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Interactions between physical and psychosocial demands of work associated to low back pain

Interação entre demandas físicas e psicossociais na ocorrência de lombalgia

ABSTRACT

OBJECTIVE: To examine the interaction between physical and psychosocial demands of work associated to low back pain.

METHODS: Cross-sectional study carried out in a stratified proportional random sample of 577 plastic industry workers in the metropolitan area of the city of Salvador, Northeast Brazil in 2002. An anonymous standard questionnaire was administered in the workplace by trained interviewers. Physical demands at work were self-rated on a 6-point numeric scale, with anchors at each end of the scale. Factor analysis was carried out on 11 physical demand variables to identify underlying factors. Psychosocial work demands were measured by demand, control and social support questions. Multivariate analysis was performed using the likelihood ratio test.

RESULTS: The factor analysis identified two physical work demand factors: material handling (factor 1) and repetitiveness (factor 2). The multiple logistic regression analysis showed that factor 1 was positively associated with low back pain (OR=2.35, 95% CI 1.50;3.66). No interaction was found between physical and psychosocial work demands but both were independently associated to low back pain.

CONCLUSIONS: The study found independent effects of physical and psychosocial work demands on low back pain prevalence and emphasizes the importance of physical demands especially of material handling involving trunk bending forward and trunk rotation regardless of age, gender, and body fitness.

DESCRIPTORS: Psychological stress. Low Back Pain, epidemiology. Exertion. Cumulative Trauma Disorders. Occupational Health. Cross-Sectional Studies.

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RESUMO

OBJETIVO: Analisar a interação entre demandas físicas e psicossociais no trabalho sobre a ocorrência de lombalgia em trabalhadores.

MÉTODOS: Estudo transversal com amostra aleatória, estratificada, proporcional de 577 trabalhadores da indústria de plásticos da região metropolitana de Salvador (BA), realizado em 2002. Questionário padronizado, anônimo, foi administrado no local de trabalho por entrevistadores treinados. As demandas físicas foram medidas pelo auto-registro de trabalhadores com uma escala numérica de seis pontos, com âncoras nas extremidades. A análise de fator foi realizada com 11 variáveis de demandas físicas, a fim de identificar os fatores subjacentes. As demandas psicossociais no trabalho foram medidas por meio de questões sobre demanda psicológica, controle e suporte social. Realizou-se análise de regressão logística, utilizando o teste da razão de verossimilhança.

RESULTADOS: A análise de fator identificou dois fatores de demandas físicas no trabalho: fator 1, caracterizando manuseio de carga; fator 2, caracterizando repetitividade. Resultados da regressão logística múltipla mostraram que o fator 1 estava associado com lombalgia (OR=2,35, IC 95% 1,50; 3,66). Não houve associação estatística entre demandas físicas e psicossociais no trabalho, mas ambas atuaram de forma independente no desfecho.

CONCLUSÕES: Os achados mostraram que para ocorrência de lombalgias houve efeitos independentes e importantes para demandas psicossociais e físicas no trabalho, com destaque para: manuseio de carga, inclinação e rotação de tronco na ocorrência de lombalgia, mesmo considerando a idade, sexo e condicionamento físico.

DESCRITORES: Estresse Psicológico. Dor Lombar, epidemiologia. Esforço Físico Transtornos Traumáticos Cumulativos. Saúde do Trabalhador. Estudos Transversais.

INTRODUCTION

Systematic literature reviews have found evidences of a relationship between low back pain and material handling including load lifting and carrying, whole-body vibration, frequent trunk bending forward and rotation, and heavy physical exertion.[2,5,13,18,22] Several cross-sectional studies have suggested a relationship between low back pain and static postures (e.g. standing in one place for long periods) and repetitiveness, but the results are so far limited.[5,18,22]

Psychosocial demands have also been identified as risk factors for low back pain.[3,5,6,9,24] Low job satisfaction, poor social support at work, and high work pace are the risk factors most often mentioned. It is believed that the effect of psychosocial factors on musculoskeletal disorders is generally partially or completely independent of physical factors.[2] Psychosocial factors are usually described as organizational factors at work, but according to Huang et al[9] (2002), they reflect structural aspects of the work process and can be better understood as "qualities of the organizational environment subjectively experienced by workers. In the present study, this distinction was considered and used for defining psychosocial factors.

