International Journal of Occupational Safety and Ergonomics (*JOSE*) 2008, Vol. 14, No. 4, 455–462

Musculoskeletal Symptoms in Workers

Mehdi Ghasemkhani
Elham Mahmudi

Occupational Health Department, School of Public Health, Medical Sciences/University of Tehran, Tehran, I.R. Iran

Hossain Jabbari

Center for Environmental Research, Medical Sciences/University of Tehran, Tehran, I.R. Iran

Self-report measures of musculoskeletal discomfort are a widely used and generally accepted risk factor for musculoskeletal disorders in epidemiologic research. The aim of this study was to investigate the prevalence of musculoskeletal symptoms in packing workers. A cross-sectional study of 75 workers was carried out using a modified Nordic questionnaire. Prevalence was determined with the percentage of positive responses to questions on musculoskeletal symptoms. Odds ratios and 95% confidence intervals were the measures of association between prevalent musculoskeletal symptoms and demographic factors; they were determined with logistic regression. Most musculoskeletal symptoms in workers were from the low back (44.0%), shoulders (33.3%) and neck (32.0%). Years worked were strongly significantly associated with musculoskeletal symptoms and pain in the neck, shoulders and wrists/hands, $P < .001–.050$. *Hazards related to repetitive movements and discomfort postures could be reduced with stretching exercises, rotation schedules and through new engineering solutions.*

musculoskeletal disorders prevalence packing repetitive movements awkward postures

1. INTRODUCTION

Musculoskeletal disorders (MSDs) continue to be a major source of disability and lost work time. There has been an increasing effort in recent years to investigate the causes of MSDs [1]. Recent reviews of priorities in occupational health research in the UK, The Netherlands and the USA all concluded that MSDs were a major problem [2, 3, 4]. A combination of physical, psychological and psychophysical workplace risk factors have been documented. Physical risk factors such as high forces, high repetition, working with arms overhead, long-term static postures, local contact forces and vibration have been commonly identified. In most industrialized countries, the costs of compensation for MSDs account for at least half of all workers' compensation costs and recent reviews have reaffirmed that a strong work-related component exists for many upper limb and low back pain cases [5]. Work-related MSDs (WMSD) comprise well over half of all reported occupational illnesses [6].

Most studies on the prevalence of WMSDs and their association with occupational tasks have been performed in the manufacturing sector, as outlined in comprehensive literature reviews by the National Institute for Occupational Safety and Health (NIOSH). The relationship between physical activity (forceful, repetitive movements with awkward postures) and MSDs is more complicated than just cause and effect. Physical activity may cause injury. Some epidemiologic studies have used statistical methods to take into

Correspondence and requests for offprints should be sent to Mehdi Ghasemkhani, Occupational Health Department, School of Public Health, Medical Sciences/University of Tehran, P.O. Box 14155-6145 Tehran, I.R. Iran. E-mail: <ghasemkh@sina.tums.ac.ir>.

account the effects of individual factors (e.g., gender, age, body mass index [BMI]). In the USA, 92 576 injuries or illnesses resulted from repetitive motion, including typing or key entry, and repetitive placing, grasping or moving of objects other than tools. Reports have indicated the highest incidence rates of work-related injuries and illnesses from repetitive motion in industries such as packing plants [7].

The relationship between packing workstations and the worker has been important to the industry; however, identification of musculoskeletal risk factors has been done to determine ways to improve productivity. Studies have investigated the relationship between workers' repetitive work and postural discomfort [8, 9]. According to the Bureau of Labor Statistics, disorders related to trauma from repetitive work movements accounted for ~40% of all reported occupational illnesses in U.S. private industry in the late 1980s [10].

The purpose of this study was to determine the prevalence of self-reported musculoskeletal symptoms in workers manufacturing hygienic products in four packing workstations.

2. MATHERIALS AND METHODS

2.1. Setting

The study was cross-sectional in design. Cross-sectional studies are most useful for identifying risk factors of a relatively frequent, long disease that is often undiagnosed or unreported [11]. The setting for the study was a group of workers manufacturing hygienic products. Those products were packed into various containers, primarily boxes, tubes and bottles. Products determined the containers.

