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Validation of Visual Analogue Scales of job demand and job control at the workplace: a cross-sectional study

Frederic Dutheil ,[1,2] Bruno Pereira,[3] Jean-Baptiste Bouillon-Minois ,[4] Maëlys Clinchamps ,[1] Georges Brousses,[5,6] Samuel Dewavrin,[7] Thomas Cornet,[7] Martial Mermillod,[8,9] Laurie Mondillon,[10,11] Julien S Baker,[12] Jeannot Schmidt,[4] Farès Moustafa,[13] Charlotte Lanhers[14]

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For numbered affiliations see end of article.

Correspondence to
Maëlys Clinchamps;
mclinchamps@chu-clermontferrand.fr

ABSTRACT

Objectives Work-related stress is a major concern. One of the best performing models is the Job Content Questionnaire (JCQ) of Karasek, assessing job demand and job control using 18 items. However, the JCQ is long and complex. Visual Analogue Scales (VASs) are easy to use and quick to implement. VASs have been validated to assess pain and occupational stress; however, VASs demand and control have not been evaluated. Therefore, we aimed to validate the use of VAS demand and control compared with the 18 items of the JCQ.

Design We implemented a cross-sectional observational study, by administering a self-reported questionnaire to the users of Wittyfit software, with a second test (retest) proposed 1 week later. In addition to JCQ, VAS demand and control, we measured sociodemographic outcomes, as well as characteristics of work, sleep, well-being, stress, depression and anxiety.

Participants 190 volunteers French workers using WittyFit software participated in the study, and 129 completed the test–retest.

Results VAS demand and VAS control correlated with the two Karasek domains from the JCQ, respectively, at 0.59 and 0.57 ($p<0.001$). Test–retest reliability highlighted concordance coefficients higher than 0.70. Sensitivity was higher than 70% for each VAS. External validity was acceptable. For both demand and control, VAS cut-offs were 75/100. Compared with other workers, senior executives and individuals with master's degrees had higher levels of job control but did not differ in job demand using the VAS and JCQ.

Conclusions VAS demand and VAS control are valid, quick, easy to use, and reliable tools for the assessment of job demand and job control. They can be used in daily clinical practice for primary prevention and diagnosis. However, when results are over 75 mm on VAS, we promote the use of JCQ to be more discriminant and specific to initiate action plans to help workers.

Trial registration number NCT02596737.

Strengths and limitations of this study

- The use of Visual Analogue Scales (VASs) for job demand and job control are valid, quick, easy to use and reliable tools compared with the Job Content Questionnaire (JCQ) of Karasek, considered as the historical model to assess job demand and job control.
- The findings are based on a test–retest completed by 129 participants. The number of participants who responded to both the test and retest was higher than commonly reported in the literature.
- Despite the widespread use and relevance of VAS, VAS provide global first-line evaluations that do not accurately assess putative explanations of stress factors such as those provided using the JCQ of Karasek.
- We promote the use of VAS for both demand and control domains as an easy tool to detect abnormal situations. If abnormal situations are detected; occupational physicians should further assess workplace stress with the use of the JCQ.

INTRODUCTION

Stress refers to the consequences of the failure of a living organism to respond appropriately to emotional or physical threats whether actual or imagined.[1] Stress can be defined as any threat to an organism's homoeostasis.[2] Stress is a condition that affects people daily and is influenced by multiple environmental factors, especially factors related to job such as deleterious working conditions.[3] Indeed, work-related stress is now a major concern.[4] Workplace stress encompasses a range of psychological and physical perturbations that negatively affect health, relationships, quality of life and well-being.[5] Stress at work is a risk factor for chronic diseases such as cardiovascular or mental events.[6–8] However, with most adults spending half of their waking hours at work, the workplace is an important setting to promote health and well-being.[9] Over the past decades, the concept of occupational stress has increased in popularity and several questionnaires, scales, measurements or evaluation tools have been developed and validated.

Despite further evolution and other models,[10–12] one of the historical concepts of occupational stress is the job demand-control model (JDC) created and validated by Karasek *et al*.[13] This model recognises the importance of daily environmental stressors on the long-term experience of stress.[14] It is based on two main hypotheses: the strain hypothesis predicts that job demands, aredefined as a high workload, time pressures and increased employee's stress. The buffer hypothesis predicts that increasing control (autonomy and skill use) can alleviate the negatives effects of high demands. The active job quadrant is defined by high demands and high control, and the strain high stress quadrant is defined by high demands with low control.[13 15] The Job Content Questionnaire (JCQ) derived from Karasek's model[16] has been developed and validated in several languages. Studies have highlighted its psychometric properties, especially in a French population of 24 486 workers.[17 18] However, this tool is difficult to use in daily medical consultations because of its length (18 items) and complexity. Limits of self-reported questionnaires include their low level of completion and participation,[19 20] and their low level of representativeness[21] inducing a high level of missing data.[22] Participation rate decreases with the length of the questionnaire, in addition to a decrease in attention and concentration.[23]

Occupational physicians have limited time because of the number of workers and worksites.[24] As stress at work is a major public health concern,[25] occupational physicians have to include consequences of psychosocial risks in their clinical diagnosis. They need a simple and fast instrument to use daily. The Visual Analogue Scale (VAS) is well known and valid in the clinical assessment of pain,[26] for occupational stress[27 28] and satisfaction at work.[29] The VAS is a suitable tool for clinical activity and has good psychometric characteristics.[26–28] Therefore, we hypothesised that VAS for job demand and job control would be appropriate tools to distinguish workers at risk of workplace-related stress versus the job-demand control questionnaire of Karasek.

The main purpose of the present work was to validate VAS demand and VAS control replacing the 18 items of the two domains of Karasek's model (demand and control). We evaluated the external validity of the two VAS (control and demand) by highlighting their relationships with various parameters such as sociodemographics, professionals (VAS stress at work or working hours) or well-being (sleep).

METHODS

Participants

We implemented a cross-sectional observational study. Self-reported questionnaires were proposed to voluntary French workers using WittyFit software (https://wittyfit.com/). Users of WittyFit were disseminated through several national French companies, mostly from the service sector (tertiary sector). WittyFit is software that aims to improve well-being at work with an epidemiological design, and a collaborative partnership with researchers (public–private partnership between WittyFit and the University Hospital of Clermont-Ferrand).[30] Workers using WittyFit were proposed to answer validated self-questionnaires on behavioural data for personalised evaluation. Workers can answer WittyFit questionnaires using a dedicated application, available for computers or smartphones, at any time. The concept of WittyFit is to provide health profiling with an individualised feedback based on evidence-based medicine. It aims to support behavioural change over time, and to assess the relationships between changes in knowledge, practices, and health outcomes. Exclusion criteria of participants were the inability to read, understand or answer on-line questionnaires. Answering Wittyfit questionnaires implied consent. The study was conducted on workers using WittyFit software between 1 June 2016 and 30 June 2016. All data were anonymous. The name of the employee was never revealed. The database was implemented from a human resource generated number, automatically converted in another number into the WittyFit database.[30] Data provided by employers (eg, occupation, department, sick leave) were automatically associated with the human resource-generated number.

Patient and public involvement

This was an exploratory study in an ecological situation. The WittyFit users were informed of a forthcoming questionnaire on the platform, explaining the purpose of the study (validation study) and the need to complete the questionnaire twice (test, and retest 1 week later). Workers were not involved in the design, conduct, reporting or dissemination plans of this research.

