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ORIGINAL RESEARCH

Investigation of musculoskeletal symptoms in a manufacturing company in Brazil: a cross-sectional study

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Abstract
Background: Musculoskeletal disorders are prevalent and represent the most common health problem among the working population in industrially-developing countries, with considerable costs and impact on quality of life. Despite the high incidence of disability insurance claims among Brazilian manufacturing-sector workers, only a few studies assessed musculoskeletal disorders prevalence.
Objective: To provide information on the prevalence of musculoskeletal disorders among manufacturing-sector workers and to explore the relationship between musculoskeletal disorders and sociodemographic and occupational characteristics in a medium metallurgical company located in Brazil.
Methods: A cross-sectional study was carried out. Data was collected through the use of a specifically-designed questionnaire and the items used to collect musculoskeletal disorders data were based on the Nordic Musculoskeletal Questionnaire. Descriptive statistics were used and multivariate logistic regression analysis ($p < 0.02$) was performed to explore the associations between musculoskeletal disorders and potential risk factors.
Results: The upper limb was the most frequently affected body region among manufacturing-sector workers: shoulder (24.8%), elbow and/or forearm (15.5%), wrist and/or hand (19.0%). Adjusted logistic regression analysis showed that company experience ($p = 0.02$), presence of sleep disorders ($p = 0.00$), self-reported general health state ($p = 0.00$) and perform work pause ($p = 0.00$) were significant risk factors for development of musculoskeletal disorders.

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Conclusion: Sociodemographic and work-related aspects are influential risk factors for musculoskeletal disorders. These results add comprehension about musculoskeletal disorders prevalence and suggest a need for greater emphasis on prevention strategies.

Introduction

Musculoskeletal disorders (MSD) are worldwide occupational health problems and affect all types of economic activities, with considerable costs and impact on workers' quality of life.[1,2] Poor working conditions in manual manufacturing industries often expose workers to many risk factors for musculoskeletal diseases, especially in small and medium companies that feature worse ergonomic conditions when compared with the large ones.[3,4] An increase in work-related MSD was observed in most of the Latin American countries during the 1990s, including Brazil.[5]

Growing industrialization in developing countries exposes the economically-active population to the risk of injuries.[6] Brazil has a large population of manual workers doing activities with high physical demands,[7] however only a few studies have assessed MSD prevalence among Brazilian manufacturing workers in industry.[8–10] Despite the high prevalence of MSD in industrially-developing countries, research into prevention is scarce and there is a lack of quantitative and reliable data.[5,6]

Occupational activities involving a predominance of manual tasks seem to present a higher risk of injury.[7] In Brazil, manufacturing of metal products features high incidence of disability insurance claims and ranks as eighth among work-related claims.[7] Workers in manufacturing industry are directly involved in the production process and could be exposed to different physical work demands such as lifting, lowering, pushing, pulling, and carrying besides dealing with heavy machinery.

The level of risk depends on the duration, frequency and magnitude of the exposure. Physical risk factors for MSD often cited in experimental and epidemiological studies include: repetitiveness, insufficient recovery time, physical workload, static effort, non-neutral body postures, mechanical compression of tissues, segmental or whole-body vibration and exposure to the cold.[2,11] Psychosocial and individual characteristics are also involved.[12] There are many challenges when dealing with these issues such as diagnosing and treating the MSD, establishing the relationship between risk factors and manual occupational activities as well as providing work environments that minimize their occurrence.[13,14] Therefore, this paper concentrates on detecting the prevalence of musculoskeletal symptoms among manual manufacturing workers and finding the risk factors which had impact on this prevalence.

Physical therapists and health professionals play an important role in the prevention and management of injuries and illnesses at work. The aim of this study, conducted in a medium metallurgical industry, was to determine the prevalence of musculoskeletal injuries among manufacturing workers and to investigate their relation to sociodemographic characteristics and work-related risk factors.

Methods

Study design and sample

This cross-sectional study was conducted in a medium industry in Brazil which manufactured metal products. A total of 456 employees worked in the five different sectors of the company at the time of the study.

