



THE COMBINED EFFECT OF EFFORT AND REWARD AS A PREDICTOR FOR THE OCCURRENCE OF WMSD IN THE NECK AND SHOULDER

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Abstract:

The biopsychosocial model encompasses psychosocial factors such as effort and reward among the variables that lead to the appearance of Work-Related Musculoskeletal Disorders (WMSD). The footwear industry is one of those that present a higher incidence of WMSD, although investments in ergonomic interventions have occurred increasingly. Therefore, the purpose of this article is to verify the effect of the combination of effort and reward in the development of WMSD, which lead to the appearance of more frequent and intense pain in employees of a Brazilian footwear industry. Methodologically, the Effort-reward Imbalance Questionnaire (ERI) was applied to evaluate the employees' perception of the level of effort and reward of the work. To assess the symptoms of WMSD in the neck and shoulder the Nordic Questionnaire was used. Ordinal logistic regression models were used to estimate the risk (odds ration) of employees developing symptoms of WMSD. Among the results, it was emphasized that there is an increase in the 4-fold chance of men developing more frequent pains in the shoulders; and an increase in the 51-fold chance of women developing more severe DORS in the neck region when exposed to high effort and low reward. It is concluded that the combination of effort and reward leads to the appearance of WMSD in the neck and shoulder independent of gender, with effort being the predominant factor in this relationship.

Keywords: WMSD; Effort; Reward.

1. INTRODUCTION

The European Agency for Safety and Health at Work, EU-OSHA (2008) defines Work-Related Musculoskeletal Disorders (WMSDs) as changes in organic structures at the level of muscles, joints, tendons, ligaments, nervous system, bones and circulatory system, caused or aggravated fundamentally by work and the effects of the conditions in which it is carried out. The origin of WMSDs is multifactorial, being caused by factors such as posture, static load, problems of inadequacy at the workplace, vibrations, cold, noise, localized mechanical pressure, musculoskeletal mechanical load, task invariability, cognitive demands and organizational and psychosocial factors (KUORINKA; FORCIER, 1995).

Couto and Moraes (2003) classify WMSDs as one of the biggest challenges that researchers have to solve when it comes to occupational health in all countries of the world, being considered an epidemic, as it has different origins and because of factors of nature that range from psychological, social, biomechanical, organizational and psychosocial. The costs arising from problems with WMSDs are quite onerous for the coffers of developed countries such as the United States (COOVERT; THOMPSON, 2003), reaching values of 50 billion dollars per year, and also for developing countries, such as Brazil, reaching values in 2011, 356 million reais (MORAES; BASTOS, 2013).

For Araújo et al. (2013) the biopsychosocial model is the most appropriate to explain the origin of WMSD, as it takes into account a series of factors that are difficult to measure, such as psychosocial factors. Among the biopsychosocial models, the effort-reward imbalance model proposed by Siegrist et al. (1996) who states that psychosocial stress tends to develop in situations where work effort is in dissonance with the rewards received for such effort.

Roqueleure et al. (2002) classifies the footwear industry as one of the branches of economy with a high risk of WMSD for its production employees. Colaço (2013) points out that, although large amounts of money have been invested in ergonomic

interventions, the number of WMSDs has been increasing, especially in the footwear industry. Therefore, he supported the idea that to minimize the number of WMSDs, greater attention should be paid to psychosocial factors, as these can also influence the appearance of musculoskeletal problems. The studies by Amano et al., (1988), Aghili, Asilian and Poursafa (2012), Warnakulasuriya et al. (2012) and Afonso (2013) observed a high prevalence of WMSDs in the neck region of employees in the shoe industry. Other authors, such as Serratos-Perez and Mendiola-Anda (1993), Leclerc et al. (2004), Descatha et al. (2007) and Colaço (2013) found a considerable number of employees with WMSDs in the shoulder region in footwear industries.

The findings of Gillen et al. (2007) indicate that the imbalance between effort and reward causes WMSDs in parts of the body, especially the neck. Bernard et al. (2011) found that the effort-reward imbalance leads to the appearance of shoulder and neck pain, especially in males. Yu et al. (2013) found strong evidence that the imbalance between effort and compensation has a strong relationship with the appearance of pain, especially in the shoulders and neck region, regardless of individual variables. However, not many studies were found in which the combination of effort (high and low) with reward (high and low) was found in the appearance of WMSDs among workers in footwear-producing industries.