Primary outcome

The primary objective was to validate the two VAS (demand, control) in replacement of Karasek's questionnaire. Job demand and latitude decision making was evaluated by the 18 items of the Karasek's questionnaire (JCQ)[16] and by VAS control and VAS demand. The JCQ measures nine items of job control (questions Q1–Q9), nine items of job demand (Q10–18). Items of JCQ were scored on a four-point Likert-type scale, ranging from one (strongly disagree) to four (strongly agree). As suggested by the authors, the score for each dimension was calculated using the following equations: Q10 +Q11+Q12 + (5-Q13)+Q14+Q15+Q16+Q17+Q18 for job demand, and 4*Q4 +4*(5-Q6)+4*(Q8) +2*(5-Q2)+2*(Q5) +2*(Q7) +2*(Q1) +2*(Q3) +2*(Q9) for job control. According to Karasek,[13 14] combining scores of job demand and job control allowed to define four situations at work (active, passive, relaxed, tense/job strain) corresponding to four quadrants, with an allocation between various socioprofessional groups (figure 1). From French data,[18] the job strain threshold was set for a demand score higher than 21 and a control score less than 70. VAS assessed the perceived control and demand of individuals at work, on

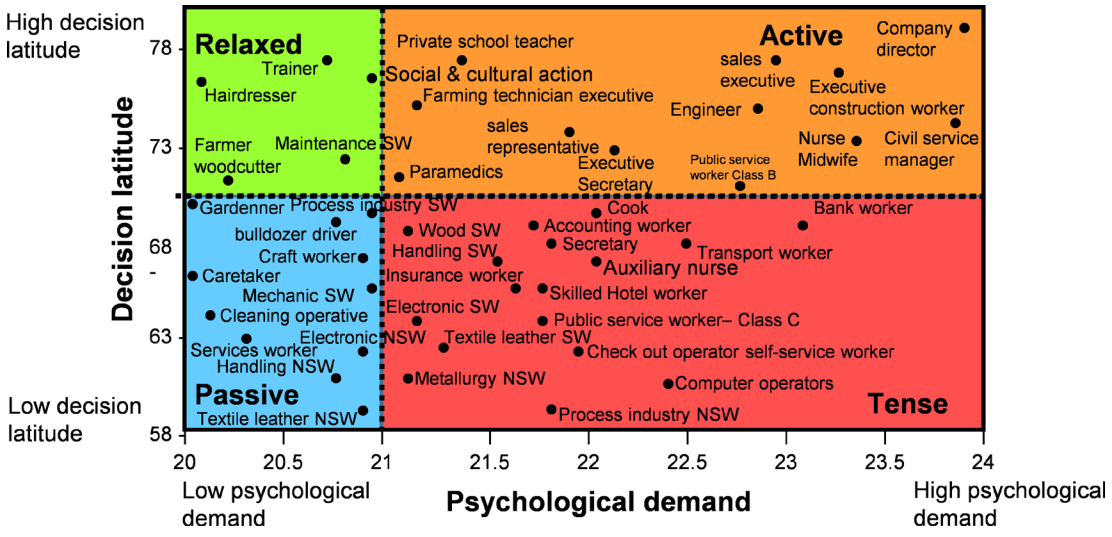

Figure 1 The job demand-control model of Karasek and its four quadrants: active, passive, relaxed and tense (job strain). NSW, non-skilled worker; SW, skilled worker.[17 18]

a horizontal, non-calibrated line of 100 mm, ranging from very low (0) to very high (100).

Secondary outcomes

We retrieved sociodemographic data such as age, gender, education level and marital status. We also collected characteristics of work: occupation, number of hours at work per week, and seniority within the company. Sleep quantity was assessed by the number of hours of sleep per night.[31] Sleep quality, well-being, stress at work and stress at home were evaluated using VAS ranging from very low (0) to very high (100).[24 28] We evaluated depression (D) and anxiety (A) with the use of the Hospital and Anxiety Depression Scale (HAD).[32] The HAD is a 14-item self-reported measure with two subscales of seven items, one assessing anxiety (HAD-A) and the other assessing depression (HAD-D), rated from zero to three. As suggested by the authors, the HAD-A score is calculated by adding the scores for questions 1, 3, 5, 7, 9, 11 and 13; and the HAD-D score with questions 2, 4, 6, 8, 10, 12 and 14. The scores for each subscale range from 0 to 21. A score less than seven means the absence of disease; between eight and ten a doubtful disease; a score higher than 11 is a confirmed disease.

Time of measurements

Participants completed the questionnaires when time was convenient to them. They were automatically asked to complete the two VAS (VAS demand and VAS control) and the JCQ 1 week after the first completion of questionnaires, to perform test–retest. Total completion time was approximately 30 min (20 min first session and 10 minutes second session).

Statistics

Sample size was determined according to COSMIN (COnsensus-based Standards for the selection of health status Measurement INstruments) recommendations[32 33]: (1) 'Rules-of-thumb vary from four to ten subjects per variable, with a minimum number of 100 subjects to ensure stability of the variance-covariance matrix' and (2) 'Often 0.70 is recommended as a minimum standard for reliability. We gave a positive rating for reliability when the ICC (Intraclass correlation coefficients) or weighted Kappa was at least 0.70 in a sample size of at least 50 patients.'

All analyses were performed using Stata software (V.13, StataCorp) for a two-sided type I error of α=5%. Participant's characteristics were expressed as means±SD or median (IQR) for continuous data (assumption of normality assessed using the Shapiro-Wilk test) and as numbers (percentages) for categorical parameters. We followed the usual steps of validation of a new questionnaire.[33] Internal validity allows verification that the independent variable (Karasek score) and is responsible for variation of the dependent variable (VAS control and VAS demand). The internal validity of the two VAS was assessed according tointernal consistency based on correlation coefficient (Pearson or Spearman) and Cronbach alpha coefficient (adequate expected values higher than 0.64)[34]—we also explored more deeply the relationship between each VAS and items of Karasek questionnaire using correlation coefficients and principal component analysis.[33] Test–retest reproducibility was assessed using Lin concordance coefficient and Bland and Altman plots.[35] External validity takes into account generalisability of the new scales, that is, relation with other variables or groups. External validity was assessed using correlation coefficients (Pearson or Spearman) between VAS and sociodemographic or other psychological measures, such as sleep, well-being, stress, anxiety or depression scores. Then, a receiver operating characteristic (ROC) curve analysis was proposed to determine the best thresholds of VAS to predict a gold-standard Karasek, according to clinical relevance and usual indexes reported in the literature (Youden, Lin and efficiency). Sensitivity, specificity, positive and negative predictive

values were calculated and presented with 95% CIs. The concordance between Karasek quadrants and their equivalents from VAS, according to cut-offs determined by ROC curve analysis, was evaluated using agreement rate and Kappa concordance coefficient. Finally, quantitative variables were compared between independent groups by analysis of variance (ANOVA) or Kruskal-Wallis test if ANOVA conditions were not met (normality and homoscedasticity analysed using the Bartlett test). When appropriate, post hoc tests were performed considering multiple comparisons (Tukey-Kramer post ANOVA and Dunn after Kruskal-Wallis). The comparisons between groups were carried out using the χ^2 or Fisher's exact test for categorical variables. When appropriate, a post hoc test was used (Marascuillo procedure).