Some models suggest that psychosocial demands influence the effects of physical demands on the musculoskeletal system (increasing the duration or intensity of exposure) while others highlight the role of psychosocial demands through the effects of psychological distress (physiological, psychological, and behavioral reactions) that would directly affect the development of musculoskeletal disorders through a neuroendocrine pathway.[3,9] Westgaard[24] (2000) carried out studies on pain associated with psychological stressors in work environments where work tasks did not require high levels of muscular activity. He hypothesized that psychological stressors, through the neuroendocrine pathway, led to an increased level of muscular activity, with sustained muscular activity in a few motor units, causing pain. Sustained muscular activity of low intensity in stress situations with low exposure

to physical demands has been well documented. However, it is not clear whether the associated pain originated in these situations is caused by sustained muscular activity. It is also possible that exposure to psychological stressors exerts a direct effect on workers' perception and reporting of musculoskeletal symptom. Some models have proposed that individual factors (coping ability and personality type) combined with work organization factors are determinants of the responses to psychological stressors and to their effects on the musculoskeletal system.[3,9,22]

Karasek et al[15] (1998) devised a model for studying job strain based on the notions of decision latitude (control), psychological demands, and social support at work: I – Control at work refers to the use of skills and decision authority; II - Psychological demands include time pressure and level of concentration required, task interruptions and need to wait for other team members to complete one's job. The control-demand model was expanded by Johnson (1986, referred by Karasek et al[15] 1998) with the inclusion of social support, that includes coworker support and supervisor support. This is one of the most widely used models in studies of stress at work.[9]

These models explaining the role of physical and psychosocial work demands have contributed with knowledge on musculoskeletal disorders in general and specifically to the studies on low back pain, recognized as a major public health problem. However, it remains unclear whether there is a synergistic action between physical and psychosocial work demands.

Epidemiologic studies investigating interactions between physical and psychosocial demands associated to low back pain are still scarce in the literature.[19,22] The objective of the present study was to assess the interaction between physical and psychosocial work demands associated to the occurrence of low back pain among plastic industry workers.

METHODS

This is a cross-sectional study including all production workers from maintenance and operation departments of all 14 plastic factories with more than 35 employees in the metropolitan area of the city of Salvador, Northeast Brazil, 2002. Workers in administrative departments were excluded. A stratified proportional random sample was selected from 1,177 eligible workers. The proportional stratification is the number of subjects by factory maintaining the same proportion of the target population in the sample.

The minimum sample size was estimated at 557 subjects considering a precision of 4%, a 95% significance level, an expected low back pain prevalence of 50.0% and a design effect of 1.4. It was decided to sample more than the minimum sample size to include potential refusals.

All employees of each company from maintenance and operation departments were eligible. The selected workers who were temporarily away from work were contacted to participate in the study. A total of 577 workers, males and females, were studied.

Data was collected at each participating company during a regular working day. A pre-tested questionnaire was used and subjects' privacy was assured. All interviewers were trained, including explanations of each item of the questionnaire and answer options. They participated in simulated interviews and in a pilot study when they interviewed workers during a working day.

The questionnaire comprised questions about sociodemographic factors; occupational history in the current company and former ones, including formal and informal jobs, the regular working day, and the number of hours worked in the last week, questions on physical work demands, information on workstation characteristics; psychosocial demands (Karasek 1985,[14] 2000[a]); lifestyle factors including smoking, medicine consumption, alcohol use and domestic and family responsibilities; physical activities and sports; information on musculoskeletal disorders; and other health information (e.g. past history of fractures, diabetes, rheumatoid arthritis, and hypothyroidism.