The inclusion criteria for taking part in the study was to have worked in the metallurgical industry sometime in the past 12 months. Workers who were on sick leave due to musculoskeletal problems did not participate in the selected sample. The study sample consisted of 226 eligible workers (192 assembly-line workers, 20 machine operators and 14 welding operators) allocated in three sectors, chosen considering tasks similarities. Work tasks performed at the evaluated sectors were cutting and bending metal tubes, assembling, welding, calibrating and packaging for the production of evaporators and tubular resistors. The sample size was representative of the total ($N = 456$), a sample error of 5% and confidence level of 95% was established.

This study was approved by the Research Ethics Committee of the Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brazil (44541315.3.0000.0121) and was conducted according to the Human Research of the National Health Council Code of Ethics. All subjects received information about objectives and procedures of the study and signed a consent form.

Data collection

Data were obtained through a specifically-designed questionnaire that featured 21 items including individual information and sociodemographic characteristics, work-related factors and MSD investigation. Face-to-face interviews with the workers were conducted by two trained data collectors during a work day.

The questionnaire consisted of three sections and items regarding workers' individual, demographic and occupational data were gathered with structured questions, based on a literature review of previous published epidemiological studies.[2,15–17]

Demographic variables included the participant's sex (male; female), age (in years), body weight (in kilograms), body stature (in meters), educational level ($\leq$9 years; 10–12 years; $\geq$13 years), marital status (married; single), self-reported hand dominance (right or left-handed), as well as individual variables such as smoking habits (no: nonsmoker

or ex-smoker; yes: smoker), practice of regular physical activities (no: does not practice regular physical activity; yes: regularly practices aerobic activity or resistance training), presence of sleep disorders (no: never or rarely; yes: often or daily) and general health state (poor or fair; good or excellent) were registered in the first part of the questionnaire.

Self-reported body weight and height were used to determine the body mass index (BMI) and subsequently used to classify subjects into three categories (normal weight – $\leq$25.0 kg/m^2; overweight – 26–29 kg/m^2; obese – $\geq$30 kg/m^2) based on the World Health Organization (WHO) classification system.[18] A four-point-Likert-type scale was used to assess the presence of sleep disorder and perceived general health state. The updated WHO's guideline[19] was adopted for physical activity, which recommended that adults (18–64 years) should do at least 150 min of moderate-intensity aerobic physical activity, or 75 min of vigorous-intensity aerobic physical activity or equivalent combination of moderate and vigorous intensity activity throughout the week.

Questions on the work-related characteristics section of the questionnaire concerned company experience (in months), workload (push and/or lift loads above 10 kg), repetitive work (perform repetitive and stereotyped motions at work), work pause (perform short rest breaks at work) and vibration exposure (use of vibrating tools). A four-point-Likert-type scale was used with ratings 'never', 'rarely', 'often', and 'always' during a regular workday to classify physical workload, repetitiveness and vibration exposure perceived by the workers. The answers 'never' or 'rarely' were classified as 'no'; answers 'often', and 'always' were classified as 'yes'.

In the third part of the questionnaire, data on musculoskeletal symptoms were collected based on the Brazilian version of the Standardized Nordic Questionnaire,[20] a tool often used in occupational settings.[20] Reliability of the Nordic Standard Form for MSD was found to be acceptable.[20] Participants were asked to indicate if they had experienced any pain, ache, discomfort or numbness in nine different body parts during the last 12 months: (1) neck, (2) upper back, (3) lower back, (4) shoulders, (5) elbows and/or forearms, (6) wrist and/or hands, (7) hips, thighs and/or buttocks, (8) knees, and (9) ankles and/or feet. For bilateral anatomical sites, musculoskeletal symptoms were classified as present if they were reported on one side of the body or both.

Data analysis

The descriptive statistics were calculated to depict the study's population and the demographic items. Musculoskeletal symptoms prevalence rates in different body parts were calculated for all participants.

Statistical analysis was performed using logistic regression models to estimate the influence of sociodemographic and work-related factors (independent variables) on the occurrence of musculoskeletal complaints (dependent variables). The binary regression logistic analysis was used with p value significance level equal or less than 0.05 for the initial selection of potential risk factors for musculoskeletal complaints. Crude associations were calculated by the enter method and the results were expressed as odds ratios (ORs) along with 95% confidence intervals (CIs). Only significant results were presented (p value < 0.05).

Subsequently, the adjusted logistic regression model was performed with the enter method. Only the potential risk factors with p value equal or less than 0.02 in the univariate analysis were retained into the multivariate analysis. In the final adjusted model for musculoskeletal symptoms, were included company experience, sleep disorders, general health state and work pause were included as independent variables. These analyses were carried out separately for the selected sites: neck, upper limb, upper/lower back and lower limb. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 17.0.