RESULTS

Participants

Among the 1580 workers using WittyFit, 190 (12.0%) agreed to participate. We had no missing data (n=190; 100%) for primary outcomes that is, Karasek questionnaire, VAS demand and VAS control. Secondary outcomes were fulfilled by 163 (85.8%)of respondents. Among them, 89 (54.1%) were women. The test–retest approach was performed on the 129 participants who answered twice to the Karasek questionnaire and the two VAS (demand and control) (figure 2). At baseline, the 190 and 163 workers did not differ according to sensibility analysis. Mean age was 41.9±11.7 years. Seniority within the company was 11.0±10.8 years. Most of the workers were senior managers (68.1%) and had a master's degree (74.9%) (table 1).

JCQ of Karasek

According to Karasek's Model, 53.2% of participants were 'active' (demand score ≥21and control score ≥70) with a mean demand score of 25.0±4.0and a mean control score of 83.8±35.0; 30.0% were 'relaxed' (demand score <21and control score ≥70) with a mean demand score of 22.0±5.0and a control score higher of 83.8±35.0; 14.7% were 'tense/job strain' (demand score ≥21and control score <70) with a demand score of 25.0±4.0and a control score of 61.9±5.6; 10.5% were 'passive' (demand score <21and control score <70) with a demand score of 22.0±5.0and a control score of 61.9±5.6 (table 2). There were no statistical differences regarding age, sex and marital status, at the dimensions evaluated by the JCQ of Karasek (demand and control) or between quadrants (active, passive, tense/job strain, relaxed). Workers with longer seniority/experience within the company tended to have higher job control (p=0.09). Compared with other workers, senior executives and master's degree staff had higher levels of job control (p<0.05) but did not differ in job demand (online supplemental appendix 1).

VAS demand and VAS control

Mean VAS demand was 75.2±20.6and mean VAS control was 81.9±21.9. Using the retrieved cut-off of 75 (see below), 56.3% of workers had a VAS demand ≥75% and 72.6% a VAS control ≥75 (table 2). As for JCQ, there were also no influence of age and sex on both VAS demand and VAS control. Married workers perceived a higher job demand (p=0.03). Workers with a higher seniority in the company had a higher VAS control (p=0.02). Workers with a seniority within the company above 15 years had a higher VAS control than workers with a seniority below 2years (90.0±5.3 vs 10.0±5.2, p<0.001). Similarly, to JCQ, senior executives and master's degree holders had or tended to have higher levels of job control (p<0.10) but did not differ in job demand (online supplemental appendix 1).

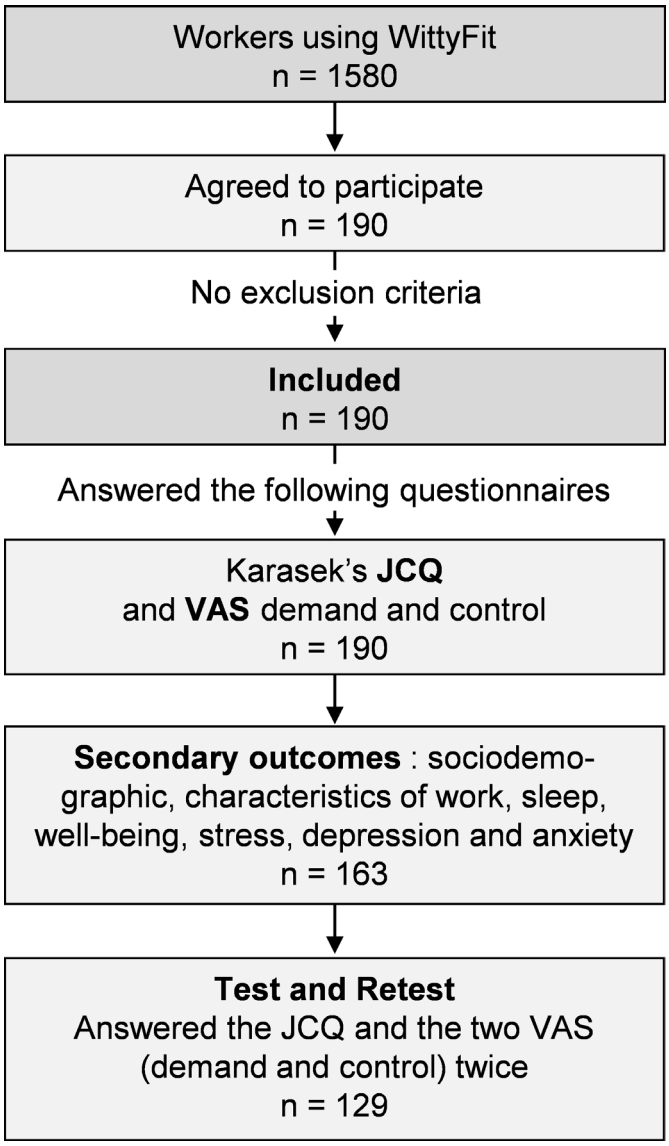

Figure 2 Flow chart and study design. JCQ, Job Content Questionnaire; VAS, Visual analogue scale.

Validation of VAS demand and VAS control: internal validity

Internal consistency

Significant correlations were emphasised: 0.59 (p<0.001) between the demand score from the JDC of Karasek and the VAS demand and 0.57 (p<0.001) between the control (latitude decision) score from the JDC of Karasek and the VAS control. The Cronbach alpha coefficient was

Table 1 Characteristics of participants

Characteristics of participants	Sample size (n=163)	%
Sex		
Women	89	54.6
Men	74	45.4
Age, year (mean±SD)	41.9±11.7	
Education level		
Bachelor degree or less	8	4.9
Undergraduate	33	20.3
Master's degree	122	74.9
Marital status		
Single	33	20.3
De Facto	45	27.6
Married	84	51.5
Widow	1	0.6
Occupational categories		
Senior executives	111	68.1
Mid-level workers	10	6.1
Skilled workers	16	9.8
Unskilled workers	26	26.9

Table 2 Job-demand and job-control assessed with the use of Visual Analogue Scale (VAS) or the Job Content Questionnaire of Karasek

Variables	Sample size n=190 (%)	Mean±SD
VAS		
VAS job-demand		**75.2±20.6**
VAS job-demand <75	83 (43.7)	53.8±19.2
VAS job-demand ≥75	107 (56.3)	88.3±8.3
VAS latitude decision		**81.9±21.9**
VAS latitude decision <75	52 (2.4)	52.3±22.2
VAS latitude decision ≥75	138 (72.6)	91.1±8.6
Modèle de Karasek		
Dimensions		
Job-demand		**22.0±5.0**
Job-demand <21	61 (32.1)	16.0±3.0
Job-demand ≥21	129 (67.9)	25.0±4.0
Latitude decision		**76.7.±8.5**
Latitude decision <70	48 (25.3)	61.9±5.6
Latitude decision ≥70	142 (74.7)	83.8±35.0
Quadrants		
Active	101 (53.2)	
Passive	20 (10.5)	
Tense/job strain	28 (14.7)	
Relaxed	41 (21.6)	

0.68. The relationships between each VAS and items of Karasek questionnaire are presented in online supplemental appendix 2. Briefly, for each dimension (control and demand), all items of the Karasek questionnaire were correlated with the corresponding VAS, except item 14, and the highest correlations were found between items 4, 6 and 8 and VAS control, and between items 11 and 15 and VAS demand.

Test–retest reproducibility

Lin concordance coefficient was 0.73 (95% CI 0.64 to 0.81) for job demand between the demand score from the JDC of Karasek and the VAS demand and 0.71 (95% CI 0.63 to 0.80) for job control the control score from the JDC of Karasek and the VAS control (figure 3).

