

The effect of musculoskeletal problems on fatigue and productivity of office personnel: a cross-sectional study

H. DANESHMANDI¹, AR. CHOOBINEH¹, H. GHAEM², M. ALHAMD³, A. FAKHERPOUR⁴

¹ Research Center for Health Sciences, Institute of Health, Shiraz University of Medical Sciences, Shiraz, Iran; ² Department of Epidemiology, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran; ³ Environmental Health Unit, Shiraz Health Center, Shiraz University of Medical Sciences, Shiraz, Iran; ⁴ Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran

Keywords

Discomfort • Fatigue • Musculoskeletal system • Office • Pain • Productivity

Summary

Introduction. Work-related Musculoskeletal Disorders (WMSDs) can impact on fatigue and productivity of office workers. This study aimed to investigate the effect of musculoskeletal problems on fatigue and productivity among office personnel.

Methods. This study was performed on 101 Iranian office workers. Data were gathered through a demographic questionnaire, Nordic Musculoskeletal Questionnaire, Numeric Rating Scale, Persian version of Multidimensional Assessment of Fatigue Scale, and Persian version of Health and Work Questionnaire.

Results. The results revealed that the highest prevalence rates of musculoskeletal symptoms in the past week were related to neck

(41.6%), lower back (41.6%), and shoulders (40.6%). The mean score of discomfort/pain was 1.67, 1.55, and 1.31 in the neck, lower back, and shoulders, respectively. Additionally, the severity of discomfort/pain in neck, shoulders, lower back, and thighs was correlated to total fatigue. The severity of discomfort/pain in neck, lower back, buttock, and thighs was also correlated to the concentration/focus subscale of productivity.

Conclusions. Improvement of working conditions is suggested to reduce musculoskeletal problems and fatigue and enhance productivity.

Introduction

Musculoskeletal Disorders (MSDs) are widespread throughout the world [1] and are the second most common cause of disability in work setting [2]. These disorders are responsible for 40-50% of the costs of all work-related diseases. In addition, 50% of all more-than-3-day absences from work and 49% of all more-than-two-week absences are caused by MSDs [3].

Workplace risk factors for development of Work-related Musculoskeletal Disorders (WMSDs) include heavy physical work, forceful overexertion, awkward and sustained postures, repetitive movement, and vibration [4]. Previous surveys indicated a significant positive association between MSDs and fatigue [5, 6], stress [6], psychosocial distress, and sleep disruption [5]. MSDs are also a significant workplace issue resulting in loss of productivity at work and sickness absence [7]. Outcomes of MSDs can range from symptoms to major impairment losses [8], such as reduction of quality of life [9], reduction of productivity (e.g., lost time) [10], and increase in medical expenses due to disability [11]. The results of some studies have also shown a significant association between the reported prevalence of MSDs and productivity loss in terms of "presenteeism" [12].

The economic and social pressure of MSDs in the working-age population are so huge that employers spend about \$103,000 for every 100 employees annually [13]. In the USA (2012), 29% of injuries and diseases leading to days off work were attributed to WMSDs. Besides, Hauffer et al. reported that the total cost of lost productivity linked to MSDs in the European Union's population [10] might be about 2% of the Gross Domestic Product (GDP) [14]. On the other hand, direct costs (medical costs) arising from MSDs were \$576 billion (4.5% of GDP) between 2004 and 2006. In the same period, indirect costs (calculated as lost wages) related to MSDs were \$373 billion (2.9% of GDP).

Office workers are exposed to risk factors of WMSDs [15, 16]. The findings of the study by Maakip et al. revealed that the 6-month prevalence of MSDs symptoms was 92.8% and 71.2% among Malaysian and Australian office workers, respectively [15]. Alavi et al. also conducted a study in Iran and found that the prevalence rates of MSDs symptoms in shoulders, hands/wrists, and elbows of office workers were 18.1%, 13.9%, 5.3%, respectively. Additionally, MSDs in shoulders, elbows, and hands/wrists were associated with poor mental health ($p < 0.001$) [17]. In the same line, Choobineh et al. demonstrated that the prevalence rate of MSDs symptoms was 56.6% in the neck, 46.7% in wrists/hands, 44.6% in

lower back, 39.2% in upper back, 38.2% in shoulders, 34.4% in knees, 24.1% in legs/feet, 15.0% in elbows, and 14.6% in thighs among Iranian office workers [18]. Generally, office workers comprise a big workforce group employed in any organization and workplace. These workers usually work in sedentary posture for a long time. This condition can be conducive for developing MSDs, fatigue, and loss of productivity. In the present study, it was hypothesized that MSDs could be effective in developing fatigue and loss of productivity. Therefore, this study was performed to assess musculoskeletal symptoms and discomfort/pain in office personnel and to examine the relationship between MSDs and fatigue and productivity.

