

Musculoskeletal Problems Among Workers of an Iranian Sugar-Producing Factory

Alireza Choobineh
Sayed Hamidreza Tabatabaee

Research Center for Health Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

Mahmoud Behzadi

School of Health and Nutrition, Shiraz University of Medical Sciences, Shiraz, Iran

Background. Assessment of the level of exposure to work-related musculoskeletal disorders (WMSDs) risk factors can be an appropriate basis for planning and implementing an interventional ergonomics program in the workplace. This study was conducted among workers of an Iranian sugar-producing factory to determine WMSD prevalence rate among production workers and to assess the level of exposure to WMSD risks. **Materials and methods.** In total, 116 workers were randomly selected from production workshops and included in the study. The Nordic musculoskeletal questionnaire was used to study prevalence of WMSDs and a quick exposure check (QEC) was used to assess physical exposure to risks. Required data were videotaped. **Results.** Most workers (87.1%) suffered from some kind of MSD symptoms during the 12 months prior to the study. The highest prevalence was reported in knees (58.6%) and the lower back (54.3%). In 99.1% of the workers, the level exposure to MSD risks established with QEC was high and very high. Awkward postures, manual material handling, and long hours of standing were the major ergonomics problems. **Conclusion.** There was a high rate of WMSDs in this factory. The level of exposure to WMSD risk factors was high and corrective measures for reducing risk level were essential.

musculoskeletal disorders QEC sugar industry

1. INTRODUCTION

Musculoskeletal disorders (MSDs) are a leading cause of occupational injury and disability in the developed and industrially developing countries [1, 2, 3, 4]. The economic loss due to those disorders affects not only the individual but also the organization and the society as a whole [3]. At present, MSDs are one of the most important problems ergonomists encounter in the workplace around the world [5]. In many countries, preventing work-related musculoskeletal disorders (WMSDs) is considered a national priority [6].

WMSDs is a worldwide concern present both in industrialized and industrially developing

countries. Poor working conditions and the absence of an effective work injury prevention program in industrially developing countries has resulted in a very high rate of MSDs [7].

Risk factors of WMSDs include workplace activities such as heavy load lifting, repetitive tasks, and awkward working postures [8, 9]. Demographic characteristics and psychosocial factors are also known to be important predictive variables [10, 11, 12].

In Iranian sugar-producing factories, workers are directly involved in the production process. In this industry, physical activities such as manual material handling (e.g., heavy load lifting, lowering, carrying, pulling, and pushing) and

awkward working postures are very common. In this situation, a high rate of WMSD is expected.

The sugar plant studied has used old technology to produce sugar for over 50 years. The production process is very labor intensive and workers are exposed to WMSD risk factors. According to the workers' medical records in this plant 22.75% of all occupational illnesses were related to the musculoskeletal system.

As far as these authors know, no ergonomics study has been conducted in the Iranian sugar-producing industry to determine the prevalence of WMSDs and to assess physical exposure to work-related musculoskeletal risks. Therefore, the present study was carried out with the objectives of (a) determining WMSD prevalence rate among workers in a sugar-producing factory and (b) to assess the level of those workers' exposure to WMSD risks. The results of this study should be an appropriate basis for planning and implementing an interventional ergonomics program in the workplace and for improving workers' health in the sugar-producing industry.

2. MATERIALS AND METHODS

2.1. Examined Population

This cross-sectional study was conducted from August to December 2007 among the production workshops of an Iranian sugar-producing factory. This plant employed 700 male workers, divided into three shifts and four groups. One hundred and sixteen workers with at least one-year job tenure were randomly selected for this study. Workers with background diseases or accidents affecting their musculoskeletal system were excluded from this study.

2.2. Questionnaire

Data were collected via anonymous questionnaires, which covered (a) personal details (including age, weight, height, job tenure, education, health, and medical background); and (b) musculoskeletal problems in different body regions. The general Nordic questionnaire of musculoskeletal symptoms [13] was used to examine reported cases of MSDs among the

study population. Reported MSD symptoms were limited to the 12 months prior to the study. All workshops were visited; the questionnaires were completed on the basis of an interview with each worker.

