JOURNAL OF
CONTEMPORARY MEDICINE

DOI:10.16899/jcm.1176447
J Contemp Med 2023;13(1):36-41

Original Article / Orijinal Araştırma

Ergonomics-Related and Work-Related Musculoskeletal Disorders in A High-Hazard Factory in Hatay Region

Hatay'da Çok Tehlikeli Sınıfta Bir Fabrikada Ergonomi ve İş ile İlişkili Kas İskelet Sistemi Yakınmaları

Mehmet Erdem, Nazan Savaş

Mustafa Kemal University, Faculty of Medicine, Department of Public Health, Hatay, Turkey

Abstract

Aim: The most common work-related diseases are musculoskeletal system disease. This study aims to determine the prevalence of work-related musculoskeletal disorders (WMSDs) in a high-hazard factory and to determine sociodemographic, occupational, and ergonomic risks.

Material and Method: The research is cross-sectional and was conducted in a high-hazard factory, in Hatay, in 2017. The research population was all factory employees (N=190), and it was aimed to reach the whole population. Of the (97.3%), 185 employees participated in the study. Anthropometric measurements, the Cornell Musculoskeletal Discomfort Scale, the observation-based Rapid Upper Limb Assessment (RULA) Ergonomic Risk Analysis Scale, and a questionnaire developed by the researchers are used for data collection. In the statistical analyses p<0,05was accepted as significant.

Results According to the Cornell Scale, the frequency of WMSDs was 58.9%. The most common WMSDs were in the lumbar region (34.1%). According to the RULA Scale, 31.9% of the employees had 3rd and 4th-degree ergonomic risk. There were linear relationships between the Cornell Waist Score and each of the three RULA scores (p<0.001). The risk factors for WMSDs in the lumbar region were the presence of chronic disease (OR=5.35), hand tool use (OR=2.63), not having had a work accident (OR=0.04) and RULA scores (OR=1.61),

Conclusion: Approximately one-third of the high-hazard factory employees had a high ergonomic risk. WMSDs existed in more than half of the employees. As the ergonomic risk increases, WMSDs increase.

Keywords: Ergonomy, work related musculo-skeletal system disorders, RULA

Öz

Amaç: İşle ilgili en sık görülen hastalıklar kas-iskelet sistemi hastalıklarıdır. Bu çalışmanın amacı, çok tehlikeli sınıfta yer alan bir fabrikada işe bağlı kas-iskelet sistemi rahatsızlıklarının İKİSR sıklığını ve sosyodemografik, iş ve ergonomik riskleri belirlemektir.

Gereç ve Yöntem: Araştırma kesitsel tipte olup 2017 yılında yapılmıştır. Araştırmanın evrenini fabrika çalışanlarının tamamı (N=190) oluşturmaktadır. Araştırmaya 185 fabrika çalışanı (%97,3) katılmış olup, verilerin toplanmasında antropometrik ölçümler, Cornell Kas İskelet Sistemi Rahatsızlık Anketi ve Hızlı Üst Ekstremite Değerlendirmesi (RULA) ergonomik risk analizi ölçeğine dayalı gözlem kullanılmıştır. İstatistiksel analizlerde p<0,05 anlamlı olarak kabul edildi.

Bulgular: Cornell Anketine göre İKİSR sıklığı %58,9 idi. En sık İKİSR bel bölgesindeydi (%34,1). RULA Ölçeğine göre çalışanların %31,9'u 3. ve 4. Derece ergonomik risk altındadır. Cornell Bel Skoru ile üç RULA skorunun her biri arasında doğrusal ilişkiler vardı. Bel bölgesinde İKİSR için risk faktörleri; kronik hastalık varlığı (OR=5,35), el aletleri kullanımı (OR=2,63), RULA puanı (OR=1,61) ve iş kazası geçirmemiş olmaktır. (OR=0,04).

Sonuç: Çalışanların yaklaşık üçte birinde yüksek ergonomik risk, yarısından fazlasında ise İKİSR bulunmaktadır. Ergonomik risk arttıkça İKİSR de artar.

