ORIGINAL ARTICLE

Ergonomic risk and musculoskeletal disorders among food industry workers in Callao in 2021

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ABSTRACT

Objective: To determine the relationship between ergonomic risk and musculoskeletal disorders (MSDs) among food industry workers in Callao, 2021.
Materials and methods: A quantitative, correlational, cross-sectional, non-experimental study. The sample consisted of 184 workers. The main variables were measured with the Rapid Entire Body Assessment (REBA) and the MSDs with Kuorinka's Standardized Nordic questionnaires. A bivariate analysis of the primary and secondary variables was performed using the chi-square test, Pearson correlation coefficient and Student's *t*-test. A significance level less than or equal to 0.05 was considered.
Results: Out of all workers, 43.48 % had a low ergonomic risk and 79.89 % developed MSDs, with greater discomfort in the back, with 27.03 %, and the hand (right wrist), with 26.35 %. In addition, the relationship between the ergonomic risk factor and MSDs was significant (p = 0.001), with a positive correlation of 0.301. Likewise, MSDs were related to sex (p = 0.015), marital status (p = 0.011), type of contract (p = 0.001) and job position (p = 0.000).
Conclusions: A relationship was found between ergonomic risk and MSDs among food industry workers in Callao, 2021. Moreover, most workers developed MSDs, with greater discomfort in the back. The variables of the present study should be taken into account when exploring effective and concrete intervention strategies to prevent MSDs. It is recommended to raise awareness of workers and employers about the appropriate ergonomic and personal measures necessary to improve the safety and well-being of workers.

Keywords: Musculoskeletal Diseases; Occupational Health; Industry (Source: MeSH NLM).

Riesgo ergonómico y trastornos musculoesqueléticos en trabajadores de industria alimentaria en el Callao en el 2021

RESUMEN

Objetivo: El presente trabajo tuvo como objetivo determinar la relación entre el riesgo ergonómico y los trastornos musculoesqueléticos (TME) en los trabajadores de una industria alimentaria en el Callao, 2021.
Materiales y métodos: Estudio con un enfoque cuantitativo, alcance correlacional, diseño transversal, no experimental. La muestra estuvo conformada por 184 trabajadores. Las variables principales se midieron con el método de Evaluación Rápida del Cuerpo Completo (REBA, por sus siglas en inglés) y los TME, con el Cuestionario Nórdico de Kuorinka. Se realizó el análisis bivariado para las variables principales y secundarias usando la prueba de chi al cuadrado, la correlación de Pearson y la prueba t de Student. Se consideró un nivel de significancia menor o igual a 0,05.
Resultados: El 43,48 % tuvo un riesgo ergonómico bajo y el 79,89 % presentó TME que se desarrollaron, con mayor molestia, en la espalda, con un 27,03 %, y en la mano (muñeca derecha), con un 26,35 %. Además, se determinó que la relación entre el factor del riesgo ergonómico y los TME fue significativa (p = 0,001), con una fuerza de correlación positiva de 0,301. Asimismo, los TME se relacionaron con sexo (p = 0,015), estado civil (p = 0,011), tipo de contrato (p = 0,001) y puesto de trabajo (p = 0,000).
Conclusiones: Se encontró relación entre el riesgo ergonómico y los TME en los trabajadores de una industria alimentaria en el Callao, 2021. Asimismo, la mayoría de los trabajadores presentaron TME, con mayor molestia en la espalda. Las variables del presente estudio deben tenerse en cuenta al explorar estrategias de intervención efectivas y concretas para evitar los TME. Se recomienda concientizar a los trabajadores y los empleadores sobre las medidas ergonómicas y personales apropiadas que son necesarias para mejorar la seguridad y el bienestar de los trabajadores.

Palabras clave: Enfermedades Musculoesqueléticas; Salud Ocupacional; Industrias (Fuente: DeCS BIREME).