Therefore, the objective of this article is to verify the effect of the combination of effort and reward on the development of WMSD, which leads to the appearance

of more frequent and intense pain in employees of a Brazilian footwear industry.

2. METHODOLOGY

The data was obtained from 184 production employees whose main function is to operate machines and tools in the manufacture of shoes. Such employees were randomly selected from the jobs that make up the industry. Initially, demographic data was collected from employees, such as gender, age, body mass index (BMI), length of service with the company, smoking habit, whether they consume alcoholic beverages, whether they practice physical activities, level of education, marital status and whether they have children.

The two psychosocial factors were assessed using the Effort-reward Imbalance Questionnaire (ERI) (SIEGRIST et al., 1996). Effort and reward scores are calculated by adding the points assigned to each question, so that the higher the score, the lower the perception of reward, or the higher the perception of effort that the employee has for their work (SOUZA et al., 2012). The average effort and reward scores were used to dichotomize each dimension into high or low exposure to such psychosocial factors (SOUZA et al., 2010). A 4-point Likert scale (totally disagree, disagree, agree and totally agree) was used to score the responses. Depending on the effort and reward scores, employees were classified according to their perception of the work, which could be low effort work with high reward (reference value); high-effort, high-reward work; low effort, low reward work; and high-effort, low-reward work.

To evaluate the frequency and intensity of WMSD in the neck and shoulder, the Nordic Questionnaire (NQ) (KUORINKA et al., 1987) with a 4-point Likert scale. To assess the frequency of WMSDs, employees marked 1 out of 4 possible points (no WMSD, symptom rarely, symptom frequently and always experience WMSD). To assess the intensity of WMSD, employees also marked 1 out of 4 points (no WMSD, mild symptom, moderate symptom and strong symptom) for the neck and shoulder. A Cronbach's alpha of 0.63 (0.54-0.71) was found, indicating some internal consistency for these questionnaires.

This project was approved by the Ethics Committee in Research at the Health Sciences Center of the Federal University of Paraíba. The project identification number is CAAE 46893215.1.0000.5188

3. RESULT

The company has approximately 1760

factory floor employees who work eight hours a day. Of these, 184 (10.45%) were selected to answer the questionnaires. Among those selected, 96 were men (53.17%) and 88 women (47.83%). The employees were chosen from the six sectors that make up the company,

The questionnaires were answered by employees Research from the Health Sciences Center of the Federal University of Paraíba. The project identification number is CAAE 46893215.1.0000.5188

informed about the objectives of the research and one of the researchers read an informed consent form that presented more information about this research.

Statistical calculations were made using the software R version 3.0.1.

In that program initially carried out descriptive statistics for data on demographics, psychosocial factors and WMSD symptoms. Subsequently, the normality of the collected data was verified to choose which statistical techniques could be used to analyze the dependence between the variables. Due to the non-normality of the data, it was decided to use non-parametric statistical methods. Therefore, the Fisher's Exact test was used, with an alpha of 5%, to verify the independence between genders regarding demographic data. The Chi-square test ($\alpha = 0.05$) was used to compare, between men and women, the results regarding psychosocial factors and WMSD symptoms. Finally, using ordinal logistic regression models, an estimator was used to express the risk (odds ratio or OR). This way, we can check the chance of an employee experiencing WMSDs in the neck or shoulder more frequently or more intensely when they are in one of the combinations of effort and reward.

Usode bebidas alcoólicas

Yes	73	82,95	80	83,33	0,9999
No	15	17,05	16	16,67	
Performs physical					
Yes	70	79,55	69	61,46	2,921*1
No	13	20,45	37	38,54	
marital status					
Married	41	46,59	57	59,38	0,1038
Singles	47	53,41	39	40,63	
Have a son					
Yes	29	32,9		73,96	2,833*1-8

46 (25.00%) from the vulcanized sector, 41 (22.28%) from the assembly sector, 40 (21.74%) from the cemented sector, 20 (10.87%) from the sewing sector, 13 (7.07) from the prefabrication sector and 24 (13.04%) from the finishing sector. Table 1 presents the demographic data of the interviewed employees,

Table 1. Demographic data for men and women.

