	0.86	0.85	0.86	0.85
RMR	0.04	0.04	0.04	0.04	0.04	0.04
Loadings	0.23–0.91	0.22–0.89	0.23–0.91	0.27–0.89	0.22–0.91	0.27–0.89
$\Delta\chi^2$			0.001	0.001	0.001	0.001

$\Delta\chi^2$: *P* for χ^2 difference test comparing the model against the preceding model

Table 6 Pearson's correlation coefficients for the JCQ scales and subscales. All coefficients except one are significant at $P < 0.001$

Scale/subscale		1	2	3	4	5	6	7	8
1. Decision latitude		1							
2. Skill discretion	Total	0.87	1						
	Men	0.86							
	Women	0.87							
3. Decision authority	Total	0.92	0.61	1					
	Men	0.92	0.59						
	Women	0.92	0.60						
4. Psychological demands	Total	0.14	0.24	0.03	1				
	Men	0.15	0.24	0.04					
	Women	0.15	0.27	0.02 ^a					
5. Social support	Total	0.37	0.32	0.34	-0.17	1			
	Men	0.37	0.32	0.34	-0.16				
	Women	0.36	0.31	0.33	-0.20				
6. Supervisor support	Total	0.34	0.29	0.32	-0.18	0.88	1		
	Men	0.35	0.29	0.33	-0.17	0.88			
	Women	0.33	0.28	0.31	-0.20	0.88			
7. Co-worker support	Total	0.24	0.22	0.21	-0.08	0.71	0.29	1	
	Men	0.23	0.22	0.19	-0.06	0.70	0.28		
	Women	0.23	0.20	0.20	-0.12	0.73	0.32		
8. Physical demands	Total	-0.21	-0.17	-0.21	0.09	-0.11	-0.10	-0.07	1
	Men	-0.26	-0.21	-0.25	0.05	-0.11	-0.11	-0.06	
	Women	-0.14	-0.10	-0.14	0.21	-0.10	-0.07	-0.11	

^aNot significant

demands increased with rising educational and occupational levels for men and women. The scores for the scale of social support and its two subscales also rose with increasing educational and occupational levels for both sexes; however, for women, the association between education and the subscale of supervisor support was not significant. Finally, the score for physical demands decreased with rising educational and occupational levels for men and women.

Job satisfaction was also explored in relation to the JCQ dimensions. Job dissatisfaction was associated with lower mean scores for decision latitude, skill discretion, decision authority, social support, supervisor support, and co-worker support, and with a higher score for physical demands. Job dissatisfaction was also related to a higher score for psychological demands for men only.

The second part of the convergent validity analysis was based on the study of job strain and iso-strain. Consequently, the scores for psychological demands, decision latitude, and social support were dichotomized at the median for the total sample. The threshold was 22 for psychological demands, 70 for decision latitude, and 22 for social support. Table 8 shows the prevalence of job strain and iso-strain by gender, and for each sex separately, by age, educational level, occupational grade, and job satisfaction. For the total sample, 20.73% of the subjects were exposed to job strain, i.e. to both low levels of decision latitude and high levels of psychological demands. The prevalence of job strain was significantly higher for women than for men (29.10% versus 17.67%). This prevalence decreased significantly with age for men, and the same tendency was observed

for women, although it was not significant. The higher the level of education, the lower the prevalence of job strain for both men and women. Similarly, the higher the grade of occupation, the lower the prevalence of job strain for both sexes. It is worth mentioning that the prevalence of job strain was highest among clerks: 34.16% for men and 40.89% for women. The prevalence of iso-strain (i.e. low decision latitude, high psychological demands, and low social support) was 15.06% for the whole study population. This prevalence was higher for women (20.45%) than for men (13.11%). It decreased significantly with age among men, but not among women. The higher the levels of education and occupation, the lower was the prevalence of iso-strain for both men and women. The occupational category of clerks was associated with the highest prevalence of iso-strain: 23.20% for men and 30.00% for women. Finally, job satisfaction was strongly associated with job strain and iso-strain. The prevalence of job strain and iso-strain increased with job dissatisfaction for both men and women.