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INTRODUCTION

Musculoskeletal disorders (MSDs) are a complex group of painful disorders of tendons, ligaments, joints, nerves and blood vessels. They occur in nine body parts: neck, shoulders, forearms, elbows, lumbar region, waist, wrists, thighs and knees, with varying frequency [1,2]. Therefore, MSDs are a major occupational health problem and one of the leading causes of disability worldwide [3].

According to the World Health Organization (WHO, 2021), an estimated 1,710 million people worldwide live with MSDs. Since 1990, low back pain has been the most frequent complaint, affecting 568 million people. Interestingly, available literature showed that the prevalence of these complaints in specific working populations and/or occupational sectors is significantly higher than in the general population [1].

The most significant figures contributing to the global burden of occupational disease are ergonomic risk, injury risk, noise, fumes and gases [4]. According to the International Labour Organization (ILO, 2019), work-related fatalities account for 64 % in Asia, 11.8 % in Africa, 11.8 % in Europe, 10.9 % in America and 0.6 % in Oceania. These estimates reflect a serious endangerment faced by the working population worldwide [5]. Regarding the prevalence of MSDs in workers, a Colombian research found that the frequency of MSDs in employees of a refrigerator factory was 60.8 %, out of whom 48.1 % presented only one affected body part [6]. On the other hand, the frequency of MSDs in employees of a refinery in Lima, Peru, was 52.9 %, and the most affected body part was low back pain associated with disc herniation (25.1 %) [7].

The Ministry of Labor and Employment Promotion (MTPE) of Peru established a legal framework to standardize ergonomics in the workplace, including the "Occupational Safety and Health Law 29783" and the "Basic Standard 375-2008." The latter covers the parameters for load handling, work postures, and maximum and minimum loads for operators according to gender [8]. An adequate ergonomic design in the work area guarantees better worker performance, as well as the epidemiological reduction of MSDs [9]. Although there is legal support, not all companies strictly comply with the provisions of the MTPE or, alternatively, fail to control all the established points; therefore, these uncontrolled situations translate into ergonomic risk factors [10,11].

Ergonomic risk refers to the probability of suffering an undesirable event at work; among the most frequent associated factors are awkward posture, repetitive motions, forceful exertions, inadequate furniture, sustained postures, high frequency of postures, among others. The REBA method analyzes the upper limb, trunk and lower limb, and also evaluates the type of grip as well as the handling of loads. In this regard, a study conducted in workers of a garment manufacturing plant in Pakistan reported that the ergonomic risk level was predominantly high (40.3 %) [12]. Likewise, a study carried out in personnel who collect solid waste in Ecuador showed a medium level of ergonomic risk (48.4 %) [13]. Finally, a study conducted in Peru by Arroyo-Castillo et al. [14] revealed that a very high level of ergonomic risk prevailed (38.46 %).

Severe and long-term MSDs could affect the quality of life, reduce work productivity, increase sick leave, shorten working life and lead to chronic work disability, as well as represent a major health challenge for individuals and health care systems worldwide [15]. Kuorinka's Standardized Nordic questionnaires measure the behavior of musculoskeletal symptoms and MSDs regarding the affected body part, event duration and intensity, and job change. Therefore, it is important to consider that ergonomic risk factors condition the occurrence, to a lesser or greater degree, of MSDs. Studies carried out in Pakistan and Ecuador confirmed that the ergonomic risk factor is significantly related to MSDs among operative workers [12,16]. It should be noted that, in order to learn more about the MSD phenomenon, it is important to consider the sociodemographic and labor profile of the workers since international and national studies show that sex [17], marital status [18,19], job position and type of contract are related to MSDs [2,17,20,21].

Good health is an essential requirement for the good performance of workers, so it is essential to ensure environments conducive to that end, as well as to provide constant training in posture hygiene and ergonomics. Therefore, as a first step, this research aims to analyze the relationship between ergonomic risk and MSDs among workers of a food company in the province of Callao, Peru, 2021.