Results

General characteristics

The study sample was composed of 226 workers and their characteristics are presented in Table 1. The mean age of the total group was 38.6 years old (SD 9.7; range 19–54). The workers' company experience was 2.6 years on average (SD 24.3), ranging from 1 month to 10 years. The majority of the studied population was female, married, right-handed, and had 12 years of education. It was also determined that 15.0% of the participants were cigarette smokers and 85.4% were not physically active. The BMI of 46.9% of subjects was found to be normal ($\leq$25.0 kg/m^2) and 40.3% was overweight (26–29 kg/m^2). Most of the subjects considered their general health state to be good or excellent, but 32.7% reported some health problems. Musculoskeletal, cardiovascular and respiratory diseases were the most frequently referred to diseases by participants.

The prevalence and the factors influencing musculoskeletal symptoms

The highest prevalence rate of musculoskeletal pain or discomfort during the past year was in the upper limbs: shoulder region (24.8%), elbow and/or forearm (15.5%), wrist and/or hand (19.0%). Prevalence of symptoms in upper and/or lower back was 13.3%, in the neck region, it was 5.8% and in the hip and/or lower limb, it was 5.3%.

According to the univariate regression analysis of sociodemographic aspects affecting the prevalence of MSD, it was determined that company experience, presence of sleep disorders, and general health state ($p < 0.05$) were influential risk factors. Occupational factors associated with prevalent MSD were evaluated and a statistically significant difference was only found in performing repetitive motions and work pause ($p < 0.05$) (Table 2). Instead, a statistically significant association on a crude model was not demonstrated for several other variables: sex, age, marital status, education level, hand dominance, BMI, tobacco smoking, presence of headaches, regular physical activity, workload and vibration exposure.

The risk for MSD at the neck region was significantly increased for those who had with the company longer and

Table 1 Description of sample characteristics regarding sociodemographic, individual and work-related aspects for subjects with musculoskeletal symptoms in a Brazilian manufacturing company ($n = 226$).

Individual characteristics and sociodemographic aspects			
Independent variables	*n* (%)	Independent variables	*n* (%)
Sex		*Marital status*	
Male	63 (27.9)	Single	83 (36.7)
Female	163 (72.1)	Married	143 (63.3)
Age		*Education*	
18–29 years	62 (27.4)	≤9 years	42 (18.6)
30–39 years	95 (42.0)	10–12 years	183 (81.0)
≥40 years	69 (30.5)	≥13 years	1 (0.4)
Hand dominance		*Sleep disorders*	
Right-handed	204 (90.3)	No	206 (91.2)
Left-handed	22 (9.7)	Yes	20 (8.8)
Body mass index		*Headaches*	
Normal weight	106 (46.9)	No	193 (85.4)
Overweight	91 (40.3)	Yes	33 (14.6)
Obese	29 (12.8)		
Tobacco smoking		*General health state*	
No	192 (85.0)	Poor/fair	32 (14.2)
Yes	34 (15.0)	Good/excellent	194 (85.8)
Regularly exercise			
no	193 (85.4)		
yes	33 (14.6)		
Work-related characteristics			
Independent variables	*n* (%)	Independent variables	*n* (%)
Company experience		*Work pause*	
≤1 year	107 (47.3)	No	76 (33.6)
2–4 years	91 (40.3)	Yes	150 (66.4)
≥5 years	28 (12.4)		
Workload		*Vibration exposure*	
No	140 (61.9)	No	203 (89.8)
Yes	86 (38.1)	Yes	23 (10.2)
Repetitive work			
No	18 (8.0)		
Yes	208 (92.0)		

n, actual number of subjects; %, percentage of actual sample.

who often had sleep disorders. The multivariate analysis showed ORs varying from 11.94 to 16.49 for the 2–4 years and up to 5 years groups ($p < 0.02$) compared to the reference category (less than 1 year group). Sleep disturbances increased the chance of neck complaints occurrence by 9.92 times ($p = 0.00$). According to our data, workers who did not observe frequent rest breaks presented with a 120.0% greater chance of experiencing significant upper limb discomfort over time ($p = 0.00$) compared to workers who took rest breaks. Perceived poor or fair self-reported general health state was a strong risk factor for MSD in upper and lower back and lower limb sites ($p = 0.00$) and indicated ORs of 5.78 and 8.68, respectively. Results for adjusted logistic regression model are presented in Table 3.