Discussion

This study, based on a large cohort of workers belonging to various occupations, showed that the psychometric properties of the French version of the JCQ scales of decision latitude, psychological demands, social support, and physical demands are satisfactory for internal consistency, and convergent validity. Cronbach's alpha coefficients, all between 0.65 and 0.86, confirmed the

Table 7 Means for the JCQ scales by gender, and for each sex separately, by age, educational level, occupation and job satisfaction (*NS* not significant)

Characteristic	Decision latitude	Skill discretion	Decision authority	Psychological demands	Social support	Supervisor support	Co-worker support	Physical demands
Sex								
Men	72.93	35.66	37.26	22.69	22.10	10.23	11.87	7.80
Women	68.26	33.16	35.07	22.81	21.75	10.15	11.60	7.68
<i>P</i>	***	***	***	NS	***	NS	***	*
Men								
Age (years)								
45–49	72.92	35.78	37.11	22.70	22.02	10.20	11.85	8.02
50–54	72.82	35.64	37.18	22.79	22.10	10.24	11.87	7.86
55–58	73.39	35.63	37.75	22.27	22.16	10.25	11.92	7.35
<i>P</i>	NS	NS	**	***	NS	NS	NS	***
Educational level								
Primary	69.40	33.55	35.77	21.37	21.71	9.88	11.85	9.26
Lower vocational	71.63	34.95	36.67	22.34	21.99	10.15	11.84	8.26
Lower secondary	71.16	34.72	36.47	22.44	21.89	10.08	11.82	7.82
Upper secondary	72.92	35.76	37.11	22.84	21.94	10.14	11.80	7.38
Upper vocational	74.93	36.98	37.96	23.41	22.22	10.33	11.88	7.20
University	77.45	38.04	39.42	23.74	22.63	10.62	12.02	6.63
<i>P</i>	***	***	***	***	***	***	**	***
Occupation								
Craftsmen	66.69	32.60	34.14	20.83	21.34	9.69	11.65	10.57
Skilled industrial workers	66.49	32.50	34.00	20.46	22.16	10.06	12.10	11.31
Clerks	63.25	30.51	32.79	22.04	21.53	9.85	11.64	8.45
Foremen	71.38	34.75	36.64	22.11	21.91	10.07	11.85	8.30
Physical, engineering and life science associate professionals	68.29	33.70	34.54	22.03	21.47	9.84	11.65	8.89
Administrative associate professionals	71.49	35.06	36.43	22.84	21.63	9.95	11.71	7.59
Engineers	75.86	37.25	38.59	23.42	22.54	10.54	12.02	6.93
Managers	77.30	37.79	39.53	23.59	22.50	10.57	11.93	6.72
<i>P</i>	***	***	***	***	***	***	***	***
Job satisfaction								
Dissatisfied	67.98	33.58	34.42	22.83	20.66	9.16	11.51	8.14
Satisfied	75.01	36.54	38.46	22.64	22.73	10.70	12.03	7.65
<i>P</i>	***	***	***	*	***	***	***	***
Women								
Age (years)								
44	68.38	33.22	35.12	22.89	21.99	10.14	11.82	7.46
45–49	68.66	33.41	35.18	22.98	21.85	10.22	11.64	7.56
50–54	67.64	32.87	34.78	22.78	21.57	10.03	11.52	7.90
55–58	68.56	32.96	35.61	22.05	21.73	10.24	11.56	7.68
<i>P</i>	NS	NS	NS	**	NS	NS	NS	**
Educational level								
Primary	64.95	31.10	33.88	21.67	21.56	10.16	11.41	8.05
Lower vocational	67.39	32.60	34.79	22.63	21.64	10.07	11.59	7.77
Lower secondary	66.67	32.57	34.13	22.78	21.80	10.19	11.54	7.91
Upper secondary	68.27	33.26	35.01	23.03	21.54	10.01	11.57	7.33
Upper vocational	72.14	35.14	36.93	23.57	22.37	10.66	11.69	7.72
University	76.09	37.43	38.40	23.91	22.32	10.31	11.95	6.93
<i>P</i>	***	***	***	***	*	NS	*	***
Occupation								
Clerks	62.52	30.64	31.80	22.48	21.07	9.63	11.44	8.18
Forewomen	68.02	32.74	35.39	22.17	22.00	10.34	11.67	7.86
Administrative associate professionals	68.05	32.91	35.13	22.80	21.83	10.24	11.59	7.67
Engineers	75.61	37.11	38.33	23.85	21.94	9.97	11.98	7.23
Managers	76.55	37.70	38.77	23.74	22.36	10.58	11.72	6.80
<i>P</i>	***	***	***	***	***	***	**	***
Job satisfaction								
Dissatisfied	63.68	31.14	32.57	22.91	20.39	9.21	11.20	7.99
Satisfied	71.03	34.37	36.60	22.76	22.53	10.68	11.83	7.48
<i>P</i>	***	***	***	NS	***	***	***	***