Methods

DATA GATHERING TOOLS

a) Demographic questionnaire: This questionnaire included questions about age, weight, height, job tenure, daily sitting working time, sex, marital status, and education level.

b) Nordic Musculoskeletal Questionnaire (NMQ): NMQ examines the reported prevalence of MSDs in different body regions among the study population [19]. In the present study, reported musculoskeletal symptoms were limited to the past week. Each participant received the questionnaire in his/her workplace. The validity and reliability of the Persian version of NMQ had been surveyed by Choobineh et al. [20].

c) Numeric Rating Scale (NRS): NRS is a unidimensional measure of discomfort and pain intensity [21].

d) Persian version of the Multidimensional Assessment of Fatigue (P-MAF) Scale: Multidimensional Assessment of Fatigue (MAF) scale was developed by Belza et al. (1993) among older adults with rheumatoid arthritis [22]. This scale is in fact a revision of the Piper Fatigue Scale developed and tested among oncology patients [23]. MAF scale contains 16 items that assess various aspects of fatigue. This scale is a self-administered questionnaire to assess four dimensions of fatigue, including degree and severity, amount of distress it causes, its timing, and the degree to which fatigue interferes with daily living activities. Respondents are asked to reflect their experiences of fatigue in the past week [22]. In our study, the psychometric properties of P-MAF scale were examined among Iranian office workers. Accordingly, the internal consistency of the scale was acceptable ($\alpha \geq 0.854$) for all subscales. Indeed, the convergent validity ranged from 0.466 to 0.948 for all subscales. Moreover, factor analysis of P-MAF scale revealed that its items were related to severity, distress, timing of fatigue, interference with activity at home, and interference with activity outside the house.

e) Persian version of Health and Work Questionnaire (P-HWQ): Health and Work Questionnaire (HWQ) was developed by Shikiar et al. (2004) among a sample of reservation agents at a US-based international airline.

HWQ assesses various aspects of workplace productivity. It consists of 30 questions responded through a 10-point Likert scale. These questions are categorized into six subscales, namely productivity, concentration/focus, supervisor relations, work and non-work satisfaction, and impatience/irritability [24]. In our study, the validity and reliability of P-HWQ were examined among Iranian office workers. Accordingly, the internal consistency of the Persian version of the questionnaire was acceptable for all subscales ($\alpha \geq 0.65$). Besides, factor analysis was acceptable (> 0.4) for each item related to the subscales.

IMPLEMENTATION OF THE STUDY

This study was conducted on 101 Iranian office workers with at least one year of working experience. Employees with underlying diseases or accidents affecting the musculoskeletal system were excluded from the study. The participants were selected from Shiraz University of Medical Sciences through simple random sampling using the table of random numbers. All subjects voluntarily participated in the study after receiving information about the study objectives. They also signed written informed consents before commencement of the study. The study was conducted in accordance with the Helsinki Declaration of 1964 as revised in 2008. The required data were gathered in two weeks consecutively:

Week 1) In the first week, demographic questionnaire was completed by the participants. In order to assess the intensity of musculoskeletal discomfort/pain, the subjects were required to rate NRS on Saturday, Monday, and Wednesday at the beginning, middle, and end of the shift. Then, difference between the NRS scores at the beginning and end of the shift during the three working days was calculated and the mean of differences was considered as musculoskeletal discomfort/pain in the working week.

Week 2) NMQ was used to determine the prevalence rate of MSDs symptoms in the past week. Besides, P-MAF scale and P-HWQ were used to assess the participants' fatigue and productivity in the past week (week 1), respectively.

