Ergonomic risk assessment among textile industry workers using two instruments: *Quick Exposure Check* and *Job Factors Questionnaire*

Avaliação do risco ergonômico em trabalhadores da indústria têxtil por dois instrumentos: Quick Exposure Check e Job Factors Questionnaire

Evaluación del riesgo ergonómico en trabajadores de la industria textil con dos instrumentos: Quick Exposure Check y Job Factors Questionnaire

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ABSTRACT | The analysis of ergonomic risk factors that are present in the textile industry helps to plan strategies that can contribute to the improvement of work conditions and the consequent reduction of musculoskeletal disorders. This study aimed at measuring levels of exposure to ergonomic risk factors among workers of two production sections in a textile factory. For this purpose, the instruments Job Factors Questionnaire (JFQ) and Quick Exposure Check (QEC) were applied in 107 workers. The results were analyzed through descriptive statistics. We used Mann-Whitney's test to compare the results between the production sections. The level of exposure to ergonomic risks, obtained through both instruments, was moderate. The risk factors considered as being critical by the JFQ are related to environmental temperature, posture maintained over long periods of time, inadequate spinal posture, and to working even when the worker feels pain or sustains injuries. The QEC identified regions of the lumbar spine and wrists/hands as being exposed to high risk. There were no statistically significant differences between the sections.

Keywords | risk assessment; ergonomics; questionnaire; textile industry.

RESUMO | A análise dos fatores de risco ergonômicos presentes em indústrias têxteis auxilia no planejamento de estratégias que contribuem para a melhora das condições de trabalho e redução dos distúrbios osteomusculares. Este estudo se propôs a mensurar os níveis de exposição aos fatores de risco ergonômicos em trabalhadores de dois setores de produção de uma indústria têxtil. Para tanto, os instrumentos *Job Factors Questionnaire* (JFQ) e o *Quick Exposure Check* (QEC) foram aplicados em 107 trabalhadores. Os resultados foram analisados por estatística descritiva. O teste de Mann-Whitney foi utilizado para comparação dos resultados obtidos entre os setores de produção. O diagnóstico do nível de exposição ao risco ergonômico, obtido por ambos os instrumentos, foi moderado. Os fatores de risco considerados pelo JFQ como mais criticos estão relacionados à temperatura ambiental; postura mantida em longos períodos de tempo; posturas inadequadas para coluna e continuar trabalhando quando está com alguma dor ou com alguma lesão. O QEC identificou as regiões de coluna lombar e punhos/mãos como expostas ao alto risco. Não houveram diferenças estatisticamente significante entre os setores.

Palavras-chave | avaliação de risco; ergonomia; questionário; indústria têxtil.

RESUMEN | El análisis de los factores de riesgo ergonómicos presentes en industrias textiles ayuda al planeamiento de estrategias que contribuyen a la mejora de las condiciones de trabajo y reducción de los trastornos osteomusculares. Este estudio se propuso medir los niveles de exposición a los factores de riesgo ergonómicos en trabajadores de dos sectores de producción de una industria textil. Para ello, los instrumentos *Job Factors Questionnaire* (JFQ) y el *Quick Exposure Check* (QEC) fueron aplicados en 107 trabajadores. Los resultados fueron analizados por estadística descriptiva. El test de Mann-Whitney fue utilizado para comparación de los resultados obtenidos entre los sectores de producción. El diagnóstico del nivel de exposición al riesgo ergonómico, obtenido por ambos instrumentos, fue moderado. Los factores de riesgo considerados por el JFQ como más críticos están

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relacionados a la temperatura ambiental; postura mantenida en largos períodos de tiempo; posturas inadecuadas para la columna y continuar trabajando cuando tiene algún dolor o con alguna lesión. El QEC identificó las regiones de columna lumbar y muñecas/manos como expuestas a alto riesgo. No hubo diferencias estadísticamente significativas entre los sectores.

Palabras clave | evaluación de riesgo; ergonomía; cuestionario, industria textil.

INTRODUCTION

The exposure to risk factors related to work conditions have contributed to the rising occurrence of mental and physical diseases among workers of different occupations[1,2]. Among these illnesses, we highlight the Work-Related Musculoskeletal Disorders (WMSDs), which were responsible for the withdrawal of 336,000 individuals from the work force around the world in 2009[3].