Anahtar Kelimeler: Ergonomi, iş ile ilişkili kas iskelet sistemi yakınmaları, RULA

Corresponding *(İletişim)*: Mehmet Erdem, Mustafa Kemal University Faculty of Medicine Public Health Department Antakya/Hatay/Turkey
E-mail *(E-posta)*: dr.m_erdem@hotmail.com
Received *(Geliş Tarihi)*: 16.09.2022 **Accepted *(Kabul Tarihi)*:** 19.12.2022

INTRODUCTION

The most common work-related diseases are musculoskeletal. Work-related musculoskeletal disorders (WMSDs) account for 50% of new cases.[1] This stand generally upper extremity diseases (neck, shoulder, elbow, hand, and wrist) and lower back diseases.[2] These diseases, which are also defined as Cumulative Trauma Disorders, negatively affect the work-life quality of the employees, work efficiency, and cost.[3]

WMSDs caused by work-related activities are a vital health problem in industrialized countries and are one of the leading causes of disability. Millions working in various sectors in European countries experience issues due to work-related musculoskeletal diseases every year.[4,5] The significant increase in the frequency of WMSDs and the costs related in industrialized countries has drawn the attention of employees, employers, governments, healthcare providers, and insurance companies. Studies on risk factors in the workplace and ergonomics programs on ergonomic initiatives, training, and rehabilitation are gaining momentum.[6]

In Europe, 22.8% of employees report having general muscular pain, while 24.7% report having lower back pain.[6] In the Years Lost due to Disability (YLD) ranking, musculoskeletal diseases are in the third place with 9.9% and are accepted as occupational diseases by law in Turkey. Despite this fact, this situation is not recognized sufficiently by employees, employers, and professionals dealing with occupational health and safety.[7]

Although it is prevalent, WMSDs are not easily detected because their etiologies are multifactorial. Cause and effect relations affiliated with WMSDs might not be easily demonstrated, work-related effects might be ignored, and WMSDs may occur due to non-work-related reasons (hobbies, sports activities, etc.).[8] The WMSDs data are mainly obtained from the records of insurance and health institutions. These hardships cause WMSDs that do not require labor loss or compensation to be ignored and make it difficult to determine the incidence and prevalence accurately and thus, make comparisons.[9]

The risk factors of work-related musculoskeletal diseases are divided into two: Work-related and personal. The primary risk factors are repetitive movements, strength, inappropriate body postures, and prolonged performance.[10] Ergonomic factors in the work environment are also crucial risk factors. The suitability of the height and use of the seat, desk, keyboard, and screen for those who work in a seated position, and of the tables, manipulators, and fixtures for those who work in industry, play an important role. Additionally, inadequate lighting and temperature are noteworthy ergonomic risk factors, as well.[11]

This study aims to determine the prevalence of work-related musculoskeletal disorders (WMSDs) in employees in a high-hazard factory and to determine related sociodemographic, occupational, and ergonomic risk factors.

MATERİAL AND METHOD

This cross-sectional study was carried out in a hazardous factory in Kırıkhan, Hatay, in 2017. The population of the research was all employees of the factory (N=190). No sampling method was accustomed, since reaching the entire population was aimed. Of 97.3% (n=185) people participated in the study.

Instruments

In the study, three different methods are used for data collection. While anthropometric measurements were carried out with the direct method, the questionnaire and the Cornell Musculoskeletal Discomfort Scale were applied by the face-to-face interview method. The Rapid Upper Limb Assessment (RULA) form was applied by direct observation to evaluate the ergonomic risk.

Anthropometric Measurement: The body mass index was calculated by measuring the height and weight of the employees from the anthropometric measurements.

Questionnaire Form: The researchers developed a form consisting of 50 questions regarding the sociodemographic and work-related characteristics of the employees. Three of the questions were graphical, in which the employees were asked to mark their body postures in lifting, pushing, and pulling while working in the factory.

Cornell Musculoskeletal Discomfort Questionnaire: The form evaluates the musculoskeletal disorders experienced by the person in 20 body regions during the previous week under the headings of frequency, severity and resulting in not being able to work. There are male and female types of the scale, and a minimum of 0 and a maximum of 16 points can be obtained from the scale for each body region. The Turkish validity and reliability study was conducted by Erdinç, Hot, and Özkaya in 2008.[12]

Rapid Upper Limb Assessment Tool: RULA was developed by Atamney and Corlett in 1992 to identify upper extremity movements that cause musculoskeletal disorders and is a method designed to quickly analyze an employee's ergonomic risks related to the upper extremity.[13] The form is based on direct observation and is applied by the researcher. Ergonomic risk is evaluated in 3 stages. The employee's arm/wrist score is measured in the first stage. The second stage calculates the neck/body/legs score. In the third stage, the scores in the first two stages are compared and the total score is calculated.