Discussion

This study was performed on 226 manufacturing workers in a medium metallurgical industry and showed that musculoskeletal symptoms were common among them. It was found that the majority of the studied population (53.5%) had experienced musculoskeletal pain or discomfort in at least one body part and that the prevalence of upper limb musculoskeletal complaints was the highest. Picoloto and Silveira[10] also found high prevalence (75.2%) of musculoskeletal discomfort during the past 12 months reported by workers of a metallurgical company in Brazil.

The shoulder was the body region with the highest prevalence of symptoms (24.8%), followed by elbow and

Table 2 Univariate regression analysis between neck, upper limb, upper and lower back and lower limb musculoskeletal discomfort in the past 12 months and general and occupational risk factors for subjects with musculoskeletal symptoms in a Brazilian manufacturing company.

Independent variables	Body parts having musculoskeletal symptoms			
	Neck OR (95% CI) *p*-value	Upper limb OR (95% CI) *p*-value	Upper/lower back OR (95% CI) *p*-value	Lower limb OR (95% CI) *p*-value
Company experience				
≤1 year	1.00	1.00	1.00	1.00
2–4 years	**11.63 (1.44–93.68) 0.02****	1.15 (0.65–2.04) 0.62	1.09 (0.47–2.54) 0.82	1.49 (0.39–5.75) 0.55
≥5 years	12.72 (1.26–127.47) 0.03*	1.85 (0.80–4.29) 0.14	1.57 (0.50–4.85) 0.43	3.09 (0.65–14.69) 0.15
Regular exercise				
No	1.00	1.00	1.00	1.00
Yes	1.06 (0.22–5.05) 0.93	0.56 (0.25–1.24) 0.15	0.88 (0.28–2.72) 0.83	0.00 (0.00–0.00) 0.99
Sleep disorders				
No	1.00	1.00	1.00	1.00
Yes	**8.25 (2.40–28.35) 0.00****	1.81 (0.71–4.56) 0.20	**4.28 (1.55–11.83) 0.00****	2.17 (0.44–10.71) 0.33
General health state				
Poor/fair	1.00	1.00	1.00	1.00
Good/excellent	0.52 (0.13–2.02) 0.34	0.50 (0.23–1.06) 0.07	**0.14 (0.05–0.33) 0.00****	**0.13 (0.04–0.46) 0.00****
Repetitive work				
No	1.00	1.00	1.00	1.00
Yes	0.00 (0.00–0.00) 0.99	3.88 (1.09–13.84) 0.03*	0.35 (0.11–1.08) 0.06	0.00 (0.00–0.00) 0.99
Work pause				
No	1.00	1.00	1.00	1.00
Yes	0.41 (0.13–1.26) 0.12	**0.50 (0.28–0.88) 0.01****	2.84 (1.04–7.74) 0.04*	0.69 (0.21–2.26) 0.54

OR, odds ratio; 95% CI, 95% confidence interval. Only significant results were presented.
* Statistically significant variables ($p < 0.05$).
** Statistically significant variables – highlighted ($p < 0.02$).

Table 3 Associations between neck, upper limb, upper/lower back and lower limb MSS and independent variables in a adjusted logistic regression model for subjects with musculoskeletal symptoms in a Brazilian manufacturing company.

Independent variables	Body parts having musculoskeletal symptoms			
	Neck OR (95% CI) *p*-value	Upper Limb OR (95% CI) *p*-value	Upper/lower back OR (95% CI) *p*-value	Lower limb OR (95% CI) *p*-value
Company experience (2–4 years)	**11.94 (1.39–102.16) 0.02***	1.01 (0.56–1.84) 0.95	0.85 (0.33–2.18) 0.75	1.01 (0.24–4.21) 0.98
Sleep disorders (yes)	**9.92 (2.16–45.40) 0.00***	1.33 (0.49–3.63) 0.57	2.56 (0.78–8.35) 0.11	0.92 (0.16–5.34) 0.93
General health state (poor/fair)	0.67 (0.12–3.76) 0.65	2.12 (0.92–4.85) 0.07	**5.78 (2.23–14.96) 0.00***	**8.68 (2.28–33.06) 0.00***
Work pause (no)	2.40 (0.69–8.28) 0.16	**2.20 (1.23–3.93) 0.00***	0.36 (0.12–1.06) 0.06	1.94 (0.54–6.95) 0.30