STATISTICAL ANALYSIS

In this study, the Statistical Package for Social Sciences 16 (SPSS Inc, Chicago, IL, USA) was used to analyze the data. Because the data did not appear to follow a normal distribution, Spearman's correlation coefficient was used to evaluate the relationship between musculoskeletal discomfort/pain, and fatigue and productivity. It is worth mentioning that Kolmogorov-Smirnov test was used to test the normality of the data.

Results

Some personal characteristics of the studied office workers have been presented in Table I.

Tab. I. Some personal characteristics of the studied office workers (n = 101).

Quantitative variables	Mean ± Standard deviation
Age (years)	37.91 ± 13.52
Weight (kg)	70.81 ± 15.80
Stature (cm)	166.32 ± 13.66
Job tenure (years)	12.30 ± 8.37
Working hours per day	8.13 ± 1.88
Working hours per week	44.40 ± 14.24
Hours of exercise per week	2.94 ± 1.96
Qualitative variables	No. (%)
Sex	
Male	56 (55.4%)
Female	45 (44.6%)
Marital status	
Single	30 (29.7%)
Married	71 (70.3%)
Education level	
Associate degree and lower	34 (33.7%)
Bachelor of science and higher	67 (66.3%)

Tab. II. The frequency of reported musculoskeletal symptoms in different body regions among workers during the past week (n = 101).

Body region	MSDs symptoms	
	No.	%
Neck	42	41.6
Shoulders	41	40.6
Elbows	15	14.9
Wrists/hands	27	26.7
Upper back	31	30.7
Lower back	42	41.6
Thighs	13	12.9
Knees	36	35.6
Legs/feet	31	30.7

Tab. III. Mean ± standard deviation of the severity of discomfort in different body regions of the participants (n = 101).

Body region	Severity of pain
	Mean ± standard deviation
Neck	1.67±2.24
Shoulders	1.31±2.28
Elbows	1.01±2.02
Wrists/hands	1.05±1.97
Lower back	1.55±2.29
Buttock	1.12±2.28
Thighs	0.97±1.99
Ankles	1.28±2.19

Tab. IV. The correlations between the severity of discomfort/pain in different body regions and the scores of P-MAF and its subscales.

		P-MAF subscales					
		Degree and severity	Distress that it causes	Degree of interference with activities of daily living	Timing of fatigue	Total fatigue/ Global Fatigue Index	
Body regions	Neck	r*	0.363	0.418	0.274	-0.351	0.344
		p**	0.000	0.000	0.010	0.001	0.002
	Shoulders	r	0.304	0.262	0.245	-0.355	0.229
		p	0.003	0.012	0.024	0.001	0.048
	Elbows	r	0.225	0.238	0.154	-0.351	0.104
		p	0.029	0.022	0.154	0.001	0.369
	Wrists/hands	r	0.271	0.279	0.123	-0.370	0.158
		p	0.008	0.007	0.263	0.000	0.174
	Lower back	r	0.283	0.316	0.159	-0.230	0.285
		p	0.006	0.002	0.144	0.027	0.013
	Buttock	r	0.166	0.171	0.121	-0.343	0.104
		p	0.111	0.104	0.265	0.001	0.366
	Thighs	r	0.210	0.274	0.251	-0.215	0.305
		p	0.041	0.008	0.019	0.039	0.007
	Ankles	r	0.160	0.184	0.118	-0.219	0.125
		p	0.123	0.078	0.275	0.036	0.278

*r: Spearman's correlation coefficient; **p: p-value, significance level $\alpha = 0.05$

Tab. V. The correlations between the severity of discomfort/pain in different body regions and the score of productivity subscales.