2.3. Ergonomics Assessment

Physical exposure to musculoskeletal risks was assessed with a pen-and-paper observation method called a quick exposure check (QEC) [14, 15]. QEC is a sensitive method for assessing physical exposure to musculoskeletal risks in the workplace with fair inter- and intraobserver reliability [16]. This technique includes an assessment of the back, shoulder/arm, wrist/hand, and neck, regarding their position and repetitive movement. In QEC, task duration, maximum weight handled, hand force exertion, vibration, visual demand of the task, and subjective responses to work are also considered, whereas the required data are obtained from the worker. The magnitude of each item is classified into exposure levels, and the combined exposure between different risk factors for each body part is calculated with a score table. Up to five pairs of combinations are considered to obtain exposure scores of the four body regions, i.e., posture versus force, movement versus force, duration versus force, posture versus duration, and movement versus duration. The total score for each body area is determined from the interactions between the exposure levels for the relevant risk factors and their subsequent addition. The exposure scores for the back, shoulder/arm, wrist/hand, and neck are categorized into four exposure categories: low, moderate, high, and very high. Moderate, high, and very high scores should be urgently addressed to reduce the level of exposure to risk factors. To obtain an overall exposure score, total scores for body parts are added and the result is divided by the highest possible score for the whole body, i.e., 176 for manual handling tasks and 162 for other tasks. Low overall exposure scores (<40%) indicate acceptable musculoskeletal loading (low risk). For overall exposure scores of 41–50%, further investigation is needed and changes may be required (moderate risk). Prompt investigation and changes are required soon for overall exposure

scores of 51–70% (high risk); and immediate investigation and changes are required for overall exposure scores over 70% (very high risk).

To find the most awkward postures with QEC, all workers were videotaped during their routine job activities for nearly 20 min. The tapes were then reviewed in a laboratory and the QEC score was calculated.

2.4. Data Analysis

Upon completion of the field survey, data were transferred into a computer for statistical analyses (SPSS version 13). An independent *t* test and χ^2 were used to assess the relationship between personal and work variables with reported MSD symptoms.

3. RESULTS

Nineteen percent of workers who participated in the study were illiterate, and 40.5% each had primary and secondary education. Table 1 summarizes other personal details. Table 2 presents the prevalence of MSD symptoms in different body regions during the 12 months prior to the study; the workers' knees, lower back, shoulders, and upper back were most commonly affected.

TABLE 1. Personal Characteristics of the Workers in this Study (*n* = 116).

Characteristics	<i>M</i> (<i>SD</i>)	Range
Age (years)	43.1 (9.70)	18–60
Weight (kg)	68.3 (10.29)	43–102
Height (cm)	170.6 (11.54)	150–194
Tenure (years)	9.4 (5.47)	1–30

TABLE 2. Frequency of Reported Musculoskeletal Disorder Symptoms in Different Body Regions in the 12 Months Prior to the Study (*n* = 116).

Body Regions	No. of Cases	%
Neck	35	30.2
Shoulders	56	48.3
Elbows	36	31.0
Wrists/hands	52	44.8
Upper back	54	46.6
Lower back	63	54.3
Thighs	36	31.0
Knees	68	58.6
Legs/feet	37	31.9

Table 3 shows the relationship between some demographic variables and reported MSD problems in at least one region. The means of age and job tenure among workers who reported MSD symptoms were significantly higher than those of workers without any symptoms (*P* < .05).