The RULA scores that can be obtained for each region and general body are 0 for the minimum and 8 for the largest. Ergonomic risk is evaluated in terms of position, muscle use, and power overload by grading the total score between 1 and 4. Accordingly, the ergonomic risk of the employee is evaluated as follows:

- Grade 1 (1-2 points): Acceptable ergonomic situation.
- Grade 2 (3-4 points): The individual needs to be evaluated further.

- 3rd Degree (5-6 points): The individual should be evaluated further and measures should be taken in a short time regarding the individual or working conditions.
- Grade 4 (7 ≤ points): The individual should be evaluated further and measures should be taken urgently for the individual or working conditions.

Statistical Analysis

Kolmogorov Smirnow, Chi-square, Mann Whitney-U, Kruskal Wallis, Spearman Correlation, Linear Regression, and Logistic Regression analyzes were used for statistical analysis. Furthermore, sociodemographic, work-related, and ergonomic variables affecting the presence of lower back pain (household monthly income, regular exercise, chronic disease, unit working at, blue/white collar working type, pushing-pulling action, lifting weights, weight lifted, using hand tools, RULA arm-hand-wrist, RULA neck-trunk-leg, and RULA total scores) in the last week were evaluated according to the Cornell scale with the binary logistic regression (Backward LR) model. $p<0.05$ was considered significant.

Ethics committee and factory institution permissions were obtained for the study. (Ethics Committee Decision Nr: 07/11/2016-216). The financial support for the study was provided by the Scientific Research Projects Coordination Unit of the Rectorate of Mustafa Kemal University (Project No: 16445).

RESULTS

The mean age of the employees participating in the study was 35.6±6.3 (18-57), of which 93.8% were male, and 85.7% were married. The results pointed out that 31.4% of the participants were high school graduates and 90.8% were blue-collar workers. The average monthly income was 2243.2±1281.2 Turkish Lira (TRY) per month. According to the survey responses, 12.4% had a previous work accident, 17.8% had a chronic disease diagnosed by a doctor, 14.2% used alcohol and 50.8% smoked. Smokers were an average of 13.8±8.0 package/year smokers. 36.8% of the employees were doing regular physical activity and the average daily sleep time was 7.2±1.2 hours.

The result of anthropometric measurements showed that the mean body mass index (BMI) was 27.3±3.9 kg/m² (17-44), 48.1% were overweight and 22.3% were obese. The BMI of women was 25.7±5.1 kg/m² and that of men was 27.4±3.8 kg/m² ($p>0.05$).

Most participants (55.1%) worked in the main production facility and 73.5% worked in shifts, whereas the average working year was 6.89±2.70 years, and the average weekly working time was 44.27±3.27 hours. Employees took an average of 2.18±1.03 breaks (times) during the day, 13.5% of them were doing additional work outside the factory.

Sixty-one percent of the participants had at least one night shift in the last 1 month, 44.2% were absent from work in the last year, and 42.2% found the physical burden of their work heavy. The mean age of those who found the physical burden of their job to be light, medium, and heavy were similar ($p>0.05$).

The most common actions while working were sitting (38.4%) and standing (33.0%), respectively. In the working environment, 17.8% of them were lifting weights frequently and 10.3% of them were lifting weights constantly. The weight lifted was 20.08±8.73 kgs on average and the distance carried was 2.22±2.30 meters on average. In addition, near twelve percent of the employees frequently, 13.0% constantly push and pull, 17.8% frequently and 19.5% constantly stay in the same position while working. 34.6% of the research group used hand tools at work. According to the answers given to the question with the graphic, 65.9% of employees while lifting weights, 59.8% while pushing action, and 68.6% while pulling action were acting with wrong ergonomic posture.

According to the Cornell Scale, 58.9% of the employees who participated in the study had WMSDs in any part of their body. The scores of all body regions and 95% confidence intervals of those with WMSDs according to the Cornell Scale are shown in (**Figure 1**). According to the Cornell Scale, the body regions where they felt the most complaints were the waist (34.1%) and the neck (13.5%), respectively (**Figure 2**).

Relationships between WMSDs and sociodemographic characteristics, anthropometric measurements, habits, work environment, and factors related to work practice were analyzed according to the Cornell Scale. WMSDs were found more frequently in women, those with low income, with chronic diseases, who perceive the physical burden of work as heavy, who lift more weights, who did not work night shifts in the last month, and those who use hand tools ($p<0.05$) (**Tables 1, 2,** and **3**).