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

Table 8 Prevalence of job strain and iso-strain by gender, and for each sex separately by age, educational level, occupation and job satisfaction (*NS* not significant)

Characteristic	Job strain (%)	Iso-strain (%)
Total	20.73	15.06
Sex		
Men	17.67	13.11
Women	29.10	20.45
<i>P</i>	***	***
Men		
Age (years)		
45–49	18.69	13.80
50–54	18.37	13.54
55–58	13.73	10.61
<i>P</i>	***	*
Educational level		
Primary	17.95	15.00
Lower vocational	19.30	14.74
Lower secondary	19.79	14.01
Upper secondary	16.27	11.09
Upper vocational	17.88	12.03
University	12.41	8.94
<i>P</i>	***	***
Occupation		
Craftsmen	24.64	20.45
Skilled industrial workers	17.63	15.04
Clerks	34.16	23.20
Foremen	17.97	13.64
Physical, engineering and life science associated professionals	24.59	18.29
Administration-associated professionals	22.43	18.41
Engineers	15.01	10.07
Managers	12.42	8.55
<i>P</i>	***	***
Job satisfaction		
Dissatisfied	27.69	23.13
Satisfied	13.46	8.82
<i>P</i>	***	***
Women		
Age (years)		
44	30.60	21.01
45–49	29.29	19.77
50–54	29.08	21.38
55–58	26.81	19.69
<i>P</i>	NS	NS
Educational level		
Primary	29.51	24.56
Lower vocational	30.06	20.75
Lower secondary	32.70	20.36
Upper secondary	33.24	25.89
Upper vocational	20.73	16.34
University	15.38	10.31
<i>P</i>	***	***
Occupation		
Clerks	40.89	30.00
Forewomen	24.78	16.92
Administration-associated professionals	29.63	20.23
Engineers	13.40	12.43
Managers	18.64	12.67
<i>P</i>	***	***
Job satisfaction		
Dissatisfied	37.33	30.75
Satisfied	24.31	14.52
<i>P</i>	***	***

P* < 0.05; **P* < 0.001

adequate internal consistency of the JCQ scales and subscales. The results of exploratory factor analysis showed that five factors were clearly associated with the dimensions of decision latitude, physical demands, psychological demands, supervisor support, and co-worker support. However, our results raise concerns about some items, which were ‘*learn new things*’, ‘*repetitive work*’, ‘*conflicting demands*’, ‘*wait on others*’, and to a lesser extent ‘*no excessive work*’. Confirmatory factor analysis suggested that the best model consisted of six latent factors: skill discretion, decision authority, psychological demands, supervisor support, co-worker support, and physical demands. However, this model may not provide an acceptable fit in our study population. Confirmatory factor analysis confirmed the low loadings of the five items mentioned previously, especially ‘*repetitive work*’, ‘*conflicting demands*’, and ‘*wait on others*’. Analysis of the correlations between scales and subscales supported the satisfactory structure of the JCQ. Finally, the variations in the mean scores and prevalences of job strain and iso-strain were consistent with the expected associations between the JCQ dimensions and the key variables of gender, age, educational level, occupational grade, and job satisfaction.

As far as we know, two previous validation studies have been performed on the French version of the JCQ: a study by Larocque et al. (Larocque et al. 1998) on a representative sample of 1,110 workers in Quebec, and a study by Brisson et al. (Brisson et al. 1998) on a sample of 8,263 white-collar workers in Quebec. In addition, two validation studies have been published by Kawakami et al. (Kawakami et al. 1995; Kawakami and Fujigaki 1996) for the Japanese version of the JCQ. A study of the Dutch version by Houtman et al. was also included in the paper by Karasek et al. (Karasek et al. 1998), in which two validation studies of the American version were described. We compared our results with the results of these studies. Obviously, sociodemographic and occupational characteristics may differ between study populations, for example for age, educational or occupational groups, which may give rise to discordant results, especially for convergent validity.

The means for each JCQ scale and subscale observed in the GAZEL cohort were compared with the means obtained from the six studies conducted in four different countries (the US; Quebec, Canada; the Netherlands; and Japan), and presented by Karasek et al. (1998). To test statistical differences, we compared the 95% confidence interval of the mean for each scale and subscale in GAZEL to the 95% confidence interval calculated from the mean and standard deviation in the total sample of the international study described previously (Karasek et al. 1998). The means for skill discretion and decision authority, and consequently for decision latitude, were higher in the GAZEL cohort. In addition, the mean for psychological demands was lower, and the means for supervisor and co-worker support were also lower in our cohort for both men and women. No comparison could be made for physical demands, because the five-item

scale was not explored in any previous study. As regards standard deviations, they were consistent with those previously reported (Karasek et al. 1998).