Cut-off's determination and concordance

For both VAS demand and VAS control, we emphasised a significant cut-off set at 75, with a good sensitivity and specificity. For VAS demand, the retrieved cut-off (p<0.001) of 75 had a sensitivity of 71%, a specificity of 74%, an area under ROC curve of 0.79±0.04 (95% CI 0.72 to 0.85), a positive predictive value of 70.5% (95% CI 61.9% to 78.2%) and a negative predictive value of 73.8% (95% CI 60.9% to 84.2%). For VAS control, the retrieved cut-off (p<0.001) of 75 had a sensitivity of 81%, specificity of 56%, an area under ROC curve of 0.76±0.04 (95% CI 0.68 to 0.84), a positive predictive value of 91% (95%CI 73.6% to 87.1%) and a negative predictive value of 54.2% (95% CI 39.2% to 68.6%).

The concordance between Karasek quadrants and their equivalents from VAS was relatively low (k=0.37) with percentages of agreement of 54.9% between Karasek quadrants and their equivalents. Groups according to VAS emphasised more 'actives' and 'strain' workers than JCQ. However, 'relaxed' and 'passives' workers were overall more highlighted with JCQ (table 3).

Validation of VAS demand and VAS control: external validity

VAS demand

According to cut-offs for VAS, a high job demand was linked with a higher stress at work (p<0.001) and at home (p=0.03), and a higher time spent at work (p<0.001). The higher job control, the higher VAS well-being (p=0.04). Relationships were similar using the JCQ, as well as for other quantitative or qualitative secondary outcomes (age, sex, education level, seniority within the company, occupation, HAD-D, HAD-A, number of hours at work per week, duration of sleep) that were non-significant according to cut-offs both for VAS demand and JCQ, except the relationship between quality of sleep and job demand that was retrieved mainly using the JCQ and between marital status and job demand that was retrieved mainly using the VAS demand (table 4 and online supplemental appendix 1).

VAS control

According to cut-offs for VAS, the higher job control is linked to the higher VAS well-being (p=0.04) and the higher education level (p=0.009). Using the JCQ, the same relationship was shown (p<0.02). Relationships

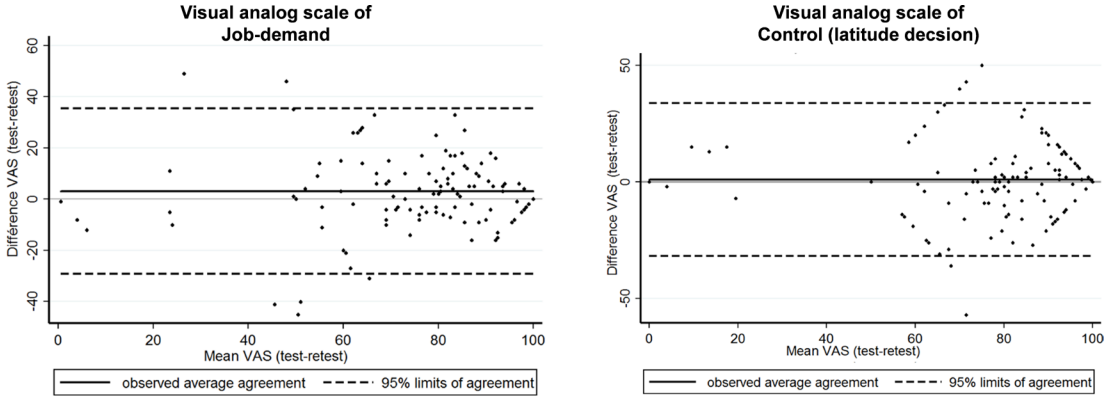

Figure 3 Bland and Altman plot or representation of agreement between both series of Visual Analogue Scales (VAS) of job demand and job control.

were similar—non-significant—for other quantitative secondary outcomes (age, sex, marital status, HAD-D, HAD-A, number of hours of work per week, duration of sleep, VAS stress at work, VAS stress at home) both for VAS control and JCQ, except the relationship between quality of sleep, occupation and job control who was only retrieved using the JCQ and between seniority and job control that was retrieved mainly using the VAS control (table 4, online supplemental appendix 1).

VAS quadrant

Using quadrants from our retrieved cut-offs for VAS, job strain (tense) workers had higher job stress and time spent at work, and lower well-being compared with relaxed workers (p<0.001, p<0.001 and p=0.05, respectively). Relationships were also similar using the JCQ, except the relationship between quality of sleep, stress at home, education level, occupation and job demand that were more pronounced using the JCQ and between marital status and job demand that was retrieved mainly using the VAS demand (table 5 and online supplemental appendix 1). Comparisons between other quadrants also retrieved similar findings.

DISCUSSION

This study allowed the validation of VASs of job demand and job control at the workplace and focused on its acceptability, internal validity, reproducibility and external validity.

Acceptability

Workplace stress—that is, jobstrain—is a concern for both employers and workers because it can be the cause of absenteeism[36] and various pathologies.[37 38] Directives stated that occupational physicians needed to assess psychosocial risks to fight against work-related stress, and improve occupational health and safety concerns.[39] Although the JDC model of Karasek is the gold standard[13] to assess psychosocial risks at work, its length makes it difficult to use routinely in daily clinical practice by occupational practitioners.[24] However, the fact that VAS are easy to implement, time-efficient in execution and easy to understand by the patient, offers a unique possibility for a consistent standardised use in common practice. Moreover, the VAS is already a common tool used by occupational physicians to assess other conditions such as stress.[24] Occupational physicians have limited time to deal with considerable numbers of workers and worksites, and considerable numbers of occupational risks such as physical, chemical, biological and psychosocial risks.[40] Even if a questionnaire is implemented before the consultation, a limited number of questions are necessary to be able to assess all occupational risks factors.[41] Therefore, VAS of job demand and job control should be used frequently in

Table 3 Concordance between quadrants retrieved from Job-Content Questionnaire (JCQ) of Karasek and their equivalents retrieved from Visual Analogue Scales (VAS) of demand and control

No of workers within each quadrant retrieved					
From JCQ of	**From VAS of demand and control**				**Total**
Karasek	Passive	Relaxed	Tense	Active	
Passive	11	6	1	2	20
Relaxed	4	24	2	11	41
Tense/job strain	4	5	10	9	28
Active	8	21	13	59	101
Total	27	56	26	81	**190**

Table 4 Agreements between Visual Analogue Scales (VAS) and Job Content Questionnaire (JCQ) of Karasek and differences in outcomes according to cut-offs for the two dimensions of the job-demand control model of Karasek