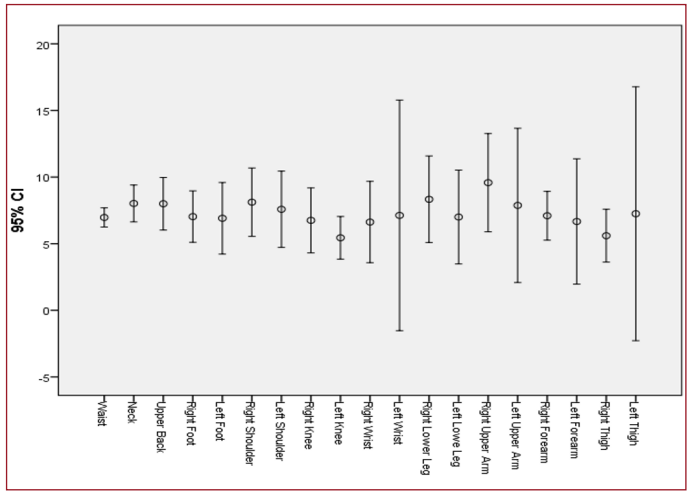

Figure 1. Scores Based on Body Regions from the Cornell Scale and 95% Confidence Intervals

Table 1. Gender, Marital Status, Education Status, BMI, Place of Residence, Smoking, Alcohol Use, Physical Activity, Chronic Disease Status According WMSDs

		WRMSC Yes		WRMSC No		p*
		n	%	n	%	
Gender	Male	84	48.8	88	51.2	0.025[a]
	Female	11	84.6	2	15.4	
Marital status	Married	84	51.5	79	48.5	0.739
	Single	11	50.0	11	50.0	
Education Status	Primary School	17	45.9	20	54.1	0.661
	Middle School	19	61.3	12	38.7	
	High School	30	51.7	28	48.3	
	Vocational high School	13	52.0	12	48.0	
	University	16	47.1	18	52.9	
BMI	Normal	28	50.9	27	49.1	0.347
	Overweight	56	62.9	33	37.1	
	Obese	25	61.0	16	39.0	
Place	Rural	18	51.4	17	48.6	0.197
	District	77	51.3	73	48.7	
Cigarette	Smoker	67	56.8	51	43.2	0.371
	Not smoker	28	41.8	39	58.2	
Alcohol	Drinker	16	59.3	11	40.7	1.000
	Not Drinker	93	58.9	65	41.1	
Physical Activity	Yes	37	54.4	31	45.6	0.342
	No	72	61.5	45	38.5	
Chronic Disease	Yes	27	81.8	6	18.2	0.006[a]
	No	82	53.9	70	46.1	

*ChiSquare Test a Yates Correction

Table 2. WMSDs According to Some Work-Related Features of Employees

		WRMSC Yes		WRMSC No		p*
		n	%	n	%	
Department	Main	61	59.8	41	40.2	0.786
	Product	48	57.8	35	42.2	
Group	Blue Collar	98	58.3	70	41.7	0.802[a]
	White Collar	11	64.7	6	35.3	
Working Schedule	Shift Procedure	74	54.4	62	45.6	0.057[a]
	Daytime Shift	35	71.4	14	28.6	
Last Month Night Work	Yes	61	2.6	55	47.4	0.034[a]
	No	48	69.6	21	30.4	
Last Week Night Work	Yes	50	52.1	46	47.9	0.050
	No	59	66.3	30	33.7	
Extra Job	Yes	8	32.0	17	68.0	0.006[a]
	No	101	63.1	59	36.9	
Physical Burden of Work	Soft	16	42.1	22	57.9	0.001[b]
	Middle	56	56.6	43	43.4	
	Heavy	37	77.1	11	22.9	
Weight Lifting Work	Yes	78	61.9	48	38.1	0.228
	No	31	52.5	28	47.5	
Push Pull Job	Yes	64	63.4	37	36.6	0.178
	No	45	53.6	39	46.4	
Hand Tools	Yes	49	76.6	15	23.4	0.001[a]
	No	60	49.6	61	50.4	
Discontinuity for the last 1 year	Yes	57	67.9	27	32.1	0.024
	No	52	51.5	49	48.5	
Work accident	Yes	12	54.5	10	45.5	0.831[a]
	No	97	59.5	66	40.5	

