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Combined use of job stress models and self-rated health in nursing

ABSTRACT

OBJECTIVE: To identify combinations of two models of psychosocial stress at work among nursing teams and their associations with self-rated health.

METHODS: This was a cross-sectional study among workers at three public hospitals in the municipality of Rio de Janeiro, Southeastern Brazil (N = 1307). In 2006, a multidimensional questionnaire including two scales for measuring stress at work (demand-control and effort-reward imbalance models) was administered. Partial and complete (including social support at work) demand-control models were considered, along with partial and complete (including excessive commitment to work) effort-reward models. Multiple logistic regression models were used to estimate adjusted odds ratios and their respective 95% confidence intervals.

RESULTS: The dimensions of both models were independently associated with self-rated health, with odds ratios between 1.70 and 3.37. The partial demand-control model was less associated with health (OR = 1.79; 95%CI 1.26;2.53) than was the partial effort-reward imbalance model (OR = 2.27; 95%CI 1.57;3.30). Incorporation of social support and excessive commitment to work increased the strength of the demand-control and effort-reward imbalance models, respectively. Increased strength of association was observed when the two partial models were combined.

CONCLUSIONS: The results indicate that the effort-reward imbalance model performed better for this specific group and for the outcome evaluated, and that there was an advantage in using complete models or combinations of partial models.

DESCRIPTORS: Nurses. Burnout, Professional. Working Conditions. Job Satisfaction. Cross-Sectional Studies.

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INTRODUCTION

Interactions between different working conditions provide work environments that are more or less favorable to health. Assessment of these factors and their influence on workers' health has advanced considerably, but measuring them remains a challenge for social epidemiology.[4,22] These measurements are often based on theoretical constructs that generate models that are tested in a variety of empirical fields.[4] Two of these models are believed to have greater explanatory power and are widely used in the worldwide literature for measuring the psychosocial working environment: the demand-control (DC) model and the effort-reward imbalance (ERI) model. These models define different stress factors in work that are potentially damaging to health, and they provide explanations regarding the relationship between stressful working conditions and physical and psychological wellbeing.[13,21]

The DC model, which was devised by Karasek,[13] originally considered interactions between two components that might promote "wear-and-tear" at work ("job strain"): psychological demands (pace and intensity of the work) and control (autonomy and skills relating to the process, required from the worker). Activities that involve high psychological demands and low control would promote job strain and consequently lead to physical and psychological illness. Subsequently, the model evolved to include a third dimension: the perception of social support for work elaborated by Johnson & Hall.[12] According to these authors, social integration, trust within the group and help from colleagues and superiors in accomplishing task might act as protective (moderating) factors in relation to the effects of job strain on health. Two different instruments have been used in Brazil to measure the model, in translations with adaptations for Brazilian Portuguese: the "Job Content Questionnaire"[6] and the reduced scale known as the "Swedish Scale for Demand-Control-Social Support" (DCS),[2] which was developed by Theorell.[25]

The ERI model, which was developed in the mid-1990s,[21] makes the assumption that imbalances between excess effort at work and low reward or recognition of this effort generate stressful situations.[21] The effort relates to the demands and obligations perceived by workers; the reward is composed of financial recompense (adequate salary), self-esteem (respect and support from colleagues and superiors) and occupational status (promotion prospects, employment stability and social status).[23] Just as in the DC model, a third dimension was incorporated into the original model: excess commitment to work. This is considered to be a dimension intrinsic to the worker, expressed through excessive endeavor at work combined with a strong desire for approval and esteem. Excess commitment to work is considered to be a factor that may interact with ERI to boost its harmful effects on health and wellbeing.[7,22]

Both models have limitations with regard to capturing the complexity of the psychosocial aspects of work. Moreover, partial models focusing exclusively on the relationships between demand and control and between effort and reward[18,20] do not explain the contributions of social support and excess commitment to work. Recent studies have recommended that the two models should be used in combination, in relation to a given outcome.[4] Studies on occupations have demonstrated that the predictive power of the combination (in comparison with the result relating to each model) is greater with regard to self-reported health,[3,18] insomnia,[19] mental stress at work,[4] acute myocardial infarction,[20] absenteeism due to illness[1,9] and depression.[26] No investigations on the effect of the combined models on health-related outcomes in Brazil were identified.