The questionnaire used for assessing musculoskeletal disorders was a Portuguese translation of the questionnaire proposed by Kuorinka & Forcier[18] (1995). The questionnaire is an expanded version of the Nordic Musculoskeletal Questionnaire (NMQ[17]) with the inclusion of questions that evaluate severity, duration and frequency of symptoms in all the investigated body areas to improve the specificity of NMQ.

The outcome included reporting of low back pain or discomfort (pain symptoms, numbness, tingling, burning, and swelling), with or without accompanying pain in other body areas, occurring in the previous twelve months, that lasted at least one week or occurred at least once a month and was not caused by an acute injury, and meeting one of following conditions: current symptom severity rating of 3 or greater (0–5 scale), or sought medical care, missing work (official or unofficial), light or restricted work (official or unofficial) or changed jobs due to these problems.[18]

Measures of exposure to physical work demands were based on workers' self-report on 11 items using a 6-point scale (of duration, frequency or intensity), with anchors at each end of the scale. Some of the questions

[a] Portuguese version of Karasek's book,[14] translated by Araujo T, 2000. (not published)

were partly based on the instrument proposed by Cail et al (1995),[a] and others were specially designed for this study.

Physical demand items included: repetitive movements with the hands, force exerted with arms or hands, general body posture including sitting, standing, walking, arm posture including hands above shoulder, trunk posture such as trunk bending forward or trunk rotation, material handling, and hand use. Spearman's rank order correlation coefficients were calculated for all 11 physical work demand items, followed by factor analysis that was carried out to identify underlying factors, reduce the number of variables and prevent variable redundancies. The initial extraction was made through the main components of the model and factors were obtained without rotation.[16] The resulting factors were used as the main independent variables for physical work demand.

Psychosocial work demands were measured using the Job Content Questionnaire (JCQ[14]) scales for psychological demands, decision latitude, and social support. A composite score on "psychosocial demands at work" was obtained based on the scores of all three scales. High psychosocial exposure criteria were high mental demands, low job control, and low social support. At least two of these criteria for high psychosocial exposure had to be met to be in this group. Low psychosocial exposure criteria were low mental demands, high job control, and high social support. At least two of these criteria for low psychosocial exposure had to be met to be in this group.[7] JCQ questions on job satisfaction were also included in the study and translated by the main author (RCPF) of this study.

The main independent variable was physical work demands, i.e., the resulting factor 1 from the factor analysis that characterized physical demands of material handling. Covariates were included in the analysis: psychosocial work demands, the resulting factor 2 from the factor analysis that characterized physical demands of repetitiveness, job dissatisfaction, years of work, work overtime, age, gender, education, marital status, having children younger than two years old, domestic work, body fitness, obesity or overweight, smoking habit and alcohol use.

The multivariate analysis to test the hypothesis of an existing interaction between physical and psychosocial demands was performed through unconditional logistic regression. The model first included an initial selection of covariates based on the biological plausibility of the involved associations and based on univariate logistic regressions according to the literature available on low back pain. The variables first selected for logistic regression, using the likelihood ratio test, besides the main independent variable, physical demands of material handling were psychosocial demands, physical demands of repetitiveness, years of work, job dissatisfaction, education, obesity or overweight, domestic work, body fitness, and frequent alcohol consumption. A backward stepwise method was used for variable selection. A confounder was a variable that produced 15% or more change in the measure of the main association or in the width of the confidence interval when removed from the maximum model. Interactions were analyzed through the statistical selection of the product term using the likelihood ratio test, one by one, in a model that contained the remaining independent variables and the product term. The product terms selected were included in the maximum model. Effect modifier would be that making a significant contribution to prediction ($\alpha = 0.20$) in the likelihood ratio test, corresponding to comparisons between the maximum model and reduced model, in which the product term of the variable under analysis had been deleted. The goodness-of-fit test and residual analysis were used for logistic regression.[8]

The study was approved by the Research Ethics Committee of *Instituto de Saúde Coletiva at Universidade Federal da Bahia.* All participants signed a free consent form before answering the questionnaire. They were informed about the study objectives and public institutions involved in this research project and interviewers assured them that their employers were contacted to allow their access to the workplaces but that their employers were not involved in this research. This aspect was considered particularly relevant for controlling information bias. They were also explained the study confidentiality and non-identification of information, and voluntary participation.