MATERIALS AND METHODS

Study design and population

A non-experimental, correlational, cross-sectional study conducted with workers of a food company in Peru, whose population consisted of 350 workers; non-probability sampling was used for an effective sample of 184 participants. According to the inclusion criteria, those who agreed to participate, as well as those who signed the informed consent form and who were also working in different areas as administrative personnel, operators, assistants, machine operators, among others, were considered in the research. Pregnant women and workers who had experienced some trauma during the month prior to the evaluation were excluded. For the screening process, these criteria were applied to the entire sample.

Variables and measurements

The study variables were ergonomic risk, measured by the REBA method, and MSDs, measured by Kuorinka's Standardized Nordic questionnaires. The assessment used for the ergonomic risk had five categories (negligible, low, medium, high and very high), measured the sustained posture and had a Cronbach's alpha of 0.93 [22]. The questionnaires used for MSDs described the behavior of the musculoskeletal symptoms and MSDs by answering Yes or No; moreover, they identified the occurrence of MSDs by body part (neck, right elbow-forearm, back, right shoulder and right hand-wrist) and had a Cronbach's alpha of 0.83 [23]. The secondary variables, which were measured using a data sheet, were also considered: sex, a nominal qualitative variable (male and female); age, a discrete quantitative variable; marital status, a nominal qualitative variable (married, cohabiting and single); type of contract, a qualitative variable (full-time and part-time); and job position, a nominal qualitative variable (administrative personnel, assistant, machine operator and production operator).

Statistical analysis

Data were processed using Microsoft Excel to create a database and analyzed with IBM SPSS Statistics. A descriptive analysis was performed, thus obtaining frequencies and percentages for the qualitative variables and the mean and standard deviation for the age. A bivariate analysis of the primary and secondary variables was conducted using the chi-square test, Pearson correlation coefficient and Student's *t*-test. A significance level less than or equal to 0.05 was considered.

Ethical considerations

The study was approved by Universidad Nacional Mayor de San Marcos through the master's degree advisor; permission was obtained from the food company, as well as the informed consents from the workers.

RESULTS

Out of the total sample of 184 workers, 58.15 % were males, the mean age was 33.56 years, 42.39 % were cohabiting, 83.7 % had a full-time contract, 64.13 % were production operators, 43.48 % presented low ergonomic risk, and 79.89 % suffered a musculoskeletal disorder (Table 1).

Table 1. Descriptive characteristics of the sample

Variables	*n*	%
Secondary variables		
Sex		
Female	77	41.85
Male	107	58.15
Age (m ± SD)	33.56 ± 6.86	
Marital status		
Married	35	19.02
Cohabiting	78	42.39
Single	71	38.59
Type of contract		
Full-time	154	83.70
Part-time	30	16.30
Job position		
Administrative personnel	30	16.30
Assistant	12	6.52
Machine operator	24	13.04
Production operator	118	64.13
Ergonomic risk		
Negligible	7	3.80
Low	80	43.48
Medium	53	28.80
High	16	8.70
Very high	28	15.22

Variables	*n*	%
Has the patient		
experienced discomfort?		
No	37	20.11
Yes	147	79.89
Body part where the patient		
experienced discomfort		
Neck	25	16.89
Right elbow-forearm	12	8.11
Back	40	27.03
Right shoulder	32	21.62
Right hand-wrist	39	26.35

Table 2 shows that the relationship between the ergonomic risk factor and MSDs was significant ($p = 0.001$), with a positive correlation strength of 0.301.

Table 2. Pearson correlation coefficient between ergonomic risk factor and MSDs

		Ergonomic risk factor	MSDs
Ergonomic risk factor	Pearson correlation coefficient	1	0.301**
	Sig. (2-tailed)		0.001
	N	184	184
MSDs	Pearson correlation coefficient	0.301**	1
	Sig. (2-tailed)	0.001	
	N	184	184

**Correlation is significant at the 0.01 level (2-tailed).

Table 3 shows that discomfort is related to sex, type of contract and job position. Older people had neck discomfort ($p = 000$), 84.42 % of workers with a full-time contract had musculoskeletal discomfort, and both machine and production operators had the same problem ($p < 0.05$).