In Brazil, the textile industry occupies the fifth position in a rank that quantifies the leaves of absence requested because of WMSDs. The individuals who withdraw from their positions present elevated prevalence of pain in the spinal region and upper limbs, associated with frequent exposure to different physical risk factors (force, repetition of movements, and inadequate posture), organizational factors (excessive work and insufficient pauses), and psychosocial factors[5-9]. Considering this scenario, the analysis of the exposure to ergonomic risk factors is useful in planning for strategies that contribute to the improvement of work conditions, and, consequently, to the reduction of osteomuscular disorders among these workers.

In addition to contributing to the efficacy of health promotion initiatives, the use of methods that analyze work conditions enables the measurement of levels of exposure to ergonomic risk factors, identification of action priorities, and decisions on the most appropriate ergonomic interventions[10,11]. However, the selection of a method and the tools to be used in the analysis often becomes an obstacle to professionals in the field of workers' health due to the large variety of techniques and instruments available, work characteristics, and the resources available for data collection and analysis[12].

In this sense, some studies have been conducted with the purpose of comparing the results obtained by the methods of direct measurement, observational protocols, and questionnaires[13-18]. The latter are the most used in clinical practice, because, besides the low cost, they enable the evaluation of various occupational activities and a large number of workers[12].

In the case of Brazilian professionals, another obstacle is the limited availability of tools that measure ergonomic risks that are culturally adapted to Brazilian Portuguese. Among the available tools are the *Job Factors Questionnaire* (JFQ)[19] and the *Quick Exposure Check* (QEC)[20], whose characteristics of individual measurement and scoring are useful for the analysis of risk among Brazilian workers. The JFQ is a questionnaire that quantifies the workers' perception about the risk to which they are exposed through 15 questions related to risk factors that contribute to the onset of osteomuscular lesions. Besides being quick and highly accepted by the workers, this questionnaire indicates the need for and the prioritization of ergonomic interventions through the diagnosis obtained by each risk factor or by the total risk classification[19,21]. The QEC is composed of an observational protocol and a questionnaire, a combination that is conducive to a more objective assessment of risk factors, especially those of biomechanical nature. Furthermore, the QEC score allows for the analysis of total ergonomic risks or risks divided by body areas[20]. It is important to highlight that the combination of observational methods and questionnaires in risk assessment has been recommended in the literature[13,14,22].

Choosing the adequate tool to asses occupational risks saves time in further analyses, and facilitates data organization and interpretation. The JFQ and the QEC are translated and adapted tools for analyzing risk, and can contribute significantly to the decisions made by professionals that act in the area of workers' health in Brazil. However, we did not find any studies that comparatively discuss the use of these instruments, their characteristics, and limitations in professional practice.

In light of this, and considering the variety of occupational conditions present in the textile industry, the aim of the present study was to measure the levels of exposure to ergonomic risk factors among workers of two production sections of a textile factory with the use of the JFQ and the QEC with the purposes of discussing their use, characteristics, and limitations.

METHODOLOGY

Outline and study population

This is a secondary analysis of the data obtained from drawing on studies on the transcultural translation and adaptation of the QEC into Brazilian Portuguese[23], and on the test of clinimetric characteristics of this version[24]. 107 workers, 102 women and five men, participated in the study (age average of 27.6±7.5 years), employed in the sewing and finishing sections of a textile factory. All workers were older than 18 years of age, and had either finished high school or attended university. Individuals who had been performing a task for less than six months were excluded from the study.

Characteristics of the activities

The selection of the sewing and finishing sections included in this study was based on their characteristics of production and on different biomechanical requirements. We analyzed 13 productive activities in total: 38.3% were performed in the sitting position; 35.5% standing up; and 26.2% with postural rotation. Regarding the nature of the activities, the great majority (91.6%) is considered repetitive; 26.2% have very short cycles (shorter than 10 seconds), and 65.4% consist of longer cycles (between 10 and 30 seconds). Only 8.4% are characterized as material handling. Thus, it was possible to evaluate the exposure to different types of ergonomic risks, with exception of contact forces and vibration, which, although considered by the QEC, are not part of the reality of these sections.

Sewing section

The sewing section is responsible for the production of socks, sweaters, and underwear. The work stations are composed of sewing and cutting machines, industrial counters and seats, and are allocated in groups or individually, depending on the type of clothing produced. There are no pre-defined pauses during the shifts, but the workers can interrupt their tasks at any moment.
In this section, occupational biomechanics is characterized by the predominant adoption of the sitting posture for long periods of time, repetitive movements in the area of the wrists, hands and fingers, and static muscular overload on the spine and shoulders. The workers are required to rotate their torsos when taking the pieces to be cut or sewn from the boxes, and when placing them in other boxes. Important environmental factors, such as heat and noise, are present in this section.