Packing can be divided into manual and semiautomatic. Manual packing was done in large and some small packing units. Small packing units automated most packing processes. Products were manually removed from one box, sorted, graded and repacked in another box.

2.2. Subjects

The study group consisted of 75 workers (20 filling, 18 boxing, 18 packing and 19 manufacturing workers), who were involved in manual or semiautomated packing.

2.3. Procedure

All 75 workers were asked to fill in a self-administered questionnaire, concerning age, job type, years worked and occurrence of musculoskeletal symptoms in the past 12 months. Musculoskeletal symptoms were defined as ache, pain or discomfort in one of the following body regions: neck, shoulders, elbows, low back or wrists/hands. The questionnaires were coded, with the code number linked to a list of employees. All the workers in packing processing were sitting and two different types of packing were assessed in this study (manual and semiautomatic).

2.4. Nordic Questionnaire

Standardized questionnaires for the analysis of musculoskeletal symptoms in an ergonomic or occupational health context were presented. The questions were forced choice variants and could be either self-administered or used in interviews. They concentrated on symptoms most often encountered in an occupational setting. The reliability of the questionnaires had been shown to be acceptable. Specific characteristics of work strain were reflected in the frequency of responses. A modified Nordic questionnaire for the analysis of musculoskeletal symptoms was used [12]. Two questions were added to the demographics section (the workers were asked about their weight and height so their BMI could be calculated). A question on the workers' education was added, too. This question was very important in finding out if there was an interest on the workers' part to learn about job-related safety and health as well as ways of acquiring this knowledge.

2.5. Statistical Methods

The results were summarized in descriptive statistics. One-year prevalence of musculoskeletal

symptoms was calculated for the workers. Statistical analysis was performed using odds ratio (OR) and 95% confidence interval (CI) was calculated with logistic regression for associations between musculoskeletal symptoms and demographic factors. The analysis was executed using SPSS version 11.5. A *P* value of .05 was defined as the criterion for statistical significance.

3. RESULTS

Table 1 presents the demographic factors related to the study population. One hundred and twenty workers were eligible to participate, with 75 actually participating (62.5% response rate). The mean (*SD*) age of workers was 34 (8.6) years and the mean period of employment was 11 (7.2) years. Most workers were under 30 years old (64%) and had worked for less than 5 years (72%).

One-year prevalence of musculoskeletal symptoms by anatomical area showed different prevalence for different anatomical areas. Seventy-two percent (n = 54) of respondents reported that musculoskeletal symptoms had troubled them in one or more of the nine defined body regions during the past 12 months.

TABLE 1. Demographics of the Study Population

Factor	Filling (n = 20) n (%)	Boxing (n = 18) n (%)	Packing (n = 18) n (%)	Manufacturing (n = 19) n (%)	Total (n = 75) n (%)
Age (years)	$\bar{X}$ = 34.0 (*SD* 8.6)	$\bar{X}$ = 33.0 (*SD* 8.2)	$\bar{X}$ = 35.0 (*SD* 8.6)	$\bar{X}$ = 33.0 (*SD* 9.5)	$\bar{X}$ = 34.0 (*SD* 8.6)
≤30	8 (40)	6 (33.3)	6 (33.3)	7 (36.8)	27 (36.0)
>30	12 (60)	12 (66.7)	12 (66.7)	12 (63.2)	48 (64.0)
Years worked	$\bar{X}$ = 10.5 (*SD* 7.2)	$\bar{X}$ = 10.0 (*SD* 7.5)	$\bar{X}$ = 10.7 (*SD* 6.4)	$\bar{X}$ = 12.5 (*SD* 7.7)	$\bar{X}$ = 11.0 (*SD* 7.2)
≤5	6 (30)	6 (33.3)	5 (27.8)	4 (21.1)	21 (28.0)
>5	14 (70)	12 (66.7)	13 (72.2)	15 (78.9)	54 (72.0)
Body mass index (kg/m^2)	$\bar{X}$ = 24.0 (*SD* 3.7)	$\bar{X}$ = 25.0 (*SD* 4.7)	$\bar{X}$ = 23.8 (*SD* 3.5)	$\bar{X}$ = 24.5 (*SD* 3.0)	$\bar{X}$ = 24.4 (*SD* 3.7)
≤25	13 (65)	11 (61.1)	11 (61.1)	10 (52.6)	45 (60.0)
>25	7 (35)	7 (37.9)	7 (38.9)	9 (47.4)	30 (40.0)
Educational status					
no diploma	14 (70)	10 (55.6)	11 (61.1)	12 (63.2)	47 (62.7)
diploma	6 (30)	8 (44.4)	7 (38.9)	7 (36.8)	28 (37.3)
Cigarette smoking					
smoker	3 (15)	5 (27.8)	4 (22.2)	5 (26.3)	17 (22.7)
nonsmoker	17 (85)	13 (72.2)	14 (77.8)	14 (73.7)	58 (77.3)
Physical exercise					
often or sometimes	9 (45)	6 (33.3)	8 (44.4)	9 (47.4)	32 (42.7)
never	11 (55)	12 (66.7)	10 (55.6)	10 (52.6)	43 (57.3)