TABLE 3. Relation of Some Demographic Variables and Musculoskeletal Disorder (MSD) Problems Among the Workers in this Study (*n* = 116)

Variables	MSD Problems				P Value*
	Reported		Not Reported		
	M	SD	M	SD	
Age (years)	42.84	9.06	34.63	11.07	.020
Weight (kg)	67.93	10.35	68.47	10.28	.852
Height (cm)	168.93	12.14	170.33	6.39	.663
Tenure (years)	9.74	5.36	6.57	5.57	.032

Notes. *—independent samples *t* test

Table 4 presents the frequency of sick leave due to musculoskeletal problems in different body regions during the 12 months prior to the study. Problems of the lower back, knees, upper back, and shoulders caused the highest rate of sick leave. Table 5 shows the results of assessment of physical exposure to work-related musculoskeletal risks.

TABLE 4. Frequency of Sick Leave (%) Due to Reported Musculoskeletal Disorder Problems in Different Body Regions in the 12 Months Prior to the Study (*n* = 116)

Body Regions	Sick Leave	
	No. of Cases	%
Neck	13	11.2
Shoulders	21	18.1
Elbows	14	12.1
Wrists/hands	18	15.5
Upper back	24	20.7
Lower back	27	23.3
Thighs	16	13.8
Knees	27	23.3
Legs/feet	16	13.8

TABLE 5. The Results of the Quick Exposure Check (QEC) for Work-Related Musculoskeletal Risks Among the Workers in this Study (*n* = 116)

Risk Level	Calculated Exposure to WRMR (%)	No. of Cases	%
Low	≤40	0	0.0
Moderate	41–50	1	0.9
High	51–70	24	20.7
Very high	>70	91	78.4

Notes. WRMR—work-related musculoskeletal risks.

Table 6 demonstrates the prevalence rate of reported symptoms in different levels of risk exposure among the workers. When risk increased, the prevalence rate increased. The χ^2 test revealed a significant relationship between the QEC risk level and the prevalence rate of reported musculoskeletal problems ($P < .034$). The prevalence rate of MSD symptoms among workers with high and very high risk levels was significantly higher than for those with a moderate risk level.

TABLE 6. The Prevalence Rate of Reported Musculoskeletal Disorder (MSD) Symptoms at Different Levels of Risk Exposure Among the Workers in this Study

Risk Level	MSD Symptoms					
	Reported		Not Reported		Total	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Low*	0	0	0	0	0	0
Moderate	0	0	1	100	1	0.9
High	21	87.5	3	12.5	24	20.7
Very high	80	87.9	11	12.1	91	78.4
total	101	87.1	15	12.9	116	100

Notes. $P < .034$; *—the low risk group was excluded from statistical analysis.

4. DISCUSSION

The questionnaire showed that MSD symptoms were common among the workers in the sugar-producing factory. Most of the study population (87.1%) had experienced some form of MDS symptoms during the 12 months prior to the study. This indicated that the problem of MSDs in this factory was serious and required due attention. Symptoms from the knees, back, and shoulders were found to be the most prevalent problems. This could be attributable to awkward working postures, manual material handling, and prolonged standing, which were common in almost all workstations and job activities observed. Moreover, the results revealed that symptoms from the knees, back, and shoulders caused the highest rate of sick leave. This implies that any interventional program for preventing or reducing MSD problems among workers in a sugar-producing factory should focus on reducing physical exposure to the MSDs risk factors of these regions.

Table 7 compares point prevalence of the symptoms among the workers in this study, the general Iranian population [17], workers in the Iranian rubber industry [18], and workers in the Iranian petrochemical industry [19]. Statistical analysis (test of proportion) revealed that the differences between the prevalence rates of symptoms in the neck, back, and large joints among the workers in this study and the general Iranian population were significant ($P < .0001$). It was also found that the prevalence rate of symptoms in the neck among the workers in this study was significantly higher than those of the general Iranian population and of workers in the rubber industry ($P < .0001$). The results demonstrated that the prevalence rate of symptoms in the upper and lower back among the workers in this study was significantly higher than those of the general Iranian population and of workers in the petrochemical industry ($P < .0001$). The prevalence rate of symptoms in large joints among the workers studied were significantly higher than those of the general Iranian population, and workers in the rubber and petrochemical industries ($P < .0001$).