The association between psychosocial factors within nursing work and self-reported health is considered to

be a summary measurement of health and an important mortality predictor.[10] The objective of the present study was to identify combinations of two models for psychological stress at work among nursing teams, and their association with self-reported health.

METHODS

This was a cross-sectional study among female nursing providers at three public hospitals in the municipality of Rio de Janeiro, Southeastern Brazil, in 2006. Out of 1,595 eligible workers, 1,307 (81.9%) took part in the study.

A self-applicable multidimensional questionnaire that had been refined through three rounds of pretesting (n = 50) and tested in a pilot study (n = 80) was administered by a trained team during working hours.

The outcome (self-reported health status) was obtained from the question: "In a general manner, compared with other people of your age, what would you say your own state of health was like?" The responses were dichotomized into two groups: good (very good/good) and poor (regular/poor).

The exposure variable DC was obtained using the Brazilian version of DCS.[2] This instrument was composed of two dimensions: psychological demands (five questions) and control (six items). One item relating to control was removed ("In your work, do you often have to repeat the same tasks?") because of its poor psychometric performance in the context of the population investigated.[8] The dimensions presented items with four response categories (from "frequently" to "never/almost never"). The scores for each dimension separately, along with the ratio between the scores (D/C), were categorized in terciles. The highest tercile represented the highest level of psychosocial stress at work, according to the DC model. The first (lowest) tercile, i.e. low psychosocial stress, was used as the reference category. Division into terciles was used as already done in other studies,[16] which also made this model comparable to ERI, which is often categorized in this manner.[4,7,22] The dimension of social support at work was also evaluated in the model, with four response categories (from "totally agree" to "totally disagree"). The score obtained (ranging from 6 to 24) was categorized into terciles, and the highest tercile (high social support) was used as a reference category.

The following covariables were taken into consideration: sociodemographic data (age, conjugal situation and schooling level), occupational data (professional nursing category, length of time in this activity, type of contract and number of jobs) and behavioral data and health-related problems (smoking, use of alcoholic drinks, physical activity practice and body mass index).

The ERI model was measured using the Brazilian version[5] of the questionnaire designed by Siegrist,[21] which presented adequate psychometric performance for the population of the present study.[9] The effort dimension contained six items and the reward dimension was composed of 11 items: esteem (five items), promotion prospects and salary (four items) and secureness at work (two items). The response categories for both dimensions were defined in two stages. The participants agreed or disagreed with statements relating to work situations and indicated the degree of stress attributed to that situation (from "not stressful" to "very stressful").

For each participant, a ratio was constructed using the formula: e/(r*c), in which "e" was the score obtained from the effort questions, "r" was the score obtained from the sum of the reward questions and "c" was a correction factor (0.545454), considering the number of items in the numerator compared with the number in the denominator (6/11).[21,22] The score for each dimension (effort and reward) and the ratio between them were categorized into terciles.[22] The first tercile (low stress level) was used as the reference category.

The dimension of excess commitment to work was composed of six items in which the workers indicated their degree of agreement with the statements (from "strongly disagree" to "strongly agree"), on a four-point scale. The score obtained was categorized into terciles and the first tercile (low risk) was considered to be the reference category.[22]

The partial DC model (demand and control) and the complete DC model which added social support at work were both taken into consideration, as were the partial ERI (effort and reward) and the complete ERI, which added excess commitment to work to the partial model.