In the GAZEL cohort, internal consistency was adequate for all scales and subscales of the JCQ, and Cronbach's alpha coefficients were consistent with those previously observed. Note that the internal consistency of psychological demands appeared to be stronger here ($\alpha = 0.77$) than in previous validation studies. During the recent workshop held in Brisbane (Karasek 2000), relatively moderate alpha coefficients, between 0.50 to 0.70, were reported for this scale. In addition, the scale of supervisor support displayed higher internal consistency for GAZEL women. As shown in previous studies, no difference was observed between men and women for internal consistency (Karasek et al. 1998).

Exploratory factor analysis showed that the expected dimensions of physical demands, supervisor support, and co-worker support were clearly found. Kawakami et al. (1995) also showed that the items of social support loaded on two different factors, thus distinguishing supervisor support from co-worker support. All the items of decision latitude loaded on the same factor, except '*repetitive work*' and '*learn new things*'. This result was in agreement with that of Kawakami et al. (1995) for the item of '*repetitive work*', but contradicted the results reported by Larocque et al. (1998) and Brisson et al. (1998), who found that all the nine items of decision latitude loaded on the same factor. Most of the items of psychological demands loaded on the same factor, except the items '*conflicting demands*', '*wait on others*', and to a lesser extent '*no excessive work*'. Larocque et al. (1998) showed that these two first items had low loadings on the psychological demand factor. In the study by Brisson et al. (1998) too, the item '*wait on others*' did not load on the psychological demand factor. Confirmatory factor analysis showed that the best model consisted of six latent factors which were skill discretion, decision authority, psychological demands, supervisor support, co-worker support, and physical demands. Consequently, the results of confirmatory factor analysis supported the division of social support into supervisor support and co-worker support, and the division of decision latitude into skill discretion and decision authority. However, the goodness-of-fit indices did not show an acceptable fit. Low loadings were observed for the items of '*conflicting demands*', '*wait on others*', '*repetitive work*', and to a lesser extent for '*no excessive work*' and '*learn new things*'. In conclusion, our results for factorial validity confirmed the general pattern of the JCQ structure, although some items displayed low factor loadings for the scales of decision latitude and psychological demands in agreement with previous reports (Karasek et al. 1998; Karasek 2000).

We explored the JCQ structure further by analyzing the correlations between scales and subscales. A coefficient of 0.61 was found for the correlation between the subscales of skill discretion and decision authority, in agreement with previous reports showing a relatively

strong positive correlation between these two subscales of decision latitude (Karasek et al. 1998). A coefficient of 0.29 was observed for the correlation between the two subscales of social support. This coefficient was lower than all the coefficients observed in previous studies, in which the mean coefficient was 0.40 (Karasek et al. 1998). Psychological demands displayed a low positive correlation with decision latitude, as shown previously (Karasek et al. 1998). This result supports the hypothesis that these two scales explore two distinct psychosocial dimensions. In addition, psychological demands were more strongly correlated with skill discretion than with decision authority, which confirmed previous results (Karasek et al. 1998) and supported the notion that skill discretion might also be another aspect of psychological demands. The two scales of social support were positively correlated with decision latitude and its subscales. Note that the positive correlations between supervisor support and the scale and subscales of decision latitude were higher in our study than in previous ones. Although the comparison is difficult for physical demands, because no previous authors used the recommended five-item scale, similar negative correlations were previously observed with the scale and subscales of decision latitude. In addition, these negative correlations were stronger for men than for women, which is also consistent with previous results. Physical demands displayed a low positive correlation with psychological demands, but it was higher for women (0.21) than for men (0.05). The correlations between physical demands and the subscales of social support were negative but low, thus confirming other results (Karasek et al. 1998).

The associations between the JCQ dimensions and key variables were examined in the convergent validity analysis. Strong differences were observed between the sexes for decision latitude and its subscales of skill discretion and decision authority. In agreement with previous studies (Karasek et al. 1998), the means for women were lower for both subscales, and consequently, for decision latitude. The mean for psychological demands did not differ for men and women in accordance with previous results (Karasek et al. 1998). Earlier studies showed that men and women had a similar mean for both supervisor support and co-worker support. In our study, no difference was observed in this respect for supervisor support, but women had a lower mean for co-worker support than men, leading to a significant difference between men and women in the total score for social support. This gender difference might partly be due to the fact that 80% of EDF-GDF employees are male. Thus, women may be more isolated in a male dominated environment than men. A small but significant difference was also observed for physical demands, which were higher for men than for women. Previous studies, in which the recommended version of the scale of physical demands was not used, showed no difference between men and women (Karasek et al. 1998).