TABLE 7. Comparison of Point Prevalence of Musculoskeletal Disorder Symptoms in the Neck, Back and Large Joints in the Workers in this Study (WS, 18–60 years old), the General Iranian Population (GI, 15–69 years old) [16], Workers in the Rubber Industry (RI, 20–60 years old) [17] and in the Petrochemical Industry (PI, 23–67 years old) [18]

Body Region	Population (%)			
	WS	GI	RI	PI
Neck	22.40	10.20	11.00	16.20
Upper and lower back	41.40	25.29	44.05	26.70
Large joints*	69.00	20.00	53.50	42.70

Notes. *—including shoulders, elbows, wrists, knees and ankles.

These comparisons indicate that jobs in the sugar-producing industry can be considered as occupations with a risk of developing MSD symptoms in different body regions. The results also indicated that age and job tenure were significantly associated with MSD symptoms in different body regions. This is in agreement with the findings of other researchers [20, 21, 22, 23]. No association was found between weight,

height, education, and MSDs prevalence rate in this population.

The results of physical exposure to work-related musculoskeletal risk assessment with QEC showed that in 99.1% of the workers in this study the level of exposure to musculoskeletal risks was high and very high. This indicated that the jobs and working conditions in the production workshops of the plant were conducive for developing WMSDs. Therefore, ergonomics interventions to improve working conditions and to decrease exposure level were necessary.

The results demonstrated that there was an association between the QEC risk level and the prevalence rate of the reported symptoms (Table 6). This implied that QEC was an appropriate method to determine the level of exposure to musculoskeletal risks in this industry and that it provided reliable results. This is in agreement with other researchers' findings [24].

Our observations showed that awkward working posture, manual material handling of heavy loads, and prolonged standing were major risk factors the workers encountered. Thus, the following general corrective measures were recommended for reducing exposure level and consequently preventing WMSDs in this sugar factory:

- using mechanical devices such as conveyer belts to carry sugar casts and bags;
- reducing the weight of sugar bags which had to be handled manually;
- repairing rails for transport wagons containing sugar casts;
- using sewing machines to sew the heads of filled sugar bags (instead of sewing them manually);
- designing sitting–standing workstations in the production workshops;
- devising an appropriate work–rest cycle.

5. CONCLUSION

The results led to the conclusion that there was a high rate of WMSDs in this factory. Workers' level of exposure to WMSDs risks was high. Taking corrective measures to reduce the level of

risk was essential. Any ergonomics intervention program in the workplace should focus on eliminating awkward postures and manual handling of heavy loads, and designing sitting–standing workstations in the production line.

REFERENCES

1. Shahnava H. Workplace injuries in the developing countries. *Ergonomics*. 1987; 30(2):397–404.
2. Genaidy AM, Al-Shedi AA, Shell RL. Ergonomics risk assessment: preliminary guidelines for analysis of repetition, force and posture. *J Hum Ergol (Tokyo)*. 1993; 22:45–55.
3. Kemmlert K. Labor inspectorate investigation for the prevention of occupational musculo-skeletal injuries [licentiate thesis]. Solna, Sweden: National Institute of Occupational Health; 1994.
4. Maul A, Laubli T, Klipstein A, Krueger H. Course of low back pain among nurses: a longitudinal study across eight years. *Occup Environ Med*. 2003;60:497–503.
5. Vanwonderghem K. Work-related musculo-skeletal problems: some ergonomics considerations. *J Hum Ergol (Tokyo)*. 1996; 25(1):5–13.
6. Spielholz P, Silverstein B, Morgan M, Checkoway H, Kaufman J. Comparison of self-report, video observation and direct measurement methods for upper extremity musculoskeletal disorder physical risk factors. *Ergonomics*. 2001;44(6):588–613.
7. Jafry T, O'Neill DH. The application of ergonomics in rural development: a review. *Appl Ergon*. 2000;31:263–8.
8. Bernard BP, editor. Musculoskeletal disorders and workplace factors (NIOSH Publication No. 97-141). Cincinnati, OH, USA: National Institute for Occupational Safety and Health (NIOSH); 1997. Retrieved June 19, 2009, from: <http://www.cdc.gov/niosh/docs/97-141/>
9. Haynes S, Williams K. Impact of seating posture on user comfort and typing performance for people with chronic low back pain. *Int J Ind Ergon*. 2008;38:35–46.