TABLE 2. 12-Month Prevalence of Musculoskeletal Symptoms in Workers by Anatomical Area

Anatomical Area	Filling (n = 20) n (%)	Boxing (n = 18) n (%)	Packing (n = 18) n (%)	Manufacturing (n = 19) n (%)	Total (n = 75) n (%)
Neck	5 (20.8)	6 (25.0)	6 (25.0)	7 (29.2)	24 (32.0)
Shoulders	7 (28.0)	7 (28.0)	7 (28.0)	4 (16.0)	25 (33.3)
Elbows	4 (33.3)	2 (16.7)	4 (33.3)	2 (16.7)	12 (16.0)
Wrist/hands	4 (28.6)	3 (21.4)	4 (28.6)	3 (21.4)	14 (18.7)
Low back	9 (27.3)	5 (15.2)	10 (30.3)	9 (27.3)	33 (44.0)

TABLE 3. Factors Associated With Prevalence of Musculoskeletal Symptoms

	Neck		Shoulders		Elbows		Wrists/Hands		Low Back	
Variable	**Crude OR (95%CI)**	**Adjusted OR (95%CI)[a]**	**Crude OR (95%CI)**	**Adjusted OR (95%CI)**	**Crude OR (95%CI)**	**Adjusted OR (95%CI)**	**Crude OR (95%CI)**	**Adjusted OR (95%CI)**	**Crude OR (95%CI)**	**Adjusted OR (95%CI)**
Age (years)										
≤30	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
>30	1.36 (0.24–7.51)	1.36 (0.24–7.51)	1.43 (0.27–7.56)	1.43 (0.27–7.55)	1.37 (0.18–10.29)	1.40 (0.26–7.44)	2.45 (0.23–25.89)	1.11 (0.15–8.27)	0.82 (0.15–4.45)	0.96 (0.21–4.39)
Years worked										
≤5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
>5	**46.05 (2.10–1010.17)[c]**	**54.05 (3.94–74.05)[d]**	5.91 (0.46–75.30)	**4.12 (1.08–15.71)[b]**	1.04 (0.04–27.25)	1.04 (0.04–27.06)	3.14 (0.12–82.25)	**12.66 (1.56–102.30)[c]**	1.08 (0.07–15.16)	1.85 (0.64–5.32)
BMI (kg /m^2)										
≤25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
>25	0.69 (0.20–2.27)	0.69 (0.21–2.29)	0.76 (0.25–2.23)	0.77 (0.28–2.10)	1.01 (0.25–4.01)	1.08 (0.31–3.80)	1.15 (0.35–3.75)	1.15 (0.35–3.75)	0.95 (0.37–2.42)	0.95 (0.37–2.42)
Educational status										
no diploma	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
diploma	**10.02 (1.02–98.36)[d]**	**11.72 (1.23–111.18)[b]**	1.95 (0.36–10.37)	2.14 (0.43–10.72)	0.55 (0.05–5.95)	1.30 (0.08–19.08)	5.27 (0.70–39.42)	4.70 (0.80–27.53)	0.83 (0.12–5.49)	0.84 (0.13–5.46)
Physical exercise										
never	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
often	3.22 (0.95–10.97)	2.93 (0.89–9.61)	0.77 (0.27–2.16)	0.76 (0.27–2.11)	**10.30 (1.34–94.83)[b]**	**10.65 (1.29–87.53)[b]**	3.09 (0.69–13.73)	3.09 (0.71–13.35)	1.01 (0.37–2.78)	1.01 (0.37–2.78)