Finishing section

The products assembled in the sewing section are sent to the finishing section, where they are prepared, separated, reviewed, and packaged. The work stations are composed only of machines or industrial tables, or a combination of both, and can have seats or not. Production demand is influenced by the machines or by the work pacing established by the other workers in the production line. For this reason, pauses are more difficult to occur.

In this section, the standing position is preferably adopted, even when postural rotation is possible. This happens because the majority of the activities require material handling and going from one place to the other, with frequent torso rotation. Movements in the upper limbs are also common, especially shoulders, wrists, and hands. The environmental factors are similar to the those in the sewing section and include heat and noise.

Procedures

This study was approved by the Ethics Committee of Universidade Cidade de São Paulo – UNICID, protocol number 1658/2010. The workers were approached in their work sections, and after agreeing to participate in the study and signing the Informed Consent, we explained how to fill out the instruments: a questionnaire with socio-demographic and occupational questions, the JFQ[19], and the QEC[23]. The latter was also filled out by an experienced physiotherapist who observed, during a period of 15 to 20 minutes, the postures and movements adopted by each individual when performing work tasks. This professional also assessed both production sections ergonomically, based on the protocol of work ergonomic analysis[25].

Instruments

Job Factors Questionnaire

The JFQ was originally developed in the United States in 1993, with the purpose of assessing ergonomic risk factors among workers in civil construction. Its psychometric characteristics were published in 2002[21]. The JFQ

aims at assessing ergonomic risk factors that can contribute to the onset of osteomuscular symptoms, based on the workers' perception. For this purpose, it presents a descriptive list with 15 risk factors to be classified from 0 to 10 on a Likert scale, where 0 means "no problem" and 10 indicates "the biggest problem possible". The questionnaire score can be obtained by the average of each of the 15 risk factors or by classifying the risk in three categories: the first, from 0 to 1, represents the "absence of problem"; the second, from 2 to 5, means "minimal to moderate" problem; and the last, from 8 to 10, indicates a "severe problem"[19,21,26]. The version used here was culturally adapted to Brazilian Portuguese, and it presented satisfactory clinimetric properties[19].

Quick Exposure Check

The QEC is an instrument that assesses ergonomic risk factors, including physical, organizational, and psychosocial factors. It is composed of an evaluation form that includes 16 questions about postures and movements performed by the spine and upper limbs, as well as other risk factors (amount of weight handled; how long it takes to perform a task; manual force; visual demand; vibration and level of hand force exerted; work pacing; and stress), and a score that allows for a partial (by body area) and total quantification of risk. This score results from the combination of answers given by the evaluator and the worker, for instance: posture versus force, duration versus force, posture versus duration, and posture versus frequency. The score can be classified according to four categories of risk exposure: low, moderate, high, and very high (Table 1)[11,20]. The adaptation of the QEC to Brazilian Portuguese abided by the guidelines recommended for this type of study[23], and the clinimetric properties presented satisfactory results[24].

Table 1. Interpretation of the Quick Exposure Check scores

Body area	Level of Exposure			
	Low	Moderate	High	Very High
Static spine	8-14	16-22	24-28	30-40
Dynamic spine	10-20	22-30	32-40	42-56
Shoulder/Arm	10-20	22-30	32-40	42-56
Wrist/Hand	10-20	22-30	32-40	42-56
Neck	4-6	8-10	12-14	16-18
Contact force	1	4	9	0
Vibration	1	4	9	0
Work pacing	1	4	9	0
Stress	1	4	9	16

Source: David et al.[20]

Data analysis

We used descriptive statistics (frequencies, averages, standard deviation, standard error, and confidence interval) to analyze the socio-demographic characteristics of the population and the levels of exposure to risk factors. Shapiro-Wilk's test was used to evaluate data normality, and, whenever we detected asymmetrical distribution, we opted for the use of non-parametric tests. In order to compare the results obtained in each of the assessment items and the total score of the JFQ and QEC between the production sections, we used Mann-Whitney's test. The significance level adopted was 5%. The statistics program SPSS (version 17.0) was used in all analyses.

RESULTS

The workers' perception, obtained through the JFQ, revealed that the risk factors considered the most critical (mean ≥6.0 points) were: working in a hot, cold, humid or wet environment; working in the same position for long periods of time; curving or twisting the back in an uncomfortable manner; and working while sustaining an injury or pain. Although the finishing section presented slightly higher scores, the variations were generally minimal and did not entail statistically significant differences. Only the question about "receiving training about how to perform the task" presented a significant difference between the groups (Table 2).