10. Linton SJ, Kamwendo K. Risk factors in the psychosocial work environment for neck and shoulder pain in secretaries. *J Occup Med*. 1989;31(7):609–13.
11. Carter JB, Banister EW. Musculoskeletal problems in VDT work: a review. *Ergonomics*. 1994;37(10):1623–48.
12. Weiser S. Psychosocial aspects of occupational musculoskeletal disorders. In: Nordin M, Andersson GBJ, Pope MH, editors. *Musculoskeletal disorders in the workplace: principles and practice*. St. Louis, MO, USA: Mosby-Year Book; 1997. p. 51–61.
13. Kuorinka I, Jonsson B, Kilbom Å, Vinterberg H, Biering-Sørensen F, Andersson G, Jørgensen K. Standardised Nordic Questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon*. 1987;18(3):233–7.
14. Buckle P, Li G. A practical approach musculoskeletal risk assessment in the real workplace. In: Seppälä P, Luopajarvi T, Nygård CH, Mattila M, editors. *Proceedings of the 13th Triennial Congress of the International Ergonomics Association*, Tampere, Finland, 1997. Helsinki, Finland: Finnish Institute of Occupational Health; 1997. pp. 138–40.
15. Li G, Buckle P. The development of practical tool for musculoskeletal risk assessment. In: Robertson SA, editor. *Contemporary ergonomics*. London, UK: Taylor & Francis; 1997. p. 442–7.
16. Li G, Buckle P. Current techniques for assessing physical exposure to work-related musculoskeletal risks, with emphasis on posture-based methods. *Ergonomics*. 1999; 42(5):674–95.
17. National Research Center of Medical Sciences of Iran. National health survey of Iran: overall country. Tehran, Iran: Health Ministry of I.R. Iran; 2001. In Persian.
18. Choobineh AR, Tabatabaei SMR, Mokhtarzadeh A, Salehi M. Musculoskeletal problems among workers of an Iranian rubber factory. *J Occup Health*. 2007;49:418–23.
19. Choobineh AR, Peyvandi Sani GR, Sharif Rohani M, Gangi Pour M, Neghab M. Perceived demands and musculoskeletal symptoms among employees of an Iranian petrochemical industry. *Int J Ind Ergon*. 2009;39:766–70.
20. Burdorf A, Sorock GS. Positive and negative evidence of risk factors for back disorders. *Scand J Work Environ Health*. 1997;23:243–56.
21. Lemasters GK, Atterbury MR, Booth AD. Prevalence of musculoskeletal disorders in active union carpenters. *Occup Environ Med*. 1998;55:421–7.
22. Kezunović L, Stamatović S, Stamatović B, Jovanović J. One-year prevalence of musculoskeletal symptoms in aluminium industry potroom workers. *Facta Universitatis (Series: Medicine and Biology)*. 2004;11(3):148–53. Retrieved August 3, 2009, from: <http://facta.junis.ni.ac.rs/mab/mab200403/mab200403-10.pdf>
23. Brage B. Musculoskeletal pain and smoking in Norway. *J Epidemiol Community Health*. 1996;50:166–9.
24. Mir Mohamadi M. Assessment of musculoskeletal disorders risk factors in a manufacturing industry [Master of Science thesis]. Tehran, Iran: School of Health and Institute of Public Health Researches, 2001. In Persian.