Table 3. Correlational analysis between MSDs and secondary variables

Secondary variables	MSDs No *n* (%)	MSDs Yes *n* (%)	*p* value
Sex			0.015
Female	22 (28.57)	55 (71.43)	
Male	15 (14.02)	92 (85.98)	
Age (m ± SD)	31.67 ± 6.73	34.03 ± 6.83	0.061
Marital status			0.011
Married	6 (17.14)	29 (85.86)	
Cohabiting	9 (11.54)	69 (88.46)	
Single	22 (30.99)	49 (69.07)	
Type of contract			0.001
Full-time	24 (15.58)	130 (84.42)	
Part-time	13 (43.33)	17 (56.67)	

Secondary variables	MSDs No *n* (%)	MSDs Yes *n* (%)	*p* value
Job position			0.000
Administrative personnel	21 (70.00)	9 (30.00)	
Assistant	3 (25.00)	9 (75.00)	
Machine operator	0 (0.00)	24 (100.00)	
Production operator	13 (11.02)	105 (88.98)	

DISCUSSION

Among the main descriptive findings, it was evident that 43.48 % of food industry workers had a low level of ergonomic risk. This differed from the findings by Ashiq et al. [12] in garment workers in Pakistan, who had long working hours and whose ergonomic risk level was predominantly high (40.3 %). Moreover, such results did not agree with those of a study conducted in Ecuador in solid waste collection workers, who were engaged in sweeping with a garbage tricycle in different work shifts and had a medium level of ergonomic risk (48.4 %) [13]. Finally, a study carried out in percussionists in Lima, Peru, showed that the level of ergonomic risk was predominantly very high (38.46 %) [14]. These disparities in findings could be due to the fact that the REBA method is mainly used for the analysis of awkward postures and not specifically for the evaluation of repetitive motions, and also because the type of place and activities could be ergonomically risky and require specific actions to minimize this risk, like the type of activities of the present work [24].

Another finding was that 79.89 % of the workers developed MSDs, the back being the most affected body part, with 27.03 %. This finding agrees with that by Russo et al. [17], where the prevalence of MSDs and back pain in Italian workers accounted for 51.0 % and 46.1 %, respectively.

Another study agreed with the previous finding since it showed that Ecuadorian fruit pickers had more discomfort in the lower back or lumbar region (26 %) [16]. A research conducted in workers of a refinery in Lima, Peru, demonstrated that 52.9 % developed MSDs and the trunk was the most affected body part [7]. These percentage disparities could be due to the difference in the study participants' perception of pain or discomfort, sample size, work environment and workload. Also, these findings confirm that MSDs remain one of the most common causes of disability worldwide and that low back pain is the most frequent condition as a result of workers' activities [25].

An important finding is that ergonomic risk is significantly related to MSDs in workers (r = 0.301), where people with very high ergonomic risk have discomfort. Ashiq et al. [12] demonstrated that there was a strong positive correlation between ergonomic risk factor and MSDs (r = 0.9, $p \leq 0.001$) in garment workers in a city of Pakistan. Likewise, the study by Pincay Vera et al. [16] concluded that there was a moderate positive correlation between ergonomic risk and MSDs and postures (r = 0.56, $p \leq 0.001$). Similarly, according to the study by Ramírez Pozo [26], both variables were significantly associated (r^2 = 0.851, p = 0.05) in a population of workers of a refinery in Lima. This finding confirms that awkward postures or movements in workers' activities can cause MSDs, and these differences in the correlation strength of the findings are possibly due to the type of work, the available assessment tools, and the strategies for the evaluation of ergonomic risks that require specific skills and adequate training to be selected and used appropriately [17].