	Demand				Control			
	VAS		JCQ of Karasek		VAS		JCQ of Karasek	
Variables	<75	≥75	<21	≥21	<75	≥75	<70	≥70
HAD-Depression								
Mean±SD	9.4±1.5	9.5±1.7	9.4±1.5	9.5±1.7	9.7±1.7	9.4±1.6	9.9±2.0	9.3±1.5
P value	0.28		0.28		0.47		0.31	
Agreement	Yes				Yes			
HAD-anxiety								
Mean±SD	14.8±3.7	13.7±4.3	15.5±3.7	13.7±4.1	13.2±4.2	14.7±4.0	13.0±4.2	14.6±4.0
P value	0.28		0.30		0.18		0.56	
Agreement	Yes				Yes			
No of hours of work per week								
Mean±SD	38.7±10.0	44.8±12.9	37.4±12.1	44.3±11.5	42.3±1.7	42.1±1.2	37.5±1.3	43.5±1.2
P value	**<0.001**		**<0.001**		0.90		0.07	
Agreement	Yes				Yes			
VAS quality of sleep								
Mean±SD	60.6±25.4	54.2±29.2	64.9±25.2	53.3±28.2	53.0±3.3	58.5±2.5	49.6±27.9	59.5±27.3
P value	0.11		**0.01**		0.18		**0.04**	
Agreement	Moderate				Moderate			
Duration of sleep								
Mean±SD	429.2±54.8	423.9±56.9	437.5±55.7	420.9±55.5	426.2±53.7	426.3±56.9	418.1±56.5	429.0±55.6
P value	0.74		0.76		0.06		0.18	
Agreement	Yes				Yes			
VAS stress at work								
Mean±SD	45.9±24.1	64.1±22.7	43.4±25.8	62.2±22.2	56.8±3.5	55.9±2.1	56.0±27.8	56.2±24.1
P value	**<0.001**		**<0.001**		0.83		0.95	
Agreement	Yes				Yes			
VAS stress at home								
Mean±SD	32.5±24.9	37.1±25.3	28.2±3.1	38.3±2.2	39.4±3.5	33.4±2.1	38.9±3.6	33.8±3.6
P value	**0.03**		**0.01**		0.15		0.22	
Agreement	Yes				Yes			
VAS well-being								
Mean±SD	64.7±21.4	61.4±22.0	66.5±3.0	61.1±1.8	57.3±3.1	65.0±2.1	54.0±24.5	65.8±19.1
P value	0.30		0.13		**0.04**		**0.01**	
Agreement	Yes				Yes			

Mean±SD.
Bold for significant relationship (p<0.05)
HAD, Hospital and Anxiety Depression.

common routine clinical practice of occupational physicians.[42] Physicians do not have time to go to the workplaces of every stressed worker to investigate working conditions, to individually clarify the situation with managers, and to find solutions.[43 44] Identifying workers under the highest pressure with improved accuracy would assist by reducing the numbers in this group to a manageable sample size. Moreover, from a statistical point of view, data ranged from minimal to maximal values, with a reasonable SD, as suggested by variation coefficients around 0.25–0.30.

Internal consistency and reproducibility

According to this study, VAS developments to assess psychosocial job characteristics based on the Karasek model appeared to be valid, reliable and precise instruments for the assessment of job demand and job control. Lin concordance coefficients were greater than 0.70 for both VAS of job demand and job control.[35] VAS demand and control detection had acceptable sensitivity and specificity factors of job strain. Positive and negative predictive values are acceptable. The thresholds are determined to be 75/100 for both VAS demand and control. SUMER (SUrveillance Médicale des Expositions aux Risques professionnels) study demonstrated satisfactory psychometric properties of Karasek's JCQ scales for the French working population.[18] Internal consistency was satisfactory as Cronbach's alpha coefficients were observed

Table 5 Agreements between Visual Analogue Scales (VAS) and Job Content Questionnaire of Karasek and differences in outcomes according to quadrants (active, passive, tense, relaxed)

	VAS quadrants				Karasek quadrants			
Variables	**Active**	**Passive**	**Tense**	**Relaxed**	**Active**	**Passive**	**Tense**	**Relaxed**
HAD-Depression								
Mean±SD	9.4±1.6	9.6±1.7	9.8±1.8	9.3±1.5	9.3±1.6	9.6±2.1	10.1±1.9	9.3±1.2
P value	0.66				0.33			
Agreement	Yes							
HAD-anxiety								
Mean±SD	14.1±4.4	13.8±4.2	12.5±4.2	15.4±3.4	14.0±4.0	14.1±3.8	12.2±4.3	16.2±3.6
P value	0.36				0.14			
Agreement	Yes							
No of hours of work per week								
Mean±SD	45.4±12.8	41.5±7.0	43.2±13.4	37.5±10.8	45.6±12.3	34.6±9.7	39.3±5.9	38.3.±12.7
P value	**<0.001**				**<0.001**			
Agreement	Yes							
VAS quality of sleep								
Mean±SD	55.6±30.5	55.0±23.1	49.9±24.9	62.8±26.0	55.6±27.9	56.1±27.3	45.0±27.9	68.7±23.1
P value	0.21				**<0.001**			
Agreement	Moderate							
Duration of sleep								
Mean±SD	424.1±58.6	426.9±55.8	423.5±52.5	430.3±54.8	424.8±55.9	433.5±59.6	407.1±52.5	439.4±54.3
P value	0.94				0.10			
Agreement	Yes							
VAS stress at work								
Mean±SD	63.6±22.5	49.4±24.8	65.8±23.6	44.3±23.8	61.7±22.0	44.8±30.2	63.9±23.3	42.7±23.8
P value	**<0.001**				**<0.001**			
Agreement	Yes							
VAS stress at home								
Mean±SD	34.5±25.4	35.1±25.6	45.1±23.4	31.4±25.6	37.6±25.3	36.0±27.8	41.0±23.3	24.6±21.9
P value	0.13				**0.01**			
Agreement	Moderate							
VAS well-being								
Mean±SD	64.0±21.5	60.5±23.1	53.4±22.2	66.6±20.5	62.9±19.9	52.9±30.2	54.8±24.0	73.1±15.5
P value	**0.05**				**<0.001**			
Agreement	Yes							

Mean±SD.
Bold for significant relationship (p<0.05)
HAD, Hospital and Anxiety Depression.

as being higher than 0.64. Convergent validity tests confirmed the expected association with key variables such as age, occupation, well-being, stress, depression or anxiety. In line with the literature,[45 46] we demonstrated that workers with a master's degree had greater job control both using VAS and JCQ, as well as for workers with higher seniority. However, the relationship between seniority and job control was found significant only using the VAS. Even if there was no relevant literature on senior executives, it seems logical that they would have higher job control as they are often more educated and qualified, with greater seniority within the company. Although no difference was apparent using the JCQ and was similar to findings reported in the literature,[47] we showed that married workers had higher levels of job demand than single workers using the VAS, which may also favour the discriminant use of VAS. Family obligations may increase a perception of overload at work.[48]

External validity

We reported a prevalence of job strain of 15%. We did not show relationships between VAS scores and quadrants and age, sex, education level, family situation, concerning Karasek domains, Karasek groups or VAS. However, the SUMER study, based on a larger sample of 24, 486 workers, reported a higher prevalence of job strain than our results (24% vs 15%) with a predominance of women (30% vs 21%).[18] The SUMER study emphasised a sharp gradient in socio-professional levels. Job control increased with high socioprofessional level as well as job demand. Consequently, job strain increased for low socio-professional level. In addition, the SUMER study demonstrated a higher job control among men and a higher job demand among women.[17 18] We hypothesise that our lower sample size and the representativity of all socioprofessional level in our sample may have precluded some significant statistical results. Nonetheless, we demonstrated that job control and job demand had acceptable external validity. According to the literature,[12 18] we showed that stress at work and time spent at work were correlated with a strong job demand, for both VAS and JCQ. VAS well-being increased with high job control. Job strain was linked with low VAS well-being, a high job stress and a high time spending at work.