RESULTS

Males accounted for 69.0% of the sample. The prevalence of low back pain was 21.2% among women and 21.4% among men.

The factor analysis with 11 variables of physical exposure resulted in two factors. Their composition, in a decreasing order of the loads presented by each variable, was as follows (Table 1): Factor 1 characterized physical demands of material handling and correlates: lifting weights, standing posture, exertions of arms and hands, arms above shoulder height, trunk rotation, mechanical hand pressure on the object of work, and trunk bending. Factor 2 characterized static trunk posture during repetitive work with the hands: repetitive hand movements, sitting posture, no walking.

[a] Portuguese version by Assunção AA, 2001, of Cail F, Aptel M, Pichene A. "Questionnaire d'évaluation du vécu du travail de salariés exposés à des risques de troubles musculosquelettiques". Paris: Institute National de Recherche et de Sécurité; 1995. (Documents pour le médecin du travail, nº 64, 4º trimestre) (not published)

Table 1. Results of factor analysis of physical work demands. Salvador, Northeast Brazil, 2002.

Component	Factor loading	Initial eigenvalue	Variance (%)
Component 1 (physical demands of material handling)		3.14	28.5
Lifting weights	0.658		
Standing posture	0.636		
Exertions of arms and hands	0.629		
Arms above shoulder height	0.564		
Trunk rotation	0.514		
Mechanical hand pressure on the object of work	0.513		
Trunk bending forward	0.478		
Component 2 (physical demands of repetitiveness)		1.99	18.1
Repetitive hand movements	0.597		
Sitting posture	0.591		
Repetitive gesturing	0.545		
Walking	–0.632		

Table 2 shows that workers exposed to physical demands of material handling (manual material handling) were more likely to have higher education, were predominantly married or lived with partner. There were no differences between exposed and non-exposed workers to physical demands of material handling regarding age, frequent alcohol consumption, gender, smoking habit, body fitness, and obesity or overweight. There were no differences between exposed and non-exposed to physical demands of material handling as for domestic work, overtime, and exposure to physical demands of repetitiveness (physical demands of repetitiveness, factor 2). However, exposed workers had higher job dissatisfaction, reported higher psychosocial demands and more years of work. The distribution of covariates according to exposure status was assessed to identify potential confounders or effect modifiers.

Prevalence, prevalence ratios and 95% confidence intervals for isolated and combined effects of physical work demands of material handling and psychosocial demands on low back pain are described in Table 3. In spite of higher prevalence of low back pain in the presence of the two exposures, the results did not show any interaction.

Tables 4 and 5 show the results of the multiple logistic regression analysis. The goodness-of-fit test and residual analysis showed a good adjustment of the final model.

No interaction between physical and psychosocial demands (likelihood ratio test, $p>0.20$) was found (Table 5). Low back pain was 2.35-fold more likely in those exposed at higher levels to physical demands of material handling than those exposed at lower levels (Table 5).

DISCUSSION

Physical work demands were positively associated with low back pain. The study findings do not support the hypothesis that psychosocial work demands interact on a multiplicative or additive scale with physical demands causing low back pain. These demands, psychosocial and physical, are independent associated factors with low back pain.

Exploring interaction is very important in the study of musculoskeletal disorders, but few studies have focused on it.[22] Although how these risk factors interact remains as a contemporary issue,[19,20] studies have not shown a statistic interaction between physical and psychosocial work demands and the occurrence of musculoskeletal disorders. Advances have been made, especially showing an association between psychosocial demands and musculoskeletal disorders, and in measuring the exposure to physical work demands. However, these demands have been mostly identified as independent risk factors for low back pain, as corroborated in the present study.