Notes. OR—odds ratio, BMI—body mass index; results in bold are statistically significant; a—musculoskeletal symptoms adjusted for age, years worked, BMI, education status and physical exercise; b—$p < .050$; c—$p < .010$; d—$p < .001$.

The criteria used to define a symptom as work-related were conservative, and included frequency and duration (the symptom had to occur at least once a week or last one week or more). The low back was the area with the highest prevalence of MSD symptoms (44%), followed by shoulders (33.3%) and the neck (32%). In the occupational subgroups, packing workers reported a higher prevalence of musculoskeletal symptoms (57.4%) than filling (53.7%) and manufacturing workers (46.3%). Those differences were not statistically significant (Table 2).

Table 3 outlines associations between prevalent musculoskeletal symptoms and demographic variables. There were significant differences between years worked, education status and physical exercise, and the prevalence of MSD symptoms, and pain in the neck, shoulders, elbows and wrists/hands, $P < .001$–$.050$ and $P < .050$, respectively. There were no significant differences between prevalence of MSD symptoms and other demographic variables. The strongest OR neck pain was for years worked (OR = 54.05, 95% CI = 3.94–74.05), followed by pain in wrists/hands (OR = 12.66, 95% CI = 1.56–102.30) and shoulders (OR = 4.12, 95% CI = 1.08–15.71) when adjusting for variables. There was a strong association between neck pain and elbow pain with education status (OR = 11.72, 95% CI = 1.23–111.18) and physical exercise (OR = 10.65, 95% CI = 1.29–87.53).

4. DISCUSSION

Workers at the four packing workstations assessed in this study were found to be at risk for WMSDs. Our results show that the prevalence of musculoskeletal symptoms was high in workers. Repetitive movements with awkward postures were especially hazardous when they involved the same joints and muscle groups and when workers did the same motion too often, too quickly and for too long. Manual workers had a static posture of the neck and back as they leaned into boxes, tubes or bottles. A static posture can produce fatigue because constantly tensed muscles never have an opportunity to recover; thus the potential for discomfort increases. A bent neck requires neck muscles to hold the weight of the head with greater bending producing greater stress. Workstation design that reduces reach and offers adjustability for workers of different height would limit bending as well as awkward postures of the elbows and shoulders. Manual packing is highly repetitive and has a high force component.

The production process of packing was automated in some small packing plants. Automation appeared to decrease physical load and repetition. Most notably, the number of tasks that a worker performed and the cycle times for those tasks decreased in semiautomatic packing. Although the same set of muscle groups was used (shoulders, arms and hands) in semiautomated packing, like in the manual process, working postures became more static. Semiautomatic packers maintained a fairly static neck and back postures that were slightly bent and leaning into the conveyor. Packers should be encouraged to frequently change their posture and stretch as they work to reduce the effect of static posture.

No measurements of worker fatigue, strain or discomfort were provided in this study. The symptom survey revealed that a large proportion of the workers experienced musculoskeletal symptoms in the past 12 months. In this study, the prevalence of MSDs was 16–44%. Simcox, Flanagan, Camp, et al. investigated packing house workers, who reported low back pain symptoms more frequently than did nurses. Approximately half of the packing house participants had work-related back pain, similar to the rate reported by nurses [13]. Silverstein, Fine and Armstrong found that workers in high-repetition/low-force jobs had a threefold greater risk of cumulative trauma disorders of the hand and wrist than workers in low-repetition/low-force jobs [14]. Both static posture and repetition can produce injury when there is no break from muscle contraction [15]. Several studies showed that awkward postures, work at shoulder level, and repetitive hand and wrist movement contributed to the development of disorders of the neck and upper limbs [16, 17]. Some work-related activities such as repetitive movements with awkward postures were previously identified as risk factors for musculoskeletal pain [7].