The association between the categories of psychosocial stress at work and self-reported health was obtained through descriptive statistics. Covariables in other studies[15,16,19,20,22,26] that were associated with the outcome and with the exposure variables, with a significance level of 10% in bivariate analysis, were considered to be potential confounding variables and were included in the logistic regression models. SPSS v.14 software was used in the analyses.

Multiple logistic regression models were estimated in three stages: the association with the outcome shown by each dimension of the models, i.e. psychological demands, control and social support at work (DC) and effort, reward and excess commitment to work (ERI); the association with the outcome shown by each partial model (DC and ERI); the association with the outcome shown by each complete model (DC/social support and ERI/ excess commitment); and the association with the outcome shown by the combination of the partial models (DC and ERI). For each model/dimension combination, the workers were categorized into four groups. The group that was not exposed in any model/dimension was taken to be the reference category. The model/dimension values (described earlier) were dichotomized according to terciles (first and second terciles taken to indicate lack of exposure, and third tercile taken to be the presence of exposure), to construct categories.

This project was approved by the Research Ethics Committees of the hospitals involved, and by CONEP since foreign cooperation was involved (Procedural no. 1318/2004).

RESULTS

The participants' mean age was 40 years (SD 12.8 years); 57.2% had had university-level education and 27.9% were nurses. Around one third had more than one nursing job and almost half were federal public employees. With regard to health conditions, 26.3% said that they had hypertension, 44.6% were classified as obese or overweight, 13.2% were smokers and more than two thirds said that they did not do physical activities. More than 80% of the interviewees said that their health was "good/regular" (Table 1). Non-completion and inconsistencies in filling out the questionnaire were identified in the proportions of 8,3% (109), 4,3% (56), 1,4% (19) e 0,08% (11) in relation to the ERI model, the DC model, the dimension of social support at work and the dimension of excess commitment to work, respectively (data not shown in tables).

Table 1. Sociodemographic factors, work characteristics and health characteristics of the nursing workers. Rio de Janeiro, Southeastern Brazil, 2006. (N = 1307)

Characteristics	n	%
Mean age in years (standard deviation)	40.1	12.8
University-level education	747	57.2
Nurses	365	27.9
Working in more than one nursing job	475	36
Federal public employees	637	48.9
Self-reported hypertension	344	26.3
Overweight or obese (BMI > 25)	571	44.6
Current smokers	172	13.2
Self-reported non-practice of physical activities	926	70.8
Self-reported health		
Good	324	24.8
Regular	725	55.6
Poor	239	18.3
Very poor	16	1.2

High psychological demand and low social support at work were associated with low self-reported perceptions of health in the DC model. Weaker associations were observed with job control. There were associations with higher levels of excess commitment to work, followed by lower levels of reward and higher levels of effort (ERI model). In both models, there was a clear dose-response gradient, even after adjusting for confounding variables. Stronger associations were observed as the exposure levels increased (Table 2).

In the partial models, higher levels of psychosocial stress were associated with poor health and presented higher odds ratios. Association measurements with higher values were observed in the ERI model. Both models gained additional strength of association through inclusion of the additional dimensions (social support at work in the DC model and excess commitment to work in ERI) (Table 3).

Combination of the two partial models led to a stronger association. The odds of reporting poor health were 1.60 times higher (95% CI: 1.77;3.83) among individuals classified as presenting stress in both models, compared with the value observed among individuals who were not classified in any of the models. In the case of stress classified only in the DC model, the odds ratio was 1.55 (95% CI: 1.00;2.41), and in the ERI model alone, the odds ratio was 1.67 (95% CI: 1.08;2.59) (Table 4).

Table 2. Self-reported poor health and crude and adjusted odds ratios, according to the dimensions of the demand-control and effort-reward imbalance models, among nursing workers. Rio de Janeiro, Southeastern Brazil, 2006.