		P-HWQ subscales								
		Productivity	Productivity own assessment	Productivity others assessment	Concentration/ focus	Supervisor relations	Non-work satisfaction	Work satisfaction	Impatience/ irritability	
Body regions	Neck	r*	-0.044	-0.091	-0.035	0.216	-0.009	-0.078	-0.059	0.107
		p**	0.682	0.386	0.735	0.032	0.928	0.450	0.565	0.297
	Shoulders	r	-0.069	-0.007	-0.125	0.179	-0.046	-0.094	-0.047	0.170
		p	0.518	0.947	0.230	0.079	0.661	0.367	0.649	0.101
	Elbows	r	-0.008	-0.049	-0.005	0.188	-0.006	-0.076	-0.073	0.173
		p	0.940	0.639	0.960	0.063	0.955	0.457	0.475	0.091
	Wrists/hands	r	-0.002	-0.037	-0.044	0.167	-0.013	-0.006	-0.017	0.083
		p	0.983	0.729	0.671	0.103	0.899	0.954	0.866	0.427
	Lower back	r	-0.018	-0.072	-0.003	0.216	-0.006	-0.026	-0.047	0.008
		p	0.867	0.496	0.980	0.033	0.955	0.799	0.645	0.937
	Buttock	r	-0.103	-0.156	-0.088	0.223	-0.028	-0.097	-0.032	0.167
		p	0.330	0.137	0.392	0.027	0.787	0.346	0.753	0.105
	Thighs	r	-0.102	-0.104	-0.021	0.206	-0.056	-0.039	-0.049	0.102
		p	0.334	0.320	0.840	0.041	0.587	0.707	0.630	0.324
	Ankles	r	-0.017	-0.094	-0.004	0.145	-0.059	-0.035	-0.007	0.038
		p	0.873	0.375	0.966	0.155	0.568	0.732	0.946	0.716

*r: Spearman's correlation coefficient; **p: p-value, significance level $\alpha = 0.05$

The prevalence rates of the reported musculoskeletal symptoms in different body regions among office workers during the past week have been presented in Table II. Mean \pm standard deviation of severity of discomfort/pain in different body regions among the studied subjects has been displayed in Table III. As the table depicts, the means of severity of discomfort/pain were higher in the neck, lower back, and shoulders compared to other regions.

The correlations between the severity of discomfort/pain in different body regions and the scores of P-MAF and its subscales have been depicted in Table IV. Accordingly, the scores of discomfort/pain in neck, shoulders, lower back, and thighs were correlated to total fatigue. Based on the rule of thumb in interpreting the size of the correlation coefficient, these correlation coefficients were in the negligible or low correlation category (0-0.5) [25]. The correlations between the severity of discomfort/pain in different body regions and the score of productivity subscale derived from P-HWQ have been presented in Table V. Based on the results, the severity of discomfort/pain in the neck, lower back, buttock, and thighs was only correlated only to the concentration/focus subscale of productivity. Based on the rule of thumb in interpreting the size of the correlation coefficient, these correlation coefficients were in the negligible correlation category (0-0.3) [25].

Discussion

The present study was carried out to assess the effect of musculoskeletal symptoms on fatigue and productivity among office workers. The mean \pm standard deviation of age and working hours per week were 37.91 ± 13.52

years and 44.40 ± 14.24 hours, respectively. Additionally, 55.4% of the subjects were male and the rest (44.6%) were female.

The results of the study revealed that the highest prevalence rates of musculoskeletal symptoms in the past week were related to the neck (41.6%), lower back (41.6%), and shoulders (40.6%). A previous study noted that the prevalence rate of musculoskeletal symptoms among office workers ranged from 40% to 80% [26]. Besides, Rempel et al. stated that most MSDs symptoms in office workers were reported in upper limbs, neck, and shoulders and that these disorders constituted nearly 30% of all workplace injuries [27]. Moreover, the findings of the study by Choobineh et al. showed that the prevalence rate of musculoskeletal symptoms was 56.6% in the neck, 46.7% in wrists/hands, and 44.6% in lower back among Iranian office workers in the past 12 months [18]. The results of our previous study indicated that the highest prevalence rates of MSDs were related to the lower back (45.1%), neck (41.7%), and knees (33.8%) among the studied office workers [28]. Persistence of these problems can be attributed to static and awkward postures as well as repetitive movements [29]. The findings of the present study revealed that the mean scores of musculoskeletal discomfort/pain in the neck, lower back, and shoulders were 1.67, 1.55, and 1.31, respectively. This shows that the reported symptoms of musculoskeletal problems were in accordance with the participants' perceived discomfort/pain.