The results obtained by the QEC partial scores regarding biomechanical risks showed that the areas of the cervical spine (neck) and shoulders/arms are exposed to moderate risk, while the lumbar spine and wrists/hands are exposed to high risk. The workers' perception in relation to stress at work was slightly higher among the workers in the finishing section. There was no statistically significant difference between the sections ($p>0.05$) (Table 3).

Both instruments rated the level of exposure to ergonomic risk as moderate, and did not present significant differences between the sections.

DISCUSSION

The results of this study demonstrated that the instruments JFQ and QEC diagnosed the level of exposure

Table 2. Comparison of the results obtained by the *Job Factors Questionnaire* between the Sewing and Finishing Sections (n=107)

Job Factors Questionnaire		Sewing (n= 52)		Finishing (n= 55)		p-value
		Mean[a] (SE)	95%CI	Mean (SE)	95%CI	
Q1	Performing the same task over and over	4.75 (0.48)	3.80–5.70	5.09 (0.48)	4.15–6.03	0.61
Q2	Working very fast for short periods (lifting, grasping, pulling, etc.).	5.46 (0.47)	4.53–6.39	5.96 (0.46)	5.06–6.87	0.46
Q3	Having to handle or grasp small objects	2.75 (0.43)	1.90–3.60	3.11 (0.47)	2.18–4.04	0.55
Q4	Insufficient breaks or pauses during the workday	4.58 (0.52)	3.55–5.60	5.94 (0.50)	4.95–6.94	0.08
Q5	Working in awkward or cramped positions	6.33 (0.51)	5.32–7.33	6.76 (0.48)	5.80–7.72	0.57
Q6	Working in the same position for long periods (standing, bent over, sitting, kneeling, etc.)	6.52 (0.50)	5.53–7.51	6.98 (0.49)	6.01–7.95	0.47
Q7	Bending or twisting your back in an awkward way	6.33 (0.49)	5.36–7.30	6.48 (0.49)	5.51–7.45	0.86
Q8	Working near or at your physical limits	5.42 (0.52)	4.39–6.46	5.94 (0.46)	5.04–6.85	0.53
Q9	Reaching or working over your head or away from your body	3.65 (0.53)	2.60–4.71	3.13 (0.31)	2.11–4.15	0.56
Q10	Hot, cold, humid, wet conditions	6.96 (0.50)	5.98–7.95	6.52 (0.50)	5.54–7.50	0.43
Q11	Continuing to work when injured or hurt	6.62 (0.49)	5.64–7.59	6.70 (0.55)	5.63–7.78	0.50
Q12	Carrying, lifting, or moving heavy materials or equipment	4.15 (0.58)	3.00–5.31	5.04 (0.53)	3.99–6.08	0.30
Q13	Work scheduling (overtime, length of workday)	4.40 (0.50)	3.41–5.40	5.67 (0.49)	4.70–6.63	0.07
Q14	Using tools (design, weight, vibration, etc.)	2.31 (0.48)	1.35–3.26	2.02 (0.39)	1.25–2.79	0.89
Q15	Working without any type of training	2.73 (0.47)	1.80–3.67	1.74 (0.42)	0.90–2.58	0.05

[a]Score for each question (0 to 10); SE: standard error

Table 3. Comparison of the results obtained by the partial scores of the *Quick Exposure Check* between the Sewing and Finishing sections (n=107)

Quick Exposure Check	Level of Exposure by Body Area				p-value
	Sewing (n= 52)		Finishing (n= 55)		
	Mean (SE)	95%CI	Mean (SE)	95%CI	
Cervical spine (neck)	17.54 (0.11)	17.77–34.71	17.75 (0.09)	17.92–35.05	0.16
Lumbar spine	33.35 (0.84)	35.00–67.76	33.45 (0.73)	34.88–67.64	0.60
Shoulder/Arm	26.38 (0.45)	27.27–53.00	26.15 (0.51)	27.16–52.72	0.32
Wrist/Hand	32.77 (0.58)	33.92–65.90	33.92 (0.62)	34.41–66.83	0.39
Rhythm	2.13 (2.38)	1.66–2.61	2.44 (2.62)	1.91–2.96	0.42
Stress	4.90 (0.70)	3.50–6.31	6.40 (0.70)	5.00–7.80	0.09

SE: standard error

to ergonomic risks among workers of a textile factory as moderate. In this sense, we can affirm that both instruments can be used when the purpose of the analysis is to rate tasks based on the priority of ergonomic intervention[19,20]. In case the goal is more specific, such as establishing ergonomic improvements, providing training about postures and movements or assessing work organization, tools, and comfort, it is necessary to analyze the characteristics and guidelines for the use of each instrument.