Dimension	n	%	Crude OR[a] (95% CI)	Adjusted OR[b] (95% CI)
Demand-control model				
Psychological demands				
1st tercile (low score)	51	14.1	1	1
2nd tercile	104	19.1	1.36 (0.91;1.96)	1.42 (0.98;2.05)
3rd tercile	93	24.7	1.89 (1.29;2.76)	2.01 (1.37;2.97)
		p = 0.003		
Control				
1st tercile (high score)	54	15.2	1	1
2nd tercile	117	19.2	1.30 (0.91;1.85)	1.28 (0.89;1.84)
3rd tercile	79	25.1	1.84 (1.25;2.70)	1.70 (1.14;2.53)
		p = 0.006		
Social support at work				
1st tercile (high score)	44	14.1	1	1
2nd tercile	100	18.7	1.42 (0.96;2.08)	1.54 (1.04;2.28)
3rd tercile	107	24.4	1.99 (1.35;2.93)	2.40 (1.60;3.59)
		p = 0.002		
Effort-reward model				
Effort				
1st tercile (low score)	47	15.1	1	1
2nd tercile	92	16.9	1.15 (0.78;1.68)	1.21 (0.82;1.79)
3rd tercile	107	25.9	1.96 (1.34;2.87)	2.13 (1.43;3.16)
		p < 0.0001		
Reward				
1st tercile (high score)	53	13.4	1	1
2nd tercile	77	19.1	1.52 (1.04;2.23)	1.82 (1.22;2.70)
3rd tercile	106	25.6	2.22 (1.54;3.19)	2.86 (1.94;4.22)
		p < 0.0001		
Excess commitment to work				
1st tercile (low score)	56	11.6	1	1
2nd tercile	95	21.5	2.08 (1.45;2.98)	2.09 (1.52;3.17)
3rd tercile	103	28	2.93 (2.04;4.20)	3.37 (2.32;4.89)
		p < 0.0001		

[a] Adjusted for age, schooling level, type of work contract and number of jobs
[b] Chi-square for linear association

Table 3. Crude and adjusted *odds ratios* for the association between the partial and complete demand-control and effort-reward imbalance models, in relation to self-reported poor health among nursing workers. Rio de Janeiro, Southeastern Brazil, 2006.

Model	Crude OR (95% CI)	Adjusted OR[a] (95% CI)
Partial		
Demand-control		
1st tercile (low stress)	1	1
2nd tercile	1.08 (0.75;1.56)	1.13 (0.78;1.64)
3rd tercile	1.81 (1.28;2.56)	1.79 (1.26;2.53)
Effort-reward imbalance		
1st tercile (low stress)	1	1
2nd tercile	1.16 (0.79;1.69)	1.24 (0.84;1.82)
3rd tercile	2.01 (1.41;2.87)	2.27 (1.57;3.30)
Complete		
Demand-control/social support		
DC and SSW (stress absent from both)	1	1
DC only	1.66 (1.12;2.47)	1.55 (1.04;2.32)
SSW only	1.41 (0.95;2.10)	1.47 (0.98;2.22)
DC and SSW (stress present in both)	2.26 (1.55;3.29)	2.36 (1.60;3.49)
Effort-reward/excess commitment		
ERI and ECW (stress absent from both)	1	1
ERI only	1.87 (1.23;2.84)	2.04 (1.33;3.14)
ECW only	2.15 (1.35;3.45)	2.36 (1.46;3.82)
ERI and ECW (stress present in both)	2.38 (1.66;3.42)	2.74 (1.88;3.99)

[a] adjusted for age, schooling level, type of work contract, number of jobs, physical activity practice, smoking and consumption of alcoholic drinks
DC: demand-control model; ERI: effort-reward imbalance model; SSW: social support at work; ECW: excess commitment to work