The results also showed that the severity of musculoskeletal discomfort/pain in different body regions was correlated to different aspects of fatigue, including degree and severity, distress that it causes, degree of interference with activities of daily living, and timing of fatigue. Indeed, the severity of musculoskeletal discomfort/pain in

neck, shoulders, lower back, and thighs was associated with total fatigue derived from P-MAF scale. In some studies, researchers found that musculoskeletal discomfort/pain was associated with fatigue [5, 6, 30], psychosocial distress, sleep disruption [5], and stress [6]. Furthermore, the findings of previous studies have shown that holding a static and awkward posture for long periods during the work could lead to discomfort/pain and chronic fatigue [31, 32]. The findings of the research by Chavalitsakulchai and Shahnavaaz indicated a close relationship between musculoskeletal discomfort/pain and fatigue among workers [33]. Another study also demonstrated that the prevalence of discomfort/pain in the lower back and neck was higher in supermarket cashiers and that subjects reported perception of high fatigue levels after work days [34].

The results of the current study showed that the severity of discomfort/pain in the neck, lower back, buttock, and thighs was correlated to the concentration/focus subscale of productivity derived from P-HWQ. In other words, as discomfort/pain severity increased, concentration/focus decreased. This reduction could eventually lead to loss of productivity.

The findings of previous studies have revealed that some aspects of productivity were related to musculoskeletal problems [35]. Moreover, it has been pointed out that discomfort/pain might have an adverse impact on several aspects of an individual's performance, such as concentration, cognitive capacity, rationality/mood, mobility, stamina, and agility, as well as physical aspect [36]. Also, the findings of studies have shown that individuals with musculoskeletal pain might suffer from psychophysiological symptoms, such as lack of concentration, insomnia, stress-related pain, ability, and other disabling conditions [37, 38].

In addition to what was mentioned above, the consequences of WMSDs are considerable for employees as well as for employers. MSDs can be related to lost working days, early retirement and unemployment (significant for employees), decline of productivity, rise in sickness payments, and staff absenteeism (significant for employers) [39]. A prior study reported that WMSDs were the biggest single factor of medical bed days and lost working days (loss of productivity) in the United States [40]. On the other hand, WMSDs negatively affect productivity because workers are not only injured when they are fatigued, but they are also inclined to decelerate working [41]. Based on Ng et al., there was a significant association between the reported prevalence rate of WMSDs and productivity loss in terms of "presenteeism" [12]. Also, Van den Heuvel et al. stated that 26% of subjects with MSDs symptoms in neck/shoulders or hands/arms reported loss of productivity [42, 43]. Manzoli et al. mentioned in their study that promotion of health in the society is the main factor for smart, sustainable, inclusive growth, which is one of the objectives of Europe 2020 Europe's growth strategy. Based on this strategy, healthy and active people have a positive impact on productivity and competitiveness. Indeed, workplace factors (physical, psychosocial, and organizational fac-

tors) have a significant impact on improving individuals' health, especially the musculoskeletal system [44].

The results of the present study indicated a direct relationship between the presence of MSDs and fatigue in individuals and that presence of these disorders could affect individuals' concentration/focus as well as productivity. Therefore, pre-employment or periodic medical examinations are recommended to be carried out in order to control WMSDs, which are the key factor contributing to increase of fatigue and loss of productivity. In this context, workplace analysis, control of risk factors, medical management, and training individuals for prevention and elimination of WMSDs are necessary.

Limitations of the study

Regarding the cross-sectional nature of the study and self-report data gathering method, the findings are to be interpreted cautiously. Moreover, this study was carried out among office workers in Shiraz. Therefore, the results may not be generalized to other office personnel and working groups.

Conclusions

Work-related musculoskeletal discomfort/pain and symptoms that mainly occur due to physical (static and poor postures, repetitive movements, non-ergonomic workstation design, etc.), psychological (stress, mental workload, etc.), and organizational (improper work-rest cycle, lack of job enrichment, etc.) factors in the workplace may result in fatigue and affect productivity among office workers. Thus, improvement of working conditions, proper organization of work, and implementation of ergonomic interventions in the workplace are recommended as necessary measures to decrease musculoskeletal discomfort/pain among office workers.

Acknowledgments

Conflicts of interest: None declared.

This paper was extracted from the thesis written by Mr. Hadi Daneshmandi, PhD candidate of Ergonomics and was financially supported by Shiraz University of Medical Sciences (grant No. 95-01-104-11387). Hereby, the authors would like to thank Ms. A. Keivanshekouh at the Research Improvement Center of Shiraz University of Medical Sciences for improving the use of English in the manuscript.