The analysis of the data obtained through the JFQ revealed that the risk factors perceived by the workers as the most critical are related to comfort in the work environment, adoption of inadequate postures of long duration, and to working when the individual is in pain. This result shows that the JFQ is capable of retaining information compatible with the ergonomic reality of the sections, given that the activities assessed here require prolonged and/or repetitive postures in environments with noise and heat. However, although the instrument identifies the existence of inadequate or repetitive postures, its limitation is that it does not indicate the body parts where they occur.

It is expected that an instrument of analysis of ergonomic risk is capable of differentiating risks. In this study, this was the case with the JFQ, which identified that the workers in the finishing section perceive risk factors as more critical than the workers in the sewing section, even though the majority of the answers did not present statistically significant differences. This finding can be related to the organization of work adopted in these sections. In the sewing section, the rhythm of production is established by the worker, which facilitates its interruption at any moment. On the other hand, in the finishing section, production demand is influenced by the machines or by the rhythm of work established by the other workers in the line of production. This interferes with speed and with the frequency of the movements

performed; moreover, it is not conducive to pauses on the course of a work shift, which makes it more wearisome. The only difference between the sections refers to the training provided on how to perform work tasks, with a higher average in the sewing section. The fact that the activities of this section require a higher level of specialization and training can explain this result.

Thus, it is possible to verify that the JFQ has the significant advantage of measuring the workers' perception about the risk to which they are exposed, considering, for this purpose, the simultaneous assessment of various factors of ergonomic risk[27-29]. The partial score, obtained through the analysis of each risk factor, enables the identification of the most critical risk factors and the prioritization of ergonomic interventions in order to establish improvements. In addition, it is an instrument of quick application, high acceptance among the workers, and it does not require technical training[19,21]. A limitation of the JFQ is related to the fact that this instrument is a questionnaire, which does not allow for a detailed assessment of biomechanical exposure by each body region.

The results obtained by the partial scores of the QEC are compatible with the biomechanical requirements of the activities evaluated in both production sections, in the sense that they revealed that the spine and the upper limb areas are exposed to moderate and high biomechanical risk. This shows that the QEC can be a good option for the situations in which an evaluator seeks to assess biomechanical exposure by body area, in addition to analyzing general conditions. Such is the case because the scoring system of this instrument enables the analysis of risk exposure by means of the combination of biomechanical risk factors, identified by the observer in relation to each body area, and the worker's subjective answer (for example: posture versus force, duration versus force, and posture versus exposure duration).

Thus, the QEC allows the professional to identify the body area that is most exposed to risk as well as risk factors that contribute to this situation[11,20], and it is indicated to monitor ergonomic improvements, especially those that involve postural changes.

Considering the results obtained in this study, we verified that both the JFQ and the QEC were useful for the analysis of ergonomic risk in the textile industry, given that they reflect the reality of the sections evaluated. The characteristics of measurement and scoring of each instrument enabled the diagnosis of risk in a more encompassing manner, including aspects related to body biomechanics and physical, organizational, and psychosocial work conditions. However, both instruments have limitations when it comes to the assessment of specific risks, because each of them considers different risk factors in the analysis.

Therefore, considering the aim of the present study in regards to the use of the JFQ and the QEC to analyze diagnosed risks in a textile factory, both instruments are capable of diagnosing the level of exposure to ergonomic risks, and are recommended for situations in which a quick evaluation is necessary in order to define priorities of ergonomic intervention. The instruments can be used separately or combined, depending on the professional's purpose and how the results will be used in strategies of reduction of ergonomic risk[12]. However, some recommendations are necessary. In the case of the JFQ, because it is a questionnaire, we recommend the selection of an appropriate sample that can ensure the reliability of the answers. On the other hand, the QEC requires a higher level of training from the professionals because it is an observational instrument.

The results of the present study are limited to workers in the textile industry, and, therefore, cannot be generalized to include other populations of workers. The authors recommend the conduction of more studies with the purpose of analyzing a larger number of workers, and other occupational activities.

CONCLUSION

Based on our results, the level of exposure to ergonomic risks among workers in the textile industry was diagnosed as moderate by the instruments JFQ and QEC. Both instruments presented advantages and disadvantages, but both are recommended for situations in which a quick assessment is necessary in order to define priorities of ergonomic intervention. Nevertheless, if the focus of the intervention is posture and movements, the QEC is more suitable, and if the purpose is to intervene in the organization of work based on the workers' opinions, the JFQ is recommended.

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