Limitations

The study has some limitations. The response rate may seem low compared with other studies using questionnaires in French populations.[16 39] The majority of participants were high seniority precluding generalisability of our results.[45] However, we included a substantial sample size of workers allowing us to carry out statistical analyses with the number of subjects required, determined a priori. Moreover, we had a few missing data points and the number of respondents followed recommendations for the validation of questionnaires.[33 40] Despite the literature reports that a high drop-out rate is inherent to this type of study with several questionnaires,[49] the number of participants who responded to both the test and retest was higher than commonly reported in the literature.[42 43] However, VAS for job demand and job control have some limits concerning discrimination of at-risk workers. Despite its use for screening at-risk workers, JCQ was not initially conceived as a discriminative tool for clinical practice,[16] such as other questionnaires, that is, burn-out, for example.[50] The validation of a single cut-off point for both job demand and job control, by using easy, quick, and reliable VAS, may improve the decision-making process of occupational health practitioners. Even if clinical examination and occupational physicians' observations remain essential for assessing job stressors and their repercussions, the two validated VAS demand and VAS control tools will help mass screening—especially considering that an occupational physician may have >10 000 workers to follow. We did not assess social support because of an informatics issue regarding this item; however, the JCQ does not include the social support and is still widely used.[13 45–47] Sensibility, specificity, and Lin concordance coefficients were only moderate. Correlations between VAS and the Karasek groups was low. Moreover, we did not have many precisions regarding each domain using VAS. Despite the widespread use and relevance of VAS, VAS are global first-line evaluations that do not accurately assess putative explaining stress factors that are possible with the use of the JCQ of Karasek. We used some other non-validated VAS to evaluate well-being and quality of sleep, previously used in literature.[33 51 52] The selective use of VAS demand and VAS control may limit occupational physicians in their capacity to understand work-related stress, and thus to give easy counselling to workers. Therefore, we promote the use of VAS demand and control as an easy tool to detect abnormal situations, and if detected, occupational physicians should further assess workplace stress with the use of the JCQ. Moreover, VAS for job demand and job control could also be easily used thereafter to follow workers at regular intervals, possibly using dedicated software.[24] Further studies should encompass the subsequent modifications of the JCQ, specifically, adding social support—job-demand-control-support (JDCS) model; as well as the forthcoming effort–reward imbalance (ERI) model of Siegrist[10–12]; and finally, the Job Demands-Resources model that is, a sort of umbrella model including both JDCS and ERI concept.[53 54]

CONCLUSION

Although it performs less than JCQ, VAS demand and control are simple and rapid tools for screening patients with putative work-related stress. VAS demand and control can be used by the occupational practitioner in daily clinical practice for primary prevention and diagnosis. We determined a cut-off of 75 mm for both VAS job demand and job control to discriminate at-risk workers. However, when difficulties are highlighted by overreaching cut-offs of 75 mm, we promote the use of JCQ to be more

discriminant and specific because greater accuracy is needed to establish action plans and help workers

Author affiliations
[1]Occupational and Environmental Medicine, University Hospital Centre, F-63000 Clermont-Ferrand, France
[2]Physiological and Psychosocial Stress, LAPSCO, F-63000 Clermont-Ferrand, France
[3]Biostatistics Unit, Clinical Research and Innovation Direction, University Hospital Centre, F-63000 Clermont-Ferrand, France
[4]Emergency Medicine, University Hospital Centre, F-63000 Clermont-Ferrand, France
[5]Psychiatry, University Hospital Centre, F-63000 Clermont-Ferrand, France
[6]NPSY-SYDO, University Clermont Auvergne, F-63000 Clermont-Ferrand, France
[7]Wittyfit, F-92600 Asnières-sur-Seine, France
[8]Psychology and NeuroCognition Laboratory, University Grenoble Alpes, F-38000 Grenoble, France
[9]Institut Universitaire de France, F-75000 Paris, France
[10]Psychology, University Clermont Auvergne, F-63000 Clermont-Ferrand, France
[11]LAPSCO, F-63000 Clermont-Ferrand, France
[12]Hong Kong Baptist University, Kowloon, HK, Hong Kong
[13]Pôle SAMU-SMUR-Urgences, Service Urgences Adultes, University Hospital Centre, F-63000 Clermont-Ferrand, France
[14]General medicine, University Hospital Clermont-Ferrand, F-63000 Clermont-Ferrand, France

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Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Consent obtained directly from patient(s)

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ORCID iDs
Frederic Dutheil http://orcid.org/0000-0002-1468-6029
Jean-Baptiste Bouillon-Minois http://orcid.org/0000-0002-6556-4187
Maëlys Clinchamps http://orcid.org/0000-0003-4756-6928

REFERENCES

1 Chrousos GP, Gold PW. The concepts of stress and stress system disorders. overview of physical and behavioral homeostasis. *JAMA* 1992;267:1244–52.
2 Chrousos GP. Stress and disorders of the stress system. *Nat Rev Endocrinol* 2009;5:374–81.
3 Nieuwenhuijsen K, Bruinvels D, Frings-Dresen M. Psychosocial work environment and stress-related disorders, a systematic review. *Occup Med* 2010;60:277–86.
4 Backé E-M, Seidler A, Latza U, *et al*. The role of psychosocial stress at work for the development of cardiovascular diseases: a systematic review. *Int Arch Occup Environ Health* 2012;85:67–79.
5 Eisenach JH, Sprung J, Clark MM, *et al*. The psychological and physiological effects of acute occupational stress in new anesthesiology residents: a pilot trial. *Anesthesiology* 2014;121:878–93.
6 Silva-Junior JSda, Fischer FM. Long-Term sickness absence due to mental disorders is associated with individual features and psychosocial work conditions. *PLoS One* 2014;9:e115885.
7 Cohen S, Janicki-Deverts D, Miller GE. Psychological stress and disease. *JAMA* 2007;298:1685–7.
8 Proietti R, Mapelli D, Volpe B, *et al*. Mental stress and ischemic heart disease: evolving awareness of a complex association. *Future Cardiol* 2011;7:425–37.
9 Ruotsalainen JH, Verbeek JH, Marine A. Preventing occupational stress in healthcare workers. *Cochrane Database Syst Rev* 2014;13.
10 Clinchamps M, Auclair C, Prunet D, *et al*. Burnout among hospital Non-Healthcare staff: influence of job Demand-Control-Support, and Effort-Reward imbalance. *J Occup Environ Med* 2021;63:e13–20.
11 Sérole C, Auclair C, Prunet D, *et al*. The forgotten health-care occupations at risk of Burnout-A burnout, job Demand-Control-Support, and Effort-Reward imbalance survey. *J Occup Environ Med* 2021;63:e416–25.
12 Trousselard M, Dutheil F, Naughton G, *et al*. Stress among nurses working in emergency, anesthesiology and intensive care units depends on qualification: a job Demand-Control survey. *Int Arch Occup Environ Health* 2016;89:221–9.
13 Karasek R, Baker D, Marxer F, *et al*. Job decision latitude, job demands, and cardiovascular disease: a prospective study of Swedish men. *Am J Public Health* 1981;71:694–705.
14 Theorell T, Karasek RA. Current issues relating to psychosocial job strain and cardiovascular disease research. *J Occup Health Psychol* 1996;1:9–26.
15 Pisanti R, van der Doef M, Maes S, *et al*. Job characteristics, organizational conditions, and distress/well-being among Italian and Dutch nurses: a cross-national comparison. *Int J Nurs Stud* 2011;48:829–37.
16 Karasek R, Brisson C, Kawakami N, *et al*. The job content questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. *J Occup Health Psychol* 1998;3:322–55.
17 Niedhammer I, Chastang J-F, Levy D, *et al*. Study of the validity of a job-exposure matrix for psychosocial work factors: results from the National French SUMER survey. *Int Arch Occup Environ Health* 2008;82:87–97.
18 Niedhammer I, Chastang JF, Gendrey L, *et al*. [Psychometric properties of the French version of Karasek's "Job Content Questionnaire" and its scales measuring psychological pressures, decisional latitude and social support: the results of the SUMER]. *Sante Publique* 2006;18:413–27.
19 Dutheil F, Delaire P, Boudet G, *et al*. [Cost/effectiveness comparison of the vaccine campaign and reduction of sick leave, after vaccination against influenza among the Clermont-Ferrand University Hospital staff]. *Med Mal Infect* 2008;38:567–73.
20 Kelly C, Dutheil F, Haniez P, *et al*. [Analysis of motivations for antiflu vaccination of the Clermont-Ferrand University Hospital staff]. *Med Mal Infect* 2008;38:574–85.