Authors' contributions

HD: idea, data interpretation, article drafting, final approval of the article. AC: idea, data interpretation, article drafting, final approval of the article. HG: data analysis and interpretation, article drafting, final approval of the

article. MA: data gathering, article drafting, final approval of the article. AF: data gathering, article drafting, final approval of the article

References

- [1] Horton R. *GBD 2010: understanding disease, injury, and risk*. Lancet 2012;380(9859):2053-4. doi: 10.1016/S0140-6736(12)62133-3.
- [2] Armijo-Olivo S, Woodhouse LJ, Steenstra IA, Gross DP. *Predictive value of the DASH tool for predicting return to work of injured workers with musculoskeletal disorders of the upper extremity*. Occup Environ Med 2016;73(12):807-15. doi: 10.1136/oemed-2016-103791
- [3] *The European commission initiative on WRMSDs: recent developments, presentation to EUROFOUND conference on 'Musculoskeletal disorders*. In: Cammarota A, editor.; 11e12 October. Lisbon 2007. Available at: <https://www.eurofound.europa.eu/it/events/other/musculoskeletal-disorders-conference-in-cooperation-with-the-portuguese-presidency-0> [Accessed on 05/02/2017].
- [4] NIOSH. *Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck*. In: Bernard BP, editor. *Upper Extremity, and Low Back US Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) No. Cincinnati: OH* 1997, pp. 97-141. Available at: <https://www.cdc.gov/niosh/docs/97-141/pdfs/97-141.pdf> [Accessed on 05/02/2017].
- [5] Hunt I, Silman A, Benjamin S, McBeth J, Macfarlane G. *The prevalence and associated features of chronic widespread pain in the community using the 'Manchester' definition of chronic widespread pain*. Rheumatology 1999;38(3):275-9. doi: 10.1093/rheumatology/38.3.275.
- [6] Oakman J, Macdonald W. *Prevention of work-related musculoskeletal disorders: Development of a toolkit for workplace users. 2012*. Available at: http://www.iscrr.com.au/_data/assets/pdf_file/0004/297184/Prevention-Work-related-Musculoskeletal-disorders-Toolkit.pdf [Accessed on 05/02/2017].
- [7] Phillips C, Main C, Buck R, Aylward M, Wynne-Jones G, Farr A. *Prioritising pain in policy making: the need for a whole systems perspective*. Health Policy 2008;88:166-75. doi: 10.1016/j.healthpol.2008.03.008.
- [8] Rempel DM, Harrison RJ, Barnhart S. *Work-related cumulative trauma disorders of the upper extremity*. JAMA 1992;267:838-42. 9. doi: 10.1001/jama.1992.03480060084035.
- [9] Meijer EM, Sluiter JK, Frings-Dresen MH. *Is workstyle a mediating factor for pain in the upper extremity over time?* J Occup Rehabil 2008;18:262-6. doi: 10.1007/s10926-008-9145-0.
- [10] Haufler AJ, Feuerstein M, Huang GD. *Job stress, upper extremity pain and functional limitations in symptomatic computer users*. Am J Ind Med 2000;38(5):507-15. doi: 10.1002/1097-0274(200011)38:5<507::AID-AJIM3>3.0.CO;2-5.
- [11] Punnett L, Wegman DH. *Work-related musculoskeletal disorders: the epidemiologic evidence and the debate*. J Electromyogr Kinesiol 2004;14(1):13-23. doi: 10.1016/j.jelekin.2003.09.015.
- [12] Ng YG, Tamrin SBM, Yik WM, Yusoff ISM. *The prevalence of musculoskeletal disorder and association with productivity loss: a preliminary study among labour intensive manual harvesting activities in oil palm plantation*. Ind Health 2014;52(1):78-85. doi: 10.2486/indhealth.2013-0017.
- [13] Summers K, Jinnett K, Bevan S. *Musculoskeletal Disorders, Workforce Health and Productivity in the United States. The center for workforced health and performance, Lancaster university. 2015*. Available at: http://www.theworkfoundation.com/wp-content/uploads/2016/11/385_White-paper-Musculoskeletal-disorders-workforce-health-and-productivity-in-the-USA-final.pdf [Accessed on 05/02/2017].