Regarding the relationship between the secondary variables and MSDs, sex was associated with MSDs (p = 0.015) and males had greater discomfort. This result was compared with that of the studies conducted by Russo et al. [17] and Ramírez Pozo [26], which showed that sex is significantly related to MSDs. However, only the study by Russo et al. [17] claimed that females were the most affected by MSDs. These results confirm that nowadays both females and males perform the same work tasks and face the same likelihood of developing MSDs, which may be due to differences in social roles, activities and behaviors [27]. However, because of biological divergences, males' muscles are more developed than females', with thicker muscle fibers and less water; therefore, the female musculoskeletal system more is prone to suffer injuries. It should be noted that more males than females developed discomfort in the present study, possibly because more males participated in the research.

Age was not significantly related to MSDs (p = 0.061). This agrees with the studies carried out in Peru by Zamora-Chávez et al. [28] and by Ramírez Pozo [26]. On the other hand, MSDs were significantly associated with marital status (p = 0.011), i.e., those who had a partner (married and cohabiting) presented pain. This finding is supported by two studies, one conducted in Peru [18] and another one in China [19], which showed that marital status was related to MSDs ($p \leq 0.001$). Barzideh et al. [29] explained that married workers fulfill not only their job but also their

responsibility to the family. In addition, their rest time is relatively less than other workers'.

Job position was related to MSDs (p = 0.001) since production operators stated pain in the right shoulder and wrist. This finding is similar to that of the research carried out by Garzón Duque et al. [21], Njaka et al. [2] and Russo et al. [17], who showed that the job position was related to MSDs and confirmed that operators or manual workers presented more conditons. This is due to the frequent bending or squatting activities and lifting heavy objects from the floor, so the lower back accounted for the highest rate of MSDs. Even prolonged standing at work has a strong association with foot and leg discomfort. This is a deviation from the ergonomic principles of work, which establish that tasks should be adapted to the workers, who are also supposed to work in neutral postures and in comfort zones [30].

The type of contract was related to MSDs (p = 0.001), which is explained by the fact that people with a full-time contract have more pain than tenured workers. This finding agrees with that of the study by Dong et al. [20], who noted that employment status was significantly associated with MSDs. This could be because temporary or contract employees experience more job insecurity than permanent or tenured employees. In addition, job insecurity has been identified as an important job stressor that negatively affects the psychological and physical health and well-being of employees, thus leading to the onset or aggravation of MSDs [31].

In terms of the study limitations, the cross-sectional design allowed us to describe associations but not to draw causal inferences about the effects of the different variables of MSDs. Another limitation was that the study ignored the quantitative interactions between the occupational, psychosocial and demographic factors. A prospective cohort study design may be needed in the future to provide stronger research evidence. As in most cross-sectional studies, self-reported data was collected, so it is likely that the study subjects may have provided vague or exaggerated responses about their MSDs. This study has key strengths as it is one of the first research evidence on MSDs among food industry workers.

In conclusion, ergonomic risk was related to MSDs and showed a low positive correlation. Moreover, sex, marital status, job position and type of contract were related to MSDs, and the most affected groups were males, those who had a partner, operators and contract employees. On the other hand, it was evident that most food industry workers had a low level of ergonomic risk and developed MSDs, with greater discomfort in the back.

Based on the findings, it is recommended that further studies focus on analyzing the effectiveness of current evaluation methodologies and strategies used to assess biomechanical/ergonomic risk factors on a periodic basis, considering the most affected population according to the sociodemographic and occupational profile. These innovative strategies should be primarily aimed at improving our understanding of emerging occupational risks that may be associated with MSDs and thus developing workplace interventions to improve the process of occupational risk assessment and management, so that to implement them in health surveillance systems.

Also, workers' and employers' awareness of the appropriate ergonomic and personal measures necessary to improve the safety and well-being of workers should be increased. Finally, it is recommended to formulate policies concerning worker safety and company productivity, which would help safeguard workers and employers from health deviations and economic loss in terms of lost workdays, compensation and low productivity. Moreover, said policies would help improve working conditions, such as the work environment, to enable workers to perform a variety of recreational activities and adjust the operating cycle.

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