	Women		Men		<i>p-value</i>
	N°	%	N°	%	
No	59	67,05		26,04	0,3109
Education level					
Fundamental I	1	1,14		2,08	
Fundamental II	8	9,09		3,13	
High school	71	80,68		89,58	
Incomplete higher	6	6,82		3,13	
Graduated	2	2,27		2,08	

$p < 0.05$ are indicated in bold.

Age	8	8,33	26	29,55	$3,036 \times 10^{-10}$
(years)					
21-30	24	25,00	46	52,27	
31-40	46	47,92	11	12,50	
≥ 40	1	18,75	5	5,68	
IMC	8				$1,857 \times 10^{-3}$
(Kg/m ²)		4,17	6	6,82	
18,5-24,9	39	40,63	47	53,41	
25,0-29,9	33	34,38	33	37,50	
30,0-34,9	18	18,75	2	2,27	
35,0-39,9	1	1,04	0	0,00	
≥ 40	1	1,04	0	0,00	
Length of service (months)					$2,208 \times 10^{-4}$
≤ 12,0	10	10,42	20	22,73	
12-60	38	39,58	50	56,82	
61-120	24	25,00	12	13,64	
121-180	2	2,08	1	1,14	
181-240	14	14,58	1	1,14	
≥ 240	8	8,33	4	4,55	
Cigarette use					0,3212
Smoker	11	12,50	7	7,29	
Non smokers	77	87,50	89	92,71	

Observa-se que existem diferenças significativas regarding age, BMI, length of service, physical activity and presence of a child. There are more women over the age of 40, with a BMI greater than 30 kg/m², years of service with the company greater than 120 months and, proportionally, women practice more physical activities than men. The number of men with children is greater. Regarding other demographic variables, there was no difference between genders, but it is clear that the majority of employees do not smoke, drink alcohol, are

Based on the scores generated by the ERI questionnaire for the psychosocial factors effort and reward, employees were classified into the following categories indicated in table 2.

Table 2. Employees' perception of the combination of effort and reward.

	Women		Men		<i>p-value</i>
	N°	%	N°	%	
Perception					
Low effort and high reward	18	20,45	14	14,58	0,2117
High effort and high reward	42	47,73	57	59,38	
Low effort and low reward	13	14,77	7	7,29	
High effort and low reward	15	17,05	18	18,75	

It appears that there are no differences in employees' perception of the relationship between effort and reward. It can also be seen that the majority of employees, regardless of gender, report that their roles require a lot of effort, and that the reward is compatible with this effort. Just as perceptions of low effort and low reward are rarer, indicating that there are few employees, especially female employees, who perceive that their work requires low effort and that, for this work, they receive low reward. Approximately 17.05% of men and 18.75% of women perceive that work requires high effort and has low rewards. Therefore, a large number of employees are exposed to a situation of greater risk for the occurrence of stress.

The responses regarding WMSD symptoms are summarized in table 3, which indicates the frequencies and intensities of such WMSD symptoms for the neck and shoulder region.

Table 3. Employee perception of the combination of effort and reward.

	Shoulder				Neck			
	M	%	H	%	M	%	H	%
WMSD frequency								
Never	41	46,59	40	41,67	45	46,88	49	55,68
Rarely	20	22,73	10	11,46	11	11,46	16	18,18
Often	15	17,05	22	22,92	20	20,83	17	19,32
Ever	12	13,64	24	25,00	20	20,83	6	6,82
Intensity of								
WMSD	41	46,59	40	41,67	45	46,88	49	55,68
None	19	21,59	10	10,52	15	15,63	22	25,00
Weak	14	15,91	17	17,71	19	19,79	14	15,91
Moderate			29	30,21	17	17,71	3	3,41

*p<0.05. M = women and H = men.

There are differences in the frequency and intensity of WMSDs in the shoulder and neck between genders. A p-value equal to 0.03952 was found for the frequency of WMSDs in the shoulder and 0.03597 for the frequency of WMSDs in the neck. Regarding intensity, a p-value equal to 0.0461 for the shoulder and 0.008281 for the neck was found. A higher percentage of men (25.00%) reported always feeling pain in the

shoulders at the end of the working day, a value higher than that indicated by women (13.64%). Among men, 30.21% reported severe shoulder pain, much more than women (15.91%). Regarding neck pain, women felt more pain. Approximately 20.83% of women and 6.82% of men reported that they always feel neck pain. 17.71% of women and 3.41% of men reported feeling more severe neck pain.