- [14] Storheim K, Zwart J-A. *Musculoskeletal disorders and the Global Burden of Disease study*. BMJ Publishing Group Ltd and European League Against Rheumatism; 2014. Available at: <http://ard.bmj.com/content/73/6/949> [Accessed on 05/02/2017].
- [15] Maakip I, Keegel T, Oakman J. *Predictors of musculoskeletal discomfort: A cross-cultural comparison between Malaysian and Australian office workers*. Appl Ergon 2017;60:52-7. doi: 10.1016/j.apergo.2016.11.004.
- [16] Macedo AC, Trindade CS, Brito AP, M. SD. *On the effects of a workplace fitness program upon pain perception: a case study encompassing office workers in a Portuguese context*. J Occup Rehabil 2011;21(2):228-33. doi: 10.1007/s10926-010-9264-2.
- [17] Alavi SS, Makarem J, Abbasi M, Rahimi A, Mehrdad R. *Association between upper extremity musculoskeletal disorders and mental health status in office workers*. Work 2016;55(1):3-11. doi:10.3233/WOR-162382.
- [18] Choobineh A, Daneshmandi H, Saraj Zadeh Fard SK, Tabatabaee SH. *Prevalence of work-related musculoskeletal symptoms among iworkforce and job groups*. Int J Prev Med 2016;7(1):130. doi: 10.4103/2008-7802.195851.
- [19] Kuorinka I, Jonsson B, Kilbom A, 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. doi: 10.1016/0268-0033(88)90149-0.
- [20] Choobineh A, Lahmi M, Shahnavaz H, Khani Jazani R, Hosseini M. *Musculoskeletal symptoms as related to ergonomic factors in Iranian hand-woven carpet industry and general guidelines for workstation design*. Int J Occup Saf Ergon 2004;10(2):157-68. doi: 10.1080/10803548.2004.11076604.
- [21] Childs JD, Piva SR, Fritz JM. *Responsiveness of the numeric pain rating scale in patients with low back pain*. Spine 2005;30(11):1331-4. doi: 10.1097/01.brs.0000164099.92112.29.
- [22] Belza BL, Henke CJ, Yelin EH, Epstein WV, Gilliss CL. *Correlates of fatigue in older adults with rheumatoid arthritis*. Nurs Res. 1993;42(2):93-9. doi:10.1097/00006199-199303000-00006.
- [23] Piper BF, Lindsey AM, Dodd MJ, Ferketich S, Paul SM, Weller S. *The development of an instrument to measure the subjective dimension of fatigue. Management of pain, fatigue and nausea*. Springer 1989, pp. 199-208.
- [24] Shikiar R, Halpern MT, Rentz AM, Khan ZM. *Development of the Health and Work Questionnaire (HWQ): an instrument for assessing workplace productivity in relation to worker health*. Work 2004;22(3):219-29. <https://www.ncbi.nlm.nih.gov/pubmed/15156087>
- [25] Hinkle DE, Wiersma W, Jurs SG. *Applied Statistics for the Behavioral Sciences*. 5th ed. Boston: Houghton Mifflin 2003.
- [26] Katz JN, Amick BC, Carroll BB, Hollis C, Fossel AH, Coley CM. *Prevalence of upper extremity musculoskeletal disorders in college students*. Am J Med 2000;109(7):586-8. doi: 10.1016/S0002-9343(00)00538-6.
- [27] Rempel D, Krause N, Goldberg R, Benner D, Hudes M, Goldner G. *A randomised controlled trial evaluating the effects of two workstation interventions on upper body pain and incident musculoskeletal disorders among computer operators*. Occup Environ Med 2006;63(5):300-6. doi: 10.1136/oem.2005.022285.
- [28] Choobineh AR, Daneshmandi H, Aghabeigi M, Haghayegh A. *Prevalence of musculoskeletal symptoms among employees of Iranian petrochemical industries: October 2009 to December 2012*. Int J Occup Environ Med 2013;4(4):195-204. <https://www.ncbi.nlm.nih.gov/pubmed/24141868>.
- [29] Prakash J, Singh V, Prakash J, Bhatta S, Deane A. *Computer Usage And Musculoskeletal Disorders [MSD's]. Webmedcentral. 2014*. Available at https://www.webmedcentral.com/article_view/4506 [Accessed on 05/02/2017].