Nonoccupational factors—years worked, education status and physical exercise—were seen in OR, which correlated with some MSDs. Those risk factors can play an important role in the development of WMSDs. To evaluate the importance of nonoccupational activities in the development of reported packing house injuries, self-reported back pain symptoms were compared to reports of back and upper limb pain in other populations at risk for work-related low back pain [13].

Our study found that for older subjects, the odds of neck, shoulder, wrists/hands and low back pain increased significantly as the duration of employment increased. Duration of employment had a significant association with MSDs [18]. In other studies, there were no significant age trends within strata of the duration of employment, as confidence intervals included the null value [19].

In the current study, the prevalence of neck pain was negatively associated with education status. This may be due to the bias that underestimated the true risk of developing WMSDs, which was not consistent with previous studies [20, 21].

There was an association between elbow pain and physical exercise. Physical activity may influence the prevalence of musculoskeletal symptoms. A large proportion of workers indicated that they did not participate in physical exercise. Gundewall, Liljeqvist and Hansson's study on back pain and exercise compared 28 hospital workers who performed back specific exercises with a control group of 32 workers. The exercise group had fewer back pain complaints and fewer mean days lost from work [22]. The consensus of recent critical reviews is that exercise has some effect in preventing low back pain [23, 24].

Age and BMI were not associated with MSDs in this study. Buckwalter reported that musculoskeletal impairments were among the most prevalent and symptomatic health problems of middle and old age [25]. The prevalence of neck and neck/shoulder disorders tended to increase with age [7, 26]. According to Leboeuf-Yde, Kyvik and Bruun the association between BMI and low back pain was weak and there was no consistent positive linear trend in men [27].

5. LIMITATIONS

Certain limitations should be taken into consideration when interpreting the findings of the survey. The small number of subjects limits the ability to extrapolate those findings to the entire industry. Usually self-reports of disease or disorder are considered as less accurate measurements due to possible false reporting. Moreover, MSDs are a self-reported condition often without any objective clinical findings, and no medical test can really refute the existence of musculoskeletal symptoms. Medical examinations of participating workers would have provided some objective verification of self-reported symptoms.

6. CONCLUSIONS

Repetition and awkward postures are characteristics of packing jobs that put workers at risk of developing WMSDs. The repetitive nature of packing creates greater potential for upper limb repetitive trauma injury. There were correlations between duration of employment, educational status and physical exercise, and some MSDs. No significant relationships were identified between age and BMI with 12-month prevalence of symptoms in any body region. Workers must receive ergonomics awareness education initially and at least every 3 years. Another employer or organization may provide this training. When considering controls to reduce hazards, engineering or administrative measures should be considered first (e.g., changes to workstations and tools, process redesign, job rotation and work schedule modification). Others, such as ergonomic consultants or manufactures of packing unit production equipment, may be helpful in exploring hazard control. The focus of this study was limited to prevalence of musculoskeletal symptoms in four job classifications in this industry. Risks in other jobs in this industry could and should be evaluated.