The results for the ordinal regression models are shown in table 4 for a 95% confidence interval (CI).

Table 4. Results of regression models for shoulder and neck.

	Shoulder		Neck	
	M	H	M	H
Frequency	OR (IC)	OR (IC)	OR(IC)	OR (IC)
BExAR	1,00	1,00	1,00	1,00
AExAR	3,58 (1,19-10,70)*	3,32 (1,07-10,30)*	1,95 (0,52-7,28)	1,72 (0,52-5,67)*
BExBR	2,30 (0,56-9,54)	0,43 (0,06-2,78)	1,45 (0,27-7,84)	0,33 (0,04-2,43)
AExBR	4,83 (1,23-18,88)*	1,54 (0,41-5,74)	6,42 (1,26-32,72)*	5,07 (1,20-21,36)*
Intensity				
BExAR	1,00	1,00	1,00	1,00
AExAR	3,64 (1,20-11,04)*	2,70 (0,89-8,20)	16,41 (2,00-134,28)*	2,02 (0,67-6,16)
BExBR	1,90 (0,47-7,76)	0,64 (0,10-4,37)	18,80 (2,03-174,54)*	0,55 (0,08-3,63)
AExBR	3,11 (0,82-11,76)	2,20 (0,57-8,43)	51,22 (5,31-494,05)*	2,37 (0,66-8,50)

It is observed that the combination of high effort and high reward is a risk situation for more frequent and more intense pain to occur. This situation increases the chance of women developing more frequent and more intense pain in the shoulder region by 3 times. This combination also increases the chance of women developing more frequent pain in the neck region by 16 times. For men, this combination increases the chance of more frequent pain occurring by 3 times in the shoulder and by 72% in the neck region. Thus, it is clear that, even when the reward is considered high by employees, when it is accompanied by high effort, the risk is not mitigated, with the high reward being something that is not

eliminates the risk of WMSDs in the shoulder and neck regardless of gender.

Only women were significantly affected by the combination of low effort and low reward. An 18-fold increase in the chance of women developing WMSDs in the shoulder was found, with this relationship not being significant for the neck region. Therefore, a notion of correct reward for women is more necessary than for men, even in low-effort situations.

The combination of high effort and low reward was considered a high risk for the development of pain in both genders. Among women, the chance of developing WMSDs increases by 4 times for the shoulder and 6 times for the neck. An increase in the chance of developing more intense WMSDs was also found by 51 times for the neck. Among men, this situation leads to a 5-fold increase in the chance of developing WMSDs in the neck. Therefore, this situation presents a greater risk for the development of WMSDs in the neck and shoulder in women, so they need a greater balance between effort and reward.

3. CONCLUSION

It was concluded that some situations that combine effort and reward lead to the appearance of some WMSD symptoms in the neck and shoulder. However, those combinations made with high effort are the most harmful to the neck region for women; and the shoulder region for men. Therefore, a reduction in employees' perception of work efforts is essential to minimize the frequency and intensity of WMSD symptoms in both genders. However, taken together, an improvement in reward must be sought before a reduction in WMSD symptoms can be achieved in the footwear industry.

5. BIBLIOGRAPHIC REFERENCES

AFONSO, L.C. **Estudo comparativo da prevalência de sintomas musculoesqueléticos em trabalhadores de duas empresas da indústria do calçado: setor da costura**. 99 f. Dissertação (Mestrado em Engenharia de Segurança e Higiene Ocupacional) – Faculdade de Engenharia da Universidade do Porto, Porto, 2013.

AGÊNCIA EUROPÉIA PARA A SEGURANÇA E SAÚDE NO TRABALHO. **Work-related musculoskeletal disorders: Prevention report**. Luxembourg: European Agency for Safety and Health at Work, 2008.

AGHILI, M.M.M., ASILIAN, H., & POURSAFA, P. Evaluation of musculoskeletal disorders in sewing machine operators of a shoe manufacturing factory in Iran. **International Journal of Industrial Ergonomics**, v. 62, n.3, p. 20-25, 2012.