**ChiSquare Test a Yates Correction b Chi Square on Slope

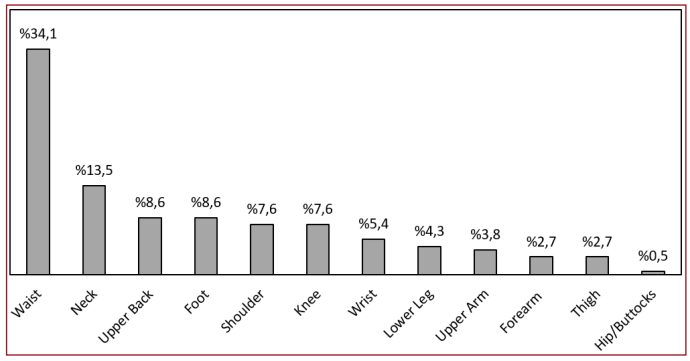

Figure 2. Body Regions During the Last 1 Week According to Cornell Questionnaire Feeling Pain (N=185)

Table 3. WMSDs According to Some of the Employees' Quantitative Demographic and Work Related Situations

	WRMSC Yes	WRMSC No	P*
	Mean±Sd	Mean±Sd	
Age	35.85±6.57	35.39±5.92	0.396
BMI	27.53±4.24	27.02±3.49	0.461
Household Monthly Income (TL)	2145.27±1303.44	2383.6±1243.85	0.043
Cigarettes (Pack / Year) (n=109)	14.57±8.91	12.62±6.31	0.478
Weekly Working Time (Hours)	44.43±3.87	44.05±2.14	0.100
1 year discontinuity (days) (n=93)	9.64±10.83	8.18±11.20	0.346
Number of Nights Worked in the Last Month (n=117)	8.98±4.60	9.17±3.85	0.799
Number of Nights Worked in the Last Week (n=95)	9.74±4.52	9.60±3.67	0.852
Daily Break Number	2.11±0.94	2.15±1.16	0.372
Daily Break Time (minutes)	43.39±19.95	46.57±21.91	0.339
Lifted Weight (kg) (n=125)	21.20±9.73	18.22±6.34	0.041
Number of Work Accidents (n=22)	1.46±0.66	1.00±0.00	0.031

*Mann Whitney-U Test

According to the RULA ergonomic risk assessment, the mean overall body RULA score of all employees was 3.61±1.86 (min.1-max.7). When the RULA score is graded; 31.9% had first-degree, 36.2% second-degree, 24.9% third-degree and 7.0% fourth-degree ergonomic risk

The arm-hand-wrist, the neck-trunk-leg, and whole body RULA scores of the employees were compared according to gender, unit worked in, being blue/white collar, lifting weights, pushing and pulling, and using hand tools.The mean RULA scores of men, blue-collar workers, weight lifters, and push-pullers were found higher ($p<0.05$) . In addition, the arm-hand wrist, neck-trunk-leg, and whole-body region RULA score averages of those with WMSDs were found to be higher than those who do not have ($p<0.01$, $p<0.05$, $p<0.01$).

Since the most common WMSDs were in the lumbar region (34.1%), the risk factors associated with WMSDs in the lumbar region were evaluated by logistic regression analysis. The risk factors for WMSDs in the lumbar region are found to be the presence of chronic disease (OR=5.35), hand tool use

(OR=2.63), the RULA score (OR=1.61), and previous work accident (OR=0.04). In this established model, low back pain risks were predicted correctly with an effect size of 65.9%.

Since the most common WMSDs were in the lumbar region (34.1%), the risk factors associated with WMSDs in the lumbar region were evaluated by logistic regression analysis. The risk factors for WMSDs in the lumbar region are found to be the presence of chronic disease (OR=5.35), hand tool use (OR=2.63), the RULA score (OR=1.61), and not have previous work accident (OR=0.04). In this established model, low back pain risks were predicted correctly with an effect size of 65.9%.

The causal relationship between the employees' total Cornell score and the RULA total score was evaluated by linear regression for genders, separately. Contrary to participating women (p=0.476), a causal relationship was discovered in men (Cornell Total score=1.603 X RULA Total score; p=0.001).