21 Carlsson F, Merlo J, Lindström M, *et al*. Representativity of a postal public health questionnaire survey in Sweden, with special reference to ethnic differences in participation. *Scand J Public Health* 2006;34:132–9.
22 Reilly EE, Brown TA, Wierenga CE. Evaluating patterns of inconsistent and missing data on the eating disorders examination-questionnaire in a sample of treatment-seeking adults and adolescents. *Eat Disord* 2019:1–10.
23 Rolstad S, Adler J, Rydén A. Response burden and questionnaire length: is shorter better? A review and meta-analysis. *Value Health* 2011;14:1101–8.
24 Dutheil F, Pereira B, Moustafa F, *et al*. At-Risk and intervention thresholds of occupational stress using a visual analogue scale. *PLoS One* 2017;12:e0178948.
25 Li J, Riedel N, Barrech A, *et al*. Long-Term effectiveness of a stress management intervention at work: a 9-year follow-up study based on a randomized Wait-List controlled trial in male managers. *Biomed Res Int* 2017;2017:18.
26 Boonstra AM, Schiphorst Preuper HR, Reneman MF, *et al*. Reliability and validity of the visual analogue scale for disability in patients with chronic musculoskeletal pain. *Int J Rehabil Res* 2008;31:165–9.
27 Lesage FX, Berjot S. Validity of occupational stress assessment using a visual analogue scale. *Occup Med* 2011;61:434–6.
28 Lesage F-X, Berjot S, Deschamps F. Clinical stress assessment using a visual analogue scale. *Occup Med* 2012;62:600–5.
29 Ratinaud MC, Chamoux A, Glace B, *et al*. Job satisfaction evaluation in low back pain: a literature review and tools appraisal. *Ann Phys Rehabil Med* 2013;56:465–81.
30 Dutheil F, Duclos M, Naughton G, *et al*. WittyFit-Live your work differently: study protocol for a Workplace-Delivered health promotion. *JMIR Res Protoc* 2017;6:e58.
31 Dutheil F, Trousselard M, Perrier C, *et al*. Urinary interleukin-8 is a biomarker of stress in emergency physicians, especially with advancing age--the JOBSTRESS* randomized trial. *PLoS One* 2013;8:e71658.
32 Bocéréan C, Dupret E. A validation study of the hospital anxiety and depression scale (HADS) in a large sample of French employees. *BMC Psychiatry* 2014;14:354.
33 Ravoux H, Pereira B, Brousse G, *et al*. Work addiction test questionnaire to assess Workaholism: validation of French version. *JMIR Ment Health* 2018;5:e12.
34 Taber KS. The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Res Sci Educ* 2018;48:1273–96.
35 Knell G, Gabriel KP, Businelle MS, *et al*. Ecological Momentary assessment of physical activity: validation study. *J Med Internet Res* 2017;19:e253.
36 Nielsen ML, Rugulies R, Smith-Hansen L, *et al*. Psychosocial work environment and registered absence from work: estimating the etiologic fraction. *Am J Ind Med* 2006;49:187–96.
37 Rusli BN, Edimansyah BA, Naing L. Working conditions, self-perceived stress, anxiety, depression and quality of life: a structural equation modelling approach. *BMC Public Health* 2008;8:48.
38 Richardson S, Shaffer JA, Falzon L, *et al*. Meta-Analysis of perceived stress and its association with incident coronary heart disease. *Am J Cardiol* 2012;110:1711–6.
39 Iavicoli S, Natali E, Deitinger P, *et al*. Occupational health and safety policy and psychosocial risks in Europe: the role of stakeholders' perceptions. *Health Policy* 2011;101:87–94.
40 Lesage F-X, Berjot S, Altintas E, *et al*. Burnout among occupational physicians: a threat to occupational health systems?--A nationwide cross-sectional survey. *Ann Occup Hyg* 2013;57:913–9.
41 Koitsalu M, Eklund M, Adolfsson J, *et al*. Effects of pre-notification, invitation length, questionnaire length and reminder on participation rate: a quasi-randomised controlled trial. *BMC Med Res Methodol* 2018;18:3.
42 Choi BK, Schnall P, Landsbergis P, *et al*. Recommendations for individual participant data meta-analyses on work stressors and health outcomes: comments on IPD-Work Consortium papers. *Scand J Work Environ Health* 2015;41:299–311.
43 Psenka TM, Freedy JR, Mims LD, *et al*. A cross-sectional study of United States family medicine residency programme director burnout: implications for mitigation efforts and future research. *Fam Pract* 2020;37:772–8.
44 Rao CR, Darshan B, Das N, *et al*. Practice of physical activity among future doctors: a cross sectional analysis. *Int J Prev Med* 2012;3:365–9.
45 Giorgi G, Arcangeli G, Ariza-Montes A, *et al*. Work-Related stress in the Italian banking population and its association with recovery experience. *Int J Occup Med Environ Health* 2019;32:255–65.
46 Moreno-Pimentel AG, Meneses Monroy A, Martín-Casas P, *et al*. Impact of social and occupational factors over job control. *Med Lav* 2019;110:226–33.
47 Blumenthal JA, Thyrum ET, Siegel WC. Contribution of job strain, job status and marital status to laboratory and ambulatory blood pressure in patients with mild hypertension. *J Psychosom Res* 1995;39:133–44.
48 Komlenac N, Stockinger L, Vogler T, *et al*. Psychometric analysis of a German-Language version of the Work-Family conflict and Family-Work conflict scale. *Front Psychol* 2021;12:782618.
49 Guo Y, Kopec JA, Cibere J, *et al*. Population survey features and response rates: a randomized experiment. *Am J Public Health* 2016;106:1422–6.
50 Choron G, Dutheil F, Lesage FX. Are nurses burned out? *Int J Nurs Stud* 2016;58:80–1.
51 Dutheil F, Boudet G, Perrier C, *et al*. JOBSTRESS study: comparison of heart rate variability in emergency physicians working a 24-hour shift or a 14-hour night shift--a randomized trial. *Int J Cardiol* 2012;158:322–5.
52 Dutheil F, Marhar F, Boudet G, *et al*. Maximal tachycardia and high cardiac strain during night shifts of emergency physicians. *Int Arch Occup Environ Health* 2017;90:467–80.
53 Bakker AB, Demerouti E. Job demands-resources theory: taking stock and looking forward. *J Occup Health Psychol* 2017;22:273–85.
54 Demerouti E, Bakker AB, Nachreiner F, *et al*. The job demands-resources model of burnout. *J Appl Psychol* 2001;86:499–512.