DISCUSSION

This study made it possible to identify different dimensions of psychosocial stress at work among nursing teams and their association with self-reported health, along with an estimate for the increase in the strength of association achieved by combining the scales. It was found that all of the separate dimensions of the DC model (demand, control and social support) and ERI model (effort, reward and excess commitment to work) were associated with self-reported health. The partial DC and ERI models were associated with self-reported health, with a stronger association observed with ERI. Incorporation of social support and excess commitment to work increased the strength of association in the DC and ERI models, respectively. Combination of the partial DC and ERI models increased the strength of the association. Social support and excess commitment to work were shown to be important in relation to the outcome analyzed, and the latter was more strongly associated with self-reported health. The partial models were sufficient to detect the association with the outcome, but incorporation of these other dimensions contributed towards increasing the strength of association. For DC, this could be attributed to a limitation of the partial model, which did not consider relationships between people,[24] which are inherent to nursing work.

Some authors have affirmed the importance of excess commitment to work in the partial ERI model,[7,22] although others have disagreed.[18] Critics have argued that excess commitment to work is a measurement of a subjective nature: an intrinsic component relating to individuals' capacity to face up to work demands. They also considered that the outcome evaluated was subjective, since it referred to workers' own assessments of their state of health. Part of this result may have been influenced by common method variance, in which the independent and dependent variables were hard to distinguish.[18] In fact, a similar analysis with this same group of workers did not identify any association between excess commitment and absenteeism.[9] Studies that evaluate the predictive capacity of incorporating excess commitment to work, into ERI in relation to different types of outcome, are recommended.

ERI was shown to be more strongly associated with health than was DC, in both the partial and the complete formulations. Greater explanatory power regarding the influence of psychosocial stress from work on health has

Table 4. Crude and adjusted odds ratios for the association between the combination of the demand-control and effort-reward imbalanced models and self-reported poor health among nursing workers. Rio de Janeiro, Southeastern Brazil, 2006.

Combined model	Crude OR (95% CI)	Adjusted OR[a] (95% CI)
DC and ERI (stress absent from both)	1	1
DC only	1.61 (1.05;2.47)	1.55 (1.00;2.41)
ERI only	1.52 (0.99;2.33)	1.67 (1.08;2.59)
DC and ERI (stress present in both)	2.49 (1.71;3.62)	2.60 (1.77;3.83)

[a] adjusted for age, schooling level, type of work contract, number of jobs, physical activity practice, smoking and consumption of alcoholic drinks.
DC: demand-control model; ERI: effort-reward imbalance model

been attributed to ERI.[4] Part of the better performance results from ERI can be attributed to the constructs of the dimensions that make up the models. For example, for certain occupations, reward may have a more important meaning than does control in the work process, within the context of the present-day world of work. In turn, control has been emphasized as an important dimension, particularly in studies evaluating cardiovascular outcomes.[3,18] As in our results, another study among healthcare professionals[7] showed that the control dimension had lower predictive power in relation to workers' wellbeing, compared with the other dimensions. In our study, this finding may have been partially attributable to problems regarding the psychometric performance of this dimension, as reported in a recent paper.[8]

The results from the present study seem to corroborate investigations that have indicated that the two partial models are complementary in nature, with regard to associations with health outcomes,[3,4,18,20,26] in that the models emphasize different aspects of the working environment relating to stress and becoming ill. While DC considers specific characteristics of work tasks, ERI is based on reciprocity between the effort expended on tasks and the recompense in terms of salary, secureness of work, prospects and esteem.

The DC-ERI combination may reduce the limitations inherent to each model. In relation to DC, its applicability to certain occupations, especially those dealing with people in service sectors, like healthcare workers, has been questioned.[4,24] This model was devised in the 1970s, within the context of industrial organizations, at a time of greater employment stability in developed countries, and for this reason, its emphasis is on the characteristics of work tasks. Thus, it does not take into consideration the recent changes in the nature of work relating to the global economy, which have added other factors such as precariousness (insecurity at work), rapid organizational changes and few prospects of promotion. Recognizing these limitations, the revised model of the Job Content Questionnaire 2.0 is currently undergoing tests in other countries.[14,17]

In the case of ERI, although it considers aspects of work within the context of a global economy, the questionnaire has a limited number of questions on social relationships within the working environment. Moreover, the score calculation favors classification errors and lack of completion among the subjects (around 8% in the present study). This scale was recently revised by Siegrist et al,[23] who put forward a shorter version with a simpler format for obtaining the scores (from "strongly disagree" to "strongly agree").