Age was not associated with either the subscales of decision authority and skill discretion, or the total score

of decision latitude for men and women. Nevertheless, an association was observed between age and decision authority for men; the higher the age, the higher the mean for decision authority, thus showing that older and/or more experienced men had a greater influence on decision making. Previous studies showed that the correlations between age and the decision latitude scale and subscales were positive but very low (Karasek et al. 1998). Psychological demands decreased with age for men and women, thus confirming the negative correlation between age and psychological demands reported in previous studies (Karasek et al. 1998). No association was observed between age and the subscales and scale of social support, contrary to previous results showing low but negative correlations between age and the social support scale and subscales (Karasek et al. 1998). Here, age was related to physical demands in a different way for men and women; thus, physical demands decreased with age for men, but not for women. These results are in agreement with those of previous studies showing a negative correlation between age and physical demands for men and a positive one for women (Karasek et al. 1998). This negative correlation for men might be due to the orientation of the older men towards jobs with a smaller physical work load. Note that our results for age may have been limited by the small range of ages in the GAZEL cohort.

The associations between educational level and the JCQ dimensions were all very significant for men and women, except for the subscale of supervisor support, which displayed no significant association with education for women. Skill discretion and decision authority, and consequently decision latitude, rose strongly with the educational level for both men and women, confirming the positive correlations observed in previous studies (Karasek et al. 1998). Psychological demands also increased with the educational level for both sexes, in agreement with the positive correlations observed previously (Karasek et al. 1998). The means for the social support scale and subscales increased with the level of education, but the association was low for women and even non-significant for supervisor support. Previous studies showed very low positive correlations between education and the subscales of social support (Karasek et al. 1998). Physical demands decreased strongly with the educational level for both men and women, thus confirming the negative correlations observed in previous studies (Karasek et al. 1998).

Occupational grade also displayed strong associations with the JCQ measurements. The means for the scale and subscales of decision latitude increased with the occupational grade for men and women. Psychological demands also increased with this grade. The means for the scale and subscales of social support increased with the occupational grade, and the mean for physical demands decreased with it. Larocque et al. (1998) and Brisson et al. (1998) also showed that psychological demands and decision latitude increased with occupational grade. In the study by Kawakami et al.

(1995), the mean score for the scale and subscales of decision latitude rose with this grade.

Job satisfaction displayed strong significant associations with the scales and subscales of the JCQ, except for psychological demands, which were not significant for women. Job satisfaction was associated with higher means for skill discretion, decision authority, decision latitude, supervisor support, co-worker support, and social support, and with a lower mean for physical demands.

The associations of job strain and iso-strain with key variables, i.e. gender, age, educational level, occupational grade, and job satisfaction, were also examined. The prevalence of job strain, i.e. the combination of high demands and low latitude, was 20.73% in our study population, and was significantly higher for women (29.10%) than for men (17.67%). Similar results were observed in previous studies conducted in Canada, Denmark, England, and the United States (Brisson 2000). These results are mainly due to the lower levels of decision latitude for women. Our results showed that the prevalence of job strain decreased with age only for men. In the study by Brisson et al. (1998), the prevalence of job strain also decreased with age, but the results were not given for men and women separately. In the GAZEL cohort, the prevalence of job strain was strongly associated with educational and occupational levels for both men and women, and decreased with increasing levels of education or occupation. These results are consistent with those of previous studies (Brisson et al. 1998; Larocque et al. 1998). Job strain was also strongly associated with job dissatisfaction for both sexes. Similar results were found here for the prevalence of iso-strain, i.e. the combination of high demands, low latitude, and low support. This prevalence was higher for women (20.45%) than for men (13.11%). It decreased with age for men only, rose with decreasing levels of education and occupation for both sexes, and was strongly associated with job dissatisfaction among both men and women.

In conclusion, the results of this validation study indicate that the psychometric properties of the French version of the four JCQ scales of psychological demands, decision latitude, social support, and physical demands were satisfactory in a large cohort of men and women employed in various occupations. Nevertheless, our results underline the fact that the inclusion of some items could be questioned for the factorial structure of the instrument and could provide a potential basis for future revision of the two scales of decision latitude and psychological demands.

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