OR, odds ratio; 95% CI, 95% confidence interval.
* Statistically significant variables – highlighted ($p < 0.02$).

forearm (15.5%), wrist and hand (19.0%), which was probably linked to the manual tasks performed, (e.g. handling average loads on a regular basis, handling lighter loads in static postures, and continuous repetitive work). The lower prevalence of subjects who reported neck complaints could be explained by the difficulty of workers to distinguish symptoms in the shoulders from those in the neck, as the trapezius muscle covers both regions.[21] Economic activities with a predominance of manual occupations have been associated with injury risk.[7] Souza and Santana[22] reported a 4-times higher annual cumulative incidence among Brazilian manufacturing-sector workers for neck and upper limbs MSD, compared to the general population (RR = 4.03; 95% CI: 3.34–4.88).

MSD were common among industrial workers exposed to jobs requiring force and repetition.[14,15] Minimal process variance and minimal task variation were usually noticed at time-balanced stations on the assembly line in manufacturing. These current trends in industry could lead to a reduction in the period of muscle rest and an increase in static and cumulative load.[23] Detailed analyses showed that work-related aspects such as repetitive work and lack of rest breaks were influential risk factors for the development of upper limb MSD. This suggested that the predominant ergonomic problems were related to exposure that strains the upper body regions, and it was consistent with manual materials handling demands and non-neutral postures observed in the studied company.

Numerous surveys of working populations have reported a prevalence of upper extremity symptoms of 20–30% or even higher.[2] Upper limb MSD has been causally related to repetitive and stereotyped motions, forceful exertions, non-neutral posture, vibration, and combinations among them.[11,16,24] Highly repetitive industrial jobs are potentially related to upper limb MSD and it has also been suggested that the muscle tissue is highly vulnerable to overuse.[14] There are different models developed for describing work-related MSD theories, but the most common model was a biomechanical one. Activities requiring force, repetitive motion, and prolonged posture maintenance place mechanical stresses on the musculoskeletal system.[24,25] Kumar[24] suggested that occupational musculoskeletal injuries were developed as a result of interactions between genetic, morphological, psychosocial and biomechanical factors.

Considering regularly scheduled break times, the studied company formally allowed a total period of 1 h and 20 min break time during a 7-h workday: 1 h for meal break, 10 min for coffee break and another 10 min for a physical conditioning program. Performing work pause (short breaks of a minute or less) was identified as a significant variable by adjusted logistic regression analysis. Workers who did not perform pauses at work were 2.2 times more likely to experience upper limb discomfort than those who executed them. Work activities that require rapid motions and insufficient recovery time might be a contributing factor to the high prevalence of upper limb MSD.[2,23] The musculoskeletal system is primarily affected by static postural and manipulative work,[26] so the opportunities for rest and recovery should be considered in preventing MSD at work.

In this study, increased neck symptoms were associated with two or more years of employment in the current work and with sleep disturbances. It was possible that

experienced workers were more exposed to the occupational risks in this particular workplace and the familiarity with the working process did not appear to be a protective factor. Moreover, sleep problems could indicate another consequence of MSD that deserves further attention.

Our results revealed that musculoskeletal complaints had a significant negative impact on manufacturing-sector workers' general health, especially those who performed hard and intensive work. Pain and discomfort in the upper and lower back and lower limb sites were found to be associated with poorer self-reported general health state in the multivariate analysis. This was a subjective measure and participants' perception was taken as reference.

Sex, age distribution, marital status and education level were not identified as significant factors for any type of musculoskeletal symptoms in the univariate analysis. The actual reasons for this observation could not be determined, but it seemed that the musculoskeletal symptoms in manufacturing-sector workers were not exclusively dependent of individuals' characteristics. In a review study, Malchaire et al.[17] found that personal factors such as weight, height, dominant hand, age, smoking and drinking habits did not play a direct role in musculoskeletal symptoms development. Previous prospective studies supported our findings,[12,27,28] but additional studies are needed to determine the indirect influence of individual factors in the development of musculoskeletal symptoms in manufacturing-sector workers. We were also unable to find any association between musculoskeletal discomfort and obesity, although in other studies, it has previously been shown to be an important risk factor for MSD.[2,29]