AMANO *et al.* Characteristics of work actions of shoe manufacturing assembly line workers and a cross-sectional factor-control study on occupational cervicobrachial disorders. **Japanese Journal of Industrial Health**, v. 30, n. 1, p. 3–12, 1988.

ARAÚJO, T.M., KIONNA, B., JESUS, C.S. **Associação entre aspectos psicossociais do trabalho e distúrbios musculoesqueléticos**. In. Simonelli, A.P., Rodrigues, D.S. (Org.). *Saúde e trabalho em debate: velhas questões, novas perspectivas*. Brasília: Paralelo 15, 2013.

BERNARD C, *et al.* Biomechanical and Psychosocial Work Exposures and Musculoskeletal Symptoms among Vineyard Workers. **Journal of Occupational Health**, v. 53, n. 5, p. 297–311, 2011.

COLAÇO, G. A. **Implementação de medidas ergonômicas em uma indústria calçadista: uma análise de suas influências sobre as condições de trabalho na atividade de desenformar calçados**. 134 f.

Dissertação (Mestrado em Engenharia de Produção) – Programa de Pós-Graduação em Engenharia de Produção, Universidade Federal da Paraíba, João Pessoa, 2013.

COOVERT, M. D.; THOMPSON, L. F. **Technology and workplace health**. In: J. C. QUICK & L. E.

TETRICK (Orgs.), *Handbook of occupational health psychology* (pp. 221-241). Washington: American Psychological Association, 2003.

COUTO, H.A.; MORAES, L.F.R. Novas Perspectivas na prevenção dos distúrbios dolorosos dos membros superiores: o entendimento dos fatores da organização do trabalho e psicossociais envolvidos em sua origem. **Revista Brasileira de Medicina do Trabalho**, v.1, n.1, p. 40-55, jul. 2003.

DESCATHA, A. *et al.* Predictive factors for incident musculoskeletal disorders in an in-plant surveillance program. **The Annals of Occupational Hygiene**, v. 51, n.3, p. 337–44. 2007.

GILLEN, M., *et al.* The association of socioeconomic status and psychosocial and physical workplace factors with musculoskeletal injury in hospital workers. **American Journal of Industrial Medicine**, v. 50, n.4, p. 245–60, 2007.

KUORINKA, I. *et al.* Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. **Applied Ergonomics** v. 18, n 3, p. 233-237, 1987.

KUORINKA, I.; FORCIER, L. (Ed.). **Work-related musculoskeletal disorders (WMSDs): a reference book for prevention**. Great Britain: Taylor & Francis, 1995.

LECLERC, A. *et al.* Incidence of shoulder pain in repetitive work. **Occupational & Environmental Medicine**, v. 61, n. 1, p. 39–44, 2004.

MORAES, P.W.T.; BASTOS, A.V.B. As LER/WMSD e os fatores psicossociais. **Arquivos Brasileiros de Psicologia**, v. 65, n.1, p. 2–20, 2013.

ROQUELAURE, Y. *et al.* Active epidemiological surveillance of musculoskeletal disorders in a shoe factory. **Occupational and Environmental Medicine**, v. 59, n. 7, p. 452–458, 2002.

SERRATOS-PEREZ, J. N.; MENDIOLA-ANDA, C. Musculoskeletal disorders among male sewing machine operators in shoemaking. **Ergonomics**, v. 36, n. 7, p. 793–800, jul. 1993.

SIEGRIST, J. Adverse health effects of high-effort/low-reward conditions. **Journal of Occupational Health Psychology**, v.1, n. 1, p. 27-41, 1996.

SOUZA, S. F. *et al.* **Depressão em trabalhadores de linhas elétricas de alta tensão**, Revista Brasileira de Epidemiologia, v. 15, n. 2, p. 235–245, 2012.

SOUZA, S.F. *et al.* Fatores psicossociais do trabalho e transtornos mentais comuns em eletricitários, **Revista de Saúde Pública**, v. 44, n. 4, p. 710–717, 2010.

WARNAKULASURIYA, S.S.P. *et al.* Musculoskeletal pain in four occupational populations in Sri Lanka. **Occupational Medicine-Oxford**, v. 62, n. 4, p. 269-272, 2012.

YU, S. *et al.* Musculoskeletal symptoms and associated risk factors in a large sample of Chinese workers in Henan province of China. **American journal of industrial medicine**, v. 55, n. 3, p. 281–93, mar.2012.