Huang et al (2003)[10] found independent effects of psychosocial and physical demands and they "emphasize the need to consider both biomechanical factors and specific work organization factors, particularly time pressure, in reducing musculoskeletal-related morbidity".

Non-occupational covariates, such as sociodemographic (age, education, gender, marital status), lifestyle and domestic work variables, and physical activity, were included in the analysis. This is a strength of this study as the literature[3,4,22] shows that most studies on musculoskeletal disorders have neglected these potential confounders.

Bongers et al (1993)[3] pointed out to the need of analyzing the concurrent effect of psychological demands, control and social support. The validity of studies that analyzed the effect of physical demands on low back pain without taking into account psychosocial demands are deeply questioned.

Table 2. Exposed and non-exposed workers according to of sociodemographic, lifestyle, domestic work, and occupational variables. Salvador, Northeast Brazil, 2002.

Variable	Physical demands of material handling				p-value
	Exposed n=285		Non-exposed n=284		
	n	%	n	%	
Age					
≤30	144	50.5	155	54.6	0.33
>30	141	49.5	129	45.4	
Education (years)					
≥11	182	63.9	149	52.5	0.01
<11	103	36.1	135	47.52	
Alcohol consumption					
<1 time/week	182	64.1	177	63.4	0.73
≥1 time/week	102	35.9	102	36.6	
Gender					
Male	205	71.9	187	65.8	0.11
Female	80	28.1	97	34.2	
Smoking					
No	253	88.8	247	87.0	0.51
Yes	32	11.2	37	13.0	
Body fitness					
Good to excellent	140	49.3	136	48.1	0.76
Poor to moderate	144	50.7	147	51.9	
Marital status					
Single or living alone	98	34.4	125	44.2	0.01
Married	187	65.6	158	55.8	
Overweight or obesity					
No	177	63.4	180	66.9	0.50
Yes	102	36.6	89	33.1	
Hours of domestic work					
<15	212	74.6	229	80.6	0.09
≥15	72	25.4	55	19.4	
Job dissatisfaction					
No	141	50.4	179	63.9	0.02
Yes	139	49.6	101	36.4	
Psychosocial demands					
No	110	42.8	147	57.2	0.02
Yes	164	60.1	109	39.9	
Physical demands of repetitiveness					
No	133	46.80	151	53.2	0.14
Yes	152	53.3	133	46.8	
Years of work					
<13	124	43.8	147	52.5	0.05
≥13	159	56.2	133	47.5	
Overtime					
No	86	30.3	82	28.9	0.58
Yes	198	69.7	202	71.1	

Table 3. Prevalence, prevalence ratios and 95% confidence intervals for the combined effects of physical and psychosocial work demands on low back pain. Salvador, Northeast Brazil, 2002.

Variable	n	Prevalence (%)	Prevalence ratio	95% CI
PDMH=0, PD=0	147	10.2	1.00	-
PDMH=0, PD=1	109	19.1	1.87	(1.01;3.46)
PDMH=1, PD=0	164	22.0	2.16	(1.19;3.91)
PDMH=1, PD=1	110	34.8	3.41	(2.02;5.75)

PDMH: Physical demands of material handling 0= lower exposure, 1=higher exposure
PD: Psychosocial demands 0= low psychosocial exposure, 1=high psychosocial exposure

Table 4. Interaction analysis in logistic regression of physical work demands and psychosocial demands on low back pain, Salvador, Northeast Brazil, 2002.