Our study did not show significant positive association between MSD in any body location and tobacco smoking. The relationship between such a risk factor and musculoskeletal pain is complex and several explanations for the association have been proposed. Previous studies hypothesized that smoking could lead to deficiencies in the muscle-tendon system and the vertebral disc through vasoconstriction, carboxyhemoglobin production, an atherogenic effect or fibrinolytic defect. Furthermore, metabolic or direct toxic effects also seemed possible.[30] However, this finding is inconsistent in the literature and further investigation is necessary to clarify the findings and to assess the implications for preventive advice.[30,31]

Most of the physical exercise activities performed by the interviewees were related to walking and jogging. Although there is a general consensus about the beneficial effects of regular physical exercise, results of one epidemiological study about the effects of exercise on musculoskeletal working population did not support this consencus.[32] In this study, regular exercise was not associated with prevalence rates of musculoskeletal complaints at any body site. This result was consistent with two other studies.[33,34] A reasonable explanation was that a low adherence among participants could have influenced the regression analysis.

Heavy physical work, whether it be heavy lifting, prolonged standing or pushing and pulling, involves long-term repetitive mechanical stress on body tissues and structures.[35] Some studies have investigated a potential causal relationship between biomechanical risk factors and work-related MSD affecting specific body parts, and the most reported risk factors with reasonable evidence were excessive repetition, awkward postures, and heavy lifting.[16] Nevertheless, crude associations among occupational factors such as workload and vibration exposure, and the occurrence of musculoskeletal complaints were not significant in the univariate analysis. A probable explanation might be due to selection bias in our workers selecting method, since it is possible that workers included in this study represented a survivor group. Cross-sectional studies are liable to selection bias called ''healthy worker effect'' and this might result in underestimation of the prevalence rate of musculoskeletal symptoms.[17]

This study has some limitations that should be considered when interpreting the findings. This investigation included a restricted number of manufacturing-sector workers. For this reason, the results cannot be generalized for the whole population and might not reflect the occupational situation in small or large-scale companies. It was not possible to establish a cause and effect relationship since this study used a cross-sectional design. The questionnaire items related to workers' individual, demographic and occupational circumstance was specifically designed for this study based on literature review of previous published epidemiological studies. The MSD collected data relied on worker self-reports rather than physical examinations and this could result in the overestimation of the prevalence rate,[36] except in the shoulder and neck regions.[21] Good sensitivity for the standardized Nordic questionnaire to identify subjects with findings from the shoulders was found. Discomfort ratings were considered a valuable marker for MSD as well.[22] Non-occupational mechanical risk factors were not the main focus of the study and the knowledge about these aspects on the development of MSD is limited.[11]

In spite of the study's limitations, the research findings provided an overview of the work situation and do add comprehension about MSD prevalence, as well as the potential risk factors among manufacturing industry workers in medium metallurgical companies. The confidentiality and privacy of the participants were maintained during all phases of this research, so as to minimize information bias. Further research is needed to clarify some aspects analyzed in the present study which should focus on appropriate preventive interventions that could help to reduce the prevalence of MSD among industrial workers. Prospective studies could provide information regarding risk factors, their magnitude, and their association with musculoskeletal pain.[16]

The results of this study indicated a need for greater attention to prevention policies in the manufacturing industry. Exposure level assessment of musculoskeletal risk factors is useful in terms of prevention efforts in an industry and can be used by healthcare providers and ergonomists for prioritization of potential intervention, targets and for planning ergonomic programs to improve occupational health and safety in developing countries. An efficient preventive program should identify biomechanical exposures and consider compensatory measures. Alternative strategies, such as physical conditioning programs,[37] should be considered in terms of primary health care.

Conclusion

We found that a high number of metallurgical industry workers were affected by upper body MSD which were closely associated with some individual and work-related risk factors. Study variables such as company experience, presence of sleep disorders, general health state, repetitive motions and work pause seem to be important factors in the development of MSD, and enhance the importance of considering individual and work-related characteristics of MSD. Ergonomic interventions in the workplace conducted by physical therapists and health care professionals should be introduced in an attempt to reduce the physical exposure and in order to prevent MSD among workers.

Conflicts of interest

The authors declare no conflicts of interest.

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