Certain limitations can be highlighted in the present study. Although relatively large, the sample was restricted to a female group with a specific occupation in public institutions. Therefore, the ability to generalize from these findings is limited. The data were cross-sectional, which does not allow a time relationship between the events studied to be established. Reverse causality cannot be dismissed, since workers with worse health levels may have overestimated the psychosocial stress at work. In addition, studies based on self-reported measurements may be influenced by factors such as memory bias, socially desirable responses and diagnostic suspicion bias. The multiplicity of ways of categorizing the model scores makes comparisons between studies difficult, since there is no consensus about the right way to make them.[11] Some authors have used the dimensions as continuous variables, or have categorized the D/C score ratio into terciles[4,15] or quartiles,[20] or dichotomized them using medians of the distribution.[3,18] In ERI, the scores for the effort-reward ratio have been categorized into terciles[4] or used as a cutoff point for values greater than one.[20]

In conclusion, the results indicate that there was better performance from the ERI model for this specific group and for the outcome assessed, and that complete models or combination of the partial models were advantageous.

REFERENCES

1. Ala-Mursula L, Vahtera J, Linna A, Pentti J, Kivimäki M. Employee worktime control moderates the effects of job strain and effort-reward imbalance on sickness absence: the 10-town study. *J Epidemiol Community Health*. 2005;59(10):851-7. DOI:10.1136/jech.2004.030924

2. Alves MGM, Chor D, Faerstein E, Lopes CS, Werneck GL. Versão resumida da "job stress scale": adaptação para o português. *Rev Saude Publica*. 2004;38(2):164-71. DOI:10.1590/S0034-89102004000200003.

3. Bosma H, Peter R, Siegrist J, Marmot M. Two alternative job stress models and the risk of coronary heart disease. *Am J Public Health*. 1998;88(1):68-74. DOI:10.2105/AJPH.88.1.68

4. Calnan M, Wadsworth E, May M, Smith A, Wainwright D. Job strain, effort – reward imbalance, and stress at work: competing or complementary models? *Scand J Publ Health*. 2004;32(2):84–93. DOI:10.1080/14034940310001668

5. Chor D, Werneck GL, Faerstein E, Alves MGM, Rotenberg L. The Brazilian version of the effort-reward imbalance questionnaire to assess job stress. *Cad Saude Publica*. 2008;24(1):219-24. DOI:10.1590/S0102-311X2008000100022

6. de Araujo TM, Karasek R. Validity and reliability of the job content questionnaire in formal and informal jobs in Brazil. *SJWEH Suppl*. 2008;(6):52–9.

7. de Jonge J, Bosma H, Peter R, Siegrist J. Job strain, effort-reward imbalance and employee well-being: a large-scale cross-sectional study. *Soc Sci Med*. 2000;50(9):1317-27. DOI:10.1016/S0277-9536(99)00388-3

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

9. Griep RH, Rotenberg L, Chor D, Toivanen S, Landsbergis P. Beyond simple approaches to studying the association between work characteristics and absenteeism: Combining the DCS and ERI models. *Work & Stress*. 2010;24(2):179–95.