Model / Variable	–2 log L	d.f. model	Likelihood ratio test χ^2
Maximum model			
Dependent: low back pain			
Independent: physical work demands of material handling, psychosocial demands, PDMH x PD[a]	530.924	3	28.609
Model after removing product term (PDMH x PD[a])			
Dependent: low back pain			
Independent: physical work demands of material handling, psychosocial demands	530.967	2	28.566

[a] Complete model includes the potential factor for interaction, psychosocial demands, with the corresponding product term; χ^2 = chi-square; p>0.20. No interaction was found.
PDMH: Physical demands of material handling
PD: Psychosocial demands

The questions used to measure exposure to physical work demands allowed obtaining a measure of exposure for each subject by using a numeric six-point scale with anchors at the end of the scale. This scale does not require the absolute measure of exposure, which is difficult to be being quantified by the worker, but it indicates the highest and the lowest level of exposure through the anchors. The most general formulation of the questions ("repetitive movements", "exertions of arms and hands") seems to have allowed workers to give the best answers concerning their perception about the exposure. This option aimed to minimize validity problems that have been identified in some questions and their response scales, as Stock et al (2005)[23] have suggested in their systematic review on reproducibility and validity of questions measuring physical work demands.

Material handling is referred as a paramount risk factor to low back pain, as well as frequent trunk bending forward and rotation. However, evidences of the association between low back pain and repetitiveness are not consistent.[22] The results of the present study corroborate the literature: low back was associated with physical demands of material handling but not with physical demands of repetitiveness in the multivariate final model. Only the covariate psychosocial demands remained in the final model, besides physical demands of material handling, as a predictor of low back pain. These results support the idea that intervention programs should seek to reduce exposure to material handling and consequently prevent low back pain.

Longitudinal studies confirmed that psychosocial factors are major determinants of subsequent low back pain. High psychological demand (high pace of work), low social support, and low job satisfaction are more strongly associated to low back pain than low control.[22] In the present study, there was no interaction between physical and psychosocial demands,

Table 5. Results of the logistic regression on the association between physical work demands and low back pain. Salvador, Northeast Brazil, 2002.

Final model/Variable (n=530)	OR (95% CI)	1-β
Dependent: low back pain		
Independent: physical demands of material handling	2,35[a] (1,50;3,66)	>99%

[a] Result adjusted for psychosocial demands.

but both physical and psychosocial demands were independently associated to low back pain. The finding of the association between psychosocial demands and musculoskeletal disorders is consistent with that reported in the literature.[12,21,22]

The present study determined the prevalence of low back pain in occupational active workers, providing an estimate of morbidity concurrently occurring with daily work activities.

Health information based on workers' self-report, a common procedure in epidemiologic studies, can motivate some criticism concerning loss of objectivity. However, self-reporting is the main approach to study symptomatic disorders, especially considering the subjective nature of symptoms of low back pain. Other methods of clinical evaluation such as physical examination have also limitations. The physical examination does not always allow a diagnosis and its validity can be questioned as there is no gold standard method for comparison.[1]

Considering the particular characteristics and the nature of relationships in the work environment, it is necessary to consider that such conflicting relationships can compromise the validity of data. In this event, morbidity may be overestimated, as well as exposure, when workers negatively evaluate work conditions. This is a potential limitation of the present study. However, some procedures were adopted during data collection to minimize information bias. All subjects were informed about the independence of the research study and investigators from their employers and that the study was sponsored by public agencies. Assuring privacy and anonymity contributed to avoid information bias. In the questionnaire, questions on the main dependent variable – presence of musculoskeletal disorders – were followed by other several questions on morbidity, such as the presence of other diseases, to minimize the likelihood of workers associating musculoskeletal disorders as the main focus of the study related to their occupation.

A selection bias, the healthy worker's effect, could have distorted the study findings. However, bias due to healthy recruiting is unlikely to be relevant since only internal comparisons to the studied population were performed. Survival healthy worker's effect could occur due to 1) transference of workers from one to another occupation, inside the company; 2) sick leave; or 3) worker's dismissal. To minimize bias due to sick leave, the study population included all employed workers, either in activity or temporarily away from work for sick leave.

Therefore, results support the recommendation of changes in work organization, including management choices, supervision methods, work teams, especially ensuring cooperative work with social support, reduction of work pace, and increased workers' control of work conditions, to reduce disease burden of occupational low back pain.[11]

Intervention programs to reduce occupational risk factors can stop the progress of low back pain to disability and more severe disorders that prevent individuals from working.

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