- [30] Middlesworth M. *The Definition and Causes of Musculoskeletal Disorders (MSDs)*. Webmedcentral. 2017. Available from: <http://ergo-plus.com/musculoskeletal-disorders-msd/>. [Accessed on 05/02/2017].
- [31] McNee C, Kieser J, Antoun J, Bennani H, Gallo L, Farella M. *Neck and shoulder muscle activity of orthodontists in natural environments*. J Electromyogr Kinesiol 2013;23(3):600-7. doi: 10.1016/j.jelekin.2013.01.011.
- [32] Valachi B, Valachi K. *Mechanisms leading to musculoskeletal disorders in dentistry*. J Am Dent Assoc 2003;134(10):1344-50. doi: 10.14219/jada.archive.2003.0048.
- [33] Chavalitsakulchai P, Shahnavaz H. *Musculoskeletal discomfort and feeling of fatigue among female professional workers: The need for ergonomics consideration*. J Hum Ergol 1991;20(2):257-64. doi: 10.11183/jhe1972.20.257.
- [34] Sirge T, Erelina J, Kums T, Gapeyeva H, Pääsuke M. *Musculoskeletal symptoms, and perceived fatigue and work characteristics in supermarket cashiers*. Agron Res 2014;12(3):915-24. https://www.researchgate.net/publication/262565375_Musculoskeletal_symptoms_and_perceived_fatigue_and_work_characteristics_in_supermarket_cashiers
- [35] Taylor K, Green N, Physio D. *What are the productivity losses caused by musculoskeletal disorders (MSDs)?: A review of the current literature*. Wellnomics Ltd 2008; 1-5.
- [36] *Most Common MSK Issues in the Workplace*. Available at: <http://spectrumwellness.ie/resources/blog/most-common-msk-issues-in-the-workplace/>. [Accessed on 02/03/2017]
- [37] Jay K, Brandt M, Sundstrup E, Jakobsen MD, Sjøgaard G, Andersen LL. *Effect of individually tailored biopsychosocial workplace interventions on chronic musculoskeletal pain, stress and work ability among laboratory technicians: randomized controlled trial protocol*. BMC Musculoskelet Disord 2014;15(1):444. doi: 10.1186/1471-2474-15-444.
- [38] Hart RP, Martelli MF, Zasler ND. *Chronic pain and neuropsychological functioning*. Neuropsychol Rev 2000;10(3):131-49. doi: 10.1023/A:1009020914358.
- [39] Aumann K, Galinsky E. *The state of health in the American workforce: Does having an effective workplace matter*. New York, NY: Families and Work Institute. 2009. <http://www.whenworkworks.org/find-solutions/workforce-trends/the-state-of-health-in-the-american-workforce-does-having-an-effective-workplace-matter>
- [40] Surgeons AAoO. *The burden of musculoskeletal diseases in the United States: Prevalence, societal and economic cost*. Rosemont, IL. 2008. Available at: https://books.google.com/books/about/The_Burden_of_Musculoskeletal_Diseases_i.html?id=Mp0TAQAAMAAJ [Accessed on 08/01/2017]
- [41] Resnick M, Zanotti A. *Using ergonomics to target productivity improvements*. Comput Ind Eng 1997;33(1-2):185-8. doi: 10.1016/S0360-8352(97)00070-3.
- [42] Van den Heuvel SG, IJmker S, Blatter BM, de Korte EM. *Loss of productivity due to neck/shoulder symptoms and hand/arm symptoms: results from the PROMO-study*. J Occup Rehabil. 2007;17(3):370-82. doi: 10.1007/s10926-007-9095-y.
- [43] Copello F, Garbarino S, Messineo A, Campagna M, Durando P; Collaborators. *Occupational medicine and hygiene: applied research in Italy*. J Prev Med Hyg 2015;56(2):102-10.
- [44] Manzoli L, Sotgiu G, Magnavita N, Durando P. *Evidence-based approach for continuous improvement of occupational health*. Epidemiol Prev 2015;39(4) Suppl 1:81-5.

■ Received on June 6, 2017. Accepted on August 10, 2017.

■ Correspondence: Alireza Choobineh, Research Center for Health Sciences, Institute of Health, Shiraz University of Medical Sciences, P.O. Box: 71645-111, Shiraz, IR Iran. Tel. +98 71 37251001-5 (291), +98 71 37260225. E-mail: alrchoobin@sums.ac.ir