10. Haseli-Mashhadi N, Pan A, Ye X, Wang J, Qi Q, Liu Y, et al. Self-rated health in middle-aged and elderly Chinese: distribution, determinants and associations with cardio-metabolic risk factors. *BMC Public Health*. 2009;9:368. DOI:10.1186/1471-2458-9-368

11. Head J, Kivimäki M, Martikainen P, Vahtera J, Ferrie JE, Marmot MG. Influence of change in psychosocial work characteristics on sickness absence: The Whitehall II Study. *J Epidemiol Com Health*. 2006;60(1):55-61. DOI:10.1136/jech.2005.038752

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

13. Karasek RA, JR. Job demands, job decision latitude, and mental strain: implications for job redesign. *Adm Sci Q*. 1979;24(2):285-308. DOI:10.2307/2392498

14. Karasek R. Low social control and physiological deregulation - the stress-disequilibrium theory, towards a new demand-control model. *SJWEH Suppl*. 2008;(6):117-35.

15. Kobayashi Y, Hirose T, Tada Y, Tsutsumi A, Kawakami N. Relationship between two job stress models and coronary risk factors among Japanese part-time female employees of a retail company. *J Occup Health*. 2005;47(3):201-10. DOI:10.1539/joh.47.201

16. Kondo K, Kobayashi Y, Hirokawa K, Tsutsumi A, Kobayashi F, Haratani T, et al. Job strain and sick leave among Japanese employees: a longitudinal study. *Int Arch Occup Environ Health*. 2006;79(3):213-9. DOI:10.1007/s00420-005-0027-x

17. Li J, Karasek R, Cho SI, Choi BK, Johnson JV, Ostry A, Landsbergis P. Reliability, scale structure and findings from Chinese JCQ 2.0 study. In: 3. ICOH International Conference on Psychosocial Factors at Work; 2008 Sept 2; Quebec, CA. S7-1.

18. Ostry AS, Kelly S, Demers PA, Mustard C, Hertzman C. A comparison between the effort-reward imbalance and demand control models. *BMC Public Health*. 2003;3(10):1-9. DOI:10.1186/1471-2458-3-10.

19. Ota A, Masue T, Yasuda N, Tsutsumi A, Mino Y, Ohara H. Association between psychosocial job characteristics and insomnia: an investigation using two relevant job stress models: the demand-control-support (DCS) model and the effort-reward imbalance (ERI) model. *Sleep Med*. 2005;6(4):353-8. DOI:10.1016/j.sleep.2004.12.008

20. Peter R, Siegrist J, Hallqvist J, Reuterwall C, Theorell T. Psychosocial work environment and myocardial infarction: improving risk estimation by combining two complementary job stress models in the SHEEP Study. *J Epidemiol Community Health*. 2002;56(4):294-300. DOI:10.1136/jech.56.4.294

21. Siegrist J. Adverse health effects of high- effort - low reward conditions at work. *J Occup Health Psychol*. 1996;1(1):27-41. DOI:10.1037/1076-8998.1.1.27

22. Siegrist J, Starke D, Chandola T, Godin I, Marmot M, Niedhammer I, et al. The measurement of effort-reward imbalance at work: European comparisons. *Soc Sci Med*. 2004;58(8):1483-99. DOI:10.1016/S0277-9536(03)00351-4

23. Siegrist J, Wege N, Pühlhofer F, Wahrendorf M. A short generic measure of work stress in the era of globalization: effort-reward imbalance. *Int Arch Occup Environ Health*. 2009;82(8):1005-13. DOI:10.1007/s00420-008-0384-3

24. Söderfeldt B, Söderfeldt M, Muntaner C, Campo P, Warg LE, Ohlson C-G. Psychosocial work environment in human service organizations: a conceptual analysis and development of the demand-control model. *Soc Sci Med*. 1996;42(9):1217–26. DOI:10.1016/0277-9536(95)00231-6

25. Theorell T, Karasek RA. Current issues relating to psychosocial job strain and cardiovascular disease research. *J Occup Health Psychol*. 1996;1(1):9-26. DOI:10.1037/1076-8998.1.1.9

26. Tsutsumi A, Kayaba K, Theorell T, Siegrist J. Association between job stress and depression among Japanese employees threatened by job loss in a comparison between twocomplementary job-stress models. *Scand J Work Environ Health.* 2001;27(2):146-53.