Supplementary Appendix 1

Agreements between visual analog scales and job content questionnaire of Karasek and differences in outcomes according to cut-offs for the two dimensions of the job-demand-control model of Karasek. Mean±SD: Mean±Standard deviation

Variables	Demand				Control			
	Visual analog scale		JCQ of Karasek		Visual analog scale		JCQ of Karasek	
	<75	≥75	<21	≥21	<75	≥75	<70	≥70
Age								
Mean±SD	41.5 ± 12.8	42.3 ± 10.8	42.5 ± 14.6	41.7 ± 10.2	41.05±11.4	42.2 ± 11.9	41.3 ± 12.5	42.1 ± 11.6
P-value	0.66		0.71		0.60		0.72	
Agreement	Yes				Yes			
Sex								
Women, n (%)	38 (43.2%)	50 (56.8%)	27 (30.7%)	61 (69.3%)	22 (25%)	66 (75%)	22 (25%)	66 (75%)
Men, n (%)	36 (48.7%)	38 (51.3%)	25 (33.8%)	49 (66.2%)	20 (27%)	54 (73%)	15 (20.3%)	59 (79.7%)
P-value	0.49		0.67		0.77		0.48	
Agreement	Yes				Yes			
Marital status								
Married / De facto, n (%)	53 (41.1%)	75 (58.6%)	39 (30.5%)	89 (69.5%)	36 (28.1%)	92 (71.9%)	27 (21.1%)	101 (78.9%)
Single / Widow, n (%)	21 (61.8%)	13 (38.2%)	13 (38.2%)	21 (61.8%)	6 (17.7%)	28 (82.3%)	10 (29.4%)	24 (70.6%)
P-value	**0.03**		0.39		0.22		0.30	
Agreement	Moderate				Yes			
Education								
Bachelor degree or less	5 (62.5%)	3 (37.5%)	4 (50%)	4 (50%)	5 (62.5%)	3 (37.5%)	4 (50%)	4 (50%)
Undergraduate	7 (53.9%)	6 (16.1%)	6 (46.2%)	7 (53.8%)	6 (46.2%)	7 (53.8%)	6 (46.2%)	7 (53.8%)
Master's degree	62 (44%)	79 (56%)	42 (29.8%)	99 (70.2%)	31 (22%)	110 (78%)	27 (16.2%)	114 (80.8%)
P-value	0.49		0.25		**0.009**		**0.015**	
Agreement	Yes				Yes			
Seniority within the company								
Mean±SD	10.7±10.9	11.1±10.6	11.7±13.2	10.6±9.4	7.8±9.0	12.1±11.0	8.6±9.5	11.7±11.0
P-value	0.68		0.56		**0.02**		0.09	
Agreement	Yes				Moderate			
Occupation								
Senior executives, n (%)	37 (46.3%)	43 (53.7%)	30 (37.5%)	50 (62.5%)	27 (33.8%)	53 (66.2%)	30 (37.5%)	50 (62.5%)
Other, n (%)	46 (41.8%)	64 (58.2%)	31 (28.2%)	79 (71.8%)	25 (22.7%)	85 (77.6%)	18 (16.4%)	92 (83.6%)
P-value	0.54		0.17		0.09		**0.001**	
Agreement	Yes				Moderate			

Agreements between visual analog scales and job content questionnaire of Karasek and differences in outcomes according to quadrants (active, passive, tense, relaxed). Mean±SD: Mean±Standard deviation

Variables	VAS Quadrants				Karasek Quadrants			
	Active	Passive	Tense	Relaxed	Active	Passive	Tense	Relaxed
Age								
Mean±SD	42.7 ± 10.9	41 ± 12.2	41.1 ± 10.8	41.7 ± 13.2	42.1 ± 10	43.1 ± 14.7	40.1 ± 10.9	42.2 ± 14.8
P-value	0.88				0.91			
Agreement	Yes							
Sex								
Women, n (%)	40 (45.4%)	12 (13.6%)	10 (11.4%)	26 (29.6%)	48 (54.6%)	9 (10.2%)	13 (14.8%)	18 (20.4%)
Men, n (%)	28 (37.8%)	10 (13.5%)	10 (13.5%)	26 (35.1%)	40 (54.1%)	6 (8.1%)	9 (12.2%)	19 (25.7%)
P-value	0.78				0.83			
Agreement	Yes							
Marital status								
Married / De facto, n (%)	58 (45.3%)	19 (14.8%)	17 (13.3%)	34 (26.6%)	74 (57.8%)	12 (9.38%)	15 (11.7%)	27 (21.1%)
Single / Widow, n (%)	10 (29.4%)	3 (13.6%)	3 (8.8%)	18 (52.9%)	14 (41.2%)	3 (8.82%)	7 (20.6%)	10 (29.4%)
P-value	**0.04**				0.29			
Agreement	Moderate							
Education								
Bachelor degree or less	1 (12.5%)	3 (37.5%)	2 (25%)	2 (25%)	3 (37.5%)	3 (37.5%)	1 (12.5%)	1 (12.5%)
Undergraduate	3 (23.1%)	3 (23.1%)	3 (23.1%)	4 (30.8%)	5 (38.5%)	4 (30.8%)	2 (15.4%)	2 (15.4%)
Master's degree	64 (45.4%)	16 (13.6%)	15 (10.6%)	46 (32.6%)	80 (56.7%)	8 (5.7%)	19 (13.5%)	34 (24.1%)
P-value	0.10				**0.008**			
Agreement	Moderate							
Seniority within the company								
Mean±SD	11.8 ± 10.8	6.71 ± 8.68	8.95 ± 9.45	12.4 ± 11.4	11.4 ± 9.84	10.2 ± 12.8	7.55 ± 6.75	12.3 ± 13.5
P-value	0.10				0.33			
Agreement	Yes							
Occupation								
Senior executives, n (%)	50 (45.5%)	11 (10%)	14 (12.7%)	35 (31.8%)	67 (60.9%)	6 (5.5%)	12 (10.9%)	15 (22.7%)
Other, n (%)	31 (38.8%)	15 (18.8%)	12 (15%)	22 (27.5%)	34 (42.5%)	14 (17.5%)	16 (20%)	16 (20%)
P-value	0.31				**0.007**			
Agreement	Moderate							

Supplementary Appendix 2

Relationships between each visual analog scale and items of Karasek questionnaire

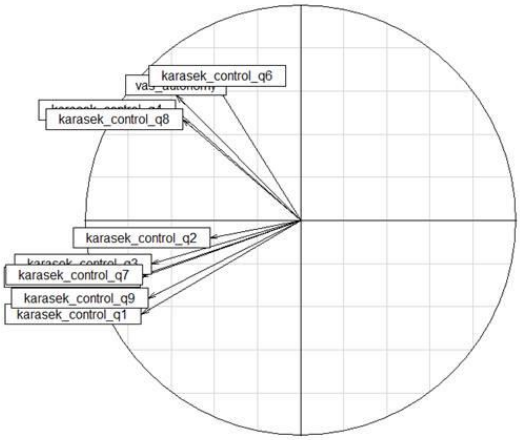
Correlation between items from the Karasek questionnaire and each visual analog scales (job demand and job control):

	Karasek questionnaire – job control items								
	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9
VAS job control	0.23**	0.21**	0.22**	0.60***	0.28***	0.44***	0.32***	0.48***	0.27***

	Karasek questionnaire – job demand items								
	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18
VAS job demand	0.50***	0.58***	0.66***	0.45***	0.14	0.43***	0.44***	0.42***	0.25***

The result of the **principal component analysis (PCA)** was expressed with a representation on the first discriminant plane projection of items of Karasek scale (circle of correlations). The closer the items are to each other and far from the center, the more important is their correlation. The horizontal axis makes it possible to present patients with high values for the items (on the left) vs. patients with low values (right). The vertical axis makes it possible to determine within these patients with high values for the items, those more or less associated with the items at the top left of the quadrant of the correlation circle vs. those at the bottom left.

Relation between VAS control and items of the job control from Karasek questionnaire



Relation between VAS demand and items of the job demand from Karasek questionnaire