Positive moderate correlations were detected between the employees' Cornell Scale waistline scores and RULA Scale arm/hand/wrist scores (r=0.339; p=0.001), between RULA scale neck/trunk/leg scores (r=0.304; p=0.001) and RULA Scale total scores (r=0.344; p=0.001). When linear regression analysis was separately performed to reveal the causal relationship between the Cornell Scale waistline score and all three RULA Scale scores, the models established were as follows:

- Cornell Scale Waist Score= 0.674 x RULA Scale arm/hand/wrist score (p<0.001)
- Cornell Scale Waist Score= 0.634 x RULA Scale neck/trunk/leg score (p<0.001)
- Cornell Scale Waist Score= 0.670 x RULA Scale total score (p<0.001)

DISCUSSION

This study aimed to determine the prevalence of work-related musculoskeletal disorders (WMSDs) in a high-hazard factory and to determine sociodemographic, occupational, and ergonomic risks. WMSDs were evaluated with the Cornell Scale, and ergonomic risk was evaluated with the RULA Scale in this study. Most studies performed with the Cornell Scale were conducted with office workers, computer workers, and healthcare workers.[14-18] Though, the sample size was limited in which the studies combined Cornell and RULA Scales. While a sample size of 92 people was used in the study conducted on dentists in Iran and 7 in the study in the metal industry in Malaysia.[19,20] The sample size of our study was 185. Besides, each employee was evaluated separately under observation in the factory environment in this study.

In our study, the WMSDs frequency was 58.9% according to the Cornell Scale, and most WMSDs were found in the lumbar region. Likewise, the frequency was 58.6% in the research conducted by Choobineh et al. in a sugar factory in İran, and 55.9% in the study conducted in the industry sector by Yıldırım et al. In İzmir/Turkey.[21-23] By contrast, the frequency of WMSDs was 73.5% in the study conducted by Jansen et al. at the production site in Estonia .

Many studies have shown that WMSDs are higher in women than in men.[24] Likewise, in our study, the frequency of WMSDs in women was found significantly higher than in men. However, in the Binary logistic regression analysis performed to reveal the risk factors for WMSDs in the lower back region, no difference was found in terms of gender. Again, in our study, no significant difference was found between women and men in terms of BMI, and no relationship was found between WMSDs and BMI.

Studies are showing that WMSDs increase with age in the literature, as well as studies showing that there is no relationship with age. In a cohort study conducted in France in 2008, it was shown that lower back pain is more common in older employees.[25] In a study conducted on women working in the carpet weaving business in Iran, no relationship was found between age and WMSDs.[26] Similarly, no relationship was found between age and WMSDs in the study.

A significant relationship was found between the perception of the difficulty of the work and WMSDs in our study. In parallel, in a prospective study conducted in 2004 by Nahit et al. aimed at investigating the relationship between musculoskeletal complaints and psycho-social factors, with 1081 participants from 12 different professions were followed for one year, it is found that high physical and mental load of the work increased participants' musculoskeletal pain.[27]

In the study, a relationship was found between WMSDs in the lower back region and weight lifting and the amount of weight lifted. In addition, the frequency of lower back pain in those who use hand tools is higher than in those who do not. According to the model we obtained in the logistic regression analysis, using a hand tool while working increases the risk of low back pain on the Cornell Scale by 2.63 points. This situation shows that employees using hand tools not only use hand tools but also have difficulty while using hand tools, lifting weights, displaying the wrong posture, and making movements that force the anatomical structure of the waist. Again, the logistic regression analysis showed that the risk of lumbar region complaints increased by 1.61 points with each increase in the RULA Scale total score. Both studies from the literature found a correlation between RULA scores and Cornell scores.[20,21] Another risk factor for WMSDs in the lumbar region was a previous work accident. The risk of low back pain in those who not have had a past work accident is 0.04 points higher than in those who have .

CONCLUSION

More than half of the very hazardous factory employees have WMSDs, and about a third have a high ergonomic risk. The most common complaint is in the lumbar region. Women employees with chronic diseases, who lift weights while working, who use hand tools, and with high ergonomic

risk are at risk of WMSDs. However, while there was a causal relationship between WMSDs and ergonomic risk in the workplace in men, it did not apply to women. Managers should assign proper jobs to employees, use technology appropriately, and regulate the ergonomics. Employee/employer training is needed to eradicate WMSDs risk factors. In addition, women's non-job-related musculoskeletal complaints and related risk factors should be taken into consideration.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Mustafa Kemal University Faculty of Medicine Local Ethics Committee (Date: 09/02/2017, Decision No: 06, Protocol Code: 07/11/2016/216).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The author has no conflicts of interest to declare.

Financial Disclosure: The financial support of the study was covered by Hatay Mustafa Kemal University Scientific Researches and Projects Coordination Unit (Project No: 16445).

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Cabeças JM. Occupational musculoskeletal disorders in Europe: impact, risk factors and preventive regulations 2006. 2006:2;95-104
2. Aptel M, Aublet-Cuvelier A, Cnockaert JC. Work-