REFERENCES

1. Buckle P. Ergonomics and musculoskeletal disorders: overview. Occup Med (Lond). 2005;55:164–7.
2. Harrington JM, Calvert IA. Research priorities in occupational medicine: a survey of United Kingdom personnel managers. Occup Environ Med. 1996;53:642–4.
3. Van Der Beek A, Frings-Dresen M, Van Dijk F, Houtman I. Priorities in occupational health research: a Delphi study in the Netherlands. Occup Environ Med. 1997;54:504–10.
4. Rosenstock L. The future of intervention research at NIOSH. Am J Ind Med. 1996; 29:295–7.
5. Norman R, Wells R. Ergonomic interventions for reducing musculoskeletal disorders: an overview, related issues and future directions. Waterloo, ON, Canada: Faculty of Applied Health Sciences, University of Waterloo; 1998. Retrieved June 11, 2008, from: http://www.qp.gov.bc.ca/rcwc/research/norman-wells-interventions.pdf
6. Morse T, Dillon C, Kenta-Bibi E, Weber J, Diva U, Warren N, et al. Trends in work-related musculoskeletal disorder reports by year, type, and industrial sector: a capture-recapture analysis. Am J Ind Med. 2005; 48:40–9.
7. Bernard BP, editor. Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back (NIOSH Pub. No. 97-141). Cincinnati, OH, USA: National Institute for Occupational Safety and Health (NIOSH); 1997. Retrieved June 11, 2008, from: http://www.cdc.gov/niosh/docs/97-141/
8. Bhatnager V, Drury CG, Schiro SG. Posture, postural discomfort, and performance. Hum Factors. 1985;27:189–99.
9. Ohlsson K, Attewell R, Paisson B, Karlsson B, Balogh I, Johnsson B, et al. Repetitive industrial work and neck and upper limb disorders in females. Am J Ind Med. 1995; *27*:731–47.
10. Eckardt J. Evaluation and management of occupational low back disorders. Am J Ind Med. 2000;37:94–111.
11. Kleinbaum DG, Kupper LL, Morgenstern H. Epidemiologic research: principles and quantitative methods. London, UK: Lifetime Learning; 1982.
12 . Kourinka I, Jonsson B, Kilbom Å, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987;18:233–37.
13. Simcox N, Flanagan ME, Camp J, Spielholz P, Snyder K. Musculoskeletal risks in Washington State apple packing companies. Seattle, USA: University of Washington, Department of Environmental Health; 2001. Retrieved June 11, 2008, from: http://depts.washington.edu/frcg/content/applepacking.pdf
14. Silverstein B, Fine LJ, Armstrong TJ. Occupational factors and carpal tunnel syndrome. Am J Ind Med. 1986;11:343–58.
15. Putz-Anderson V. Cumulative trauma disorders—a manual for musculoskeletal diseases of the upper limbs. London, UK: Taylor & Francis; 1988.
16. Hagberg M, Wegman DH. Prevalence rates and odds ratios of shoulder–neck disease in different occupational groups. Br J Ind Med. 1987;44:602–10.
17. Stock SR. Workplace ergonomics factors and the development of musculoskeletal disorders of the neck and upper limbs: a meta-analysis. Am J Ind Med. 1991;19: 87–107.
18. Mahbubi H, Laskar S, Farid A, Seikh H, Altaf H, Masaiwa I, et al. Prevalence of cervical spondylosis and musculoskeletal symptoms among coolies in a city of Bangladesh. J Occup Health. 2006;48: 69–73.
19. Corinne PA, McArthur DL, Kraus JF. Incidence of acute low-back injury among older workers in a cohort of material handlers. J Occup Environ Hyg. 2007; 1:551–7.
20. Leroux I, Brisson C, Montreuil S. Job strain and neck–shoulder symptoms: a prevalence study of women and men white-collar workers. Occup Med (Lond). 2006; 56:102–9.

21. Otani T, Iwasaki M, Ohta A, Kuroiwa M, Yosiaki S, Suzuki S, et al. Low back pain and smoking in a community sample in Japan. J Occup Health. 2002;44:207–13.
22. Gundewall B, Liljeqvist M, Hansson T. Primary prevention of back symptoms and absence from work: a prospective randomized study among hospital employees. Spine. 1993;18:587–94.
23. Lahad A, Malter A, Berg A, Deyo R. The effectiveness of four interventions for the prevention of low back pain. JAMA. 1994; 272:1286–91.
24. Van Poppel M, Koes B, Smid T, Bouter L. A systematic review of controlled clinical trials on the prevention of back pain in industry. Occup Environ Med. 1997;54: 841–47.
25. Buckwalter JA, Woo SY, Goldberg VM, Hadley EC, Booth F, Oegema TR, et al. Soft-tissue aging and musculoskeletal function. J Bone Joint Surg Am. 1993;75: 1533–48.
26. Dempsey PG, Burdorf A, Webster BS. The influence of personal variables on work-related low-back disorders and implication for future research. J Occup Environ Med. 1997;39:748–59.
27. Leboeuf-Yde C, Kyvik K, Bruun NH. Low back pain and lifestyle. Part II—obesity. Information from a population-based sample of 29,424 twin subjects. Spine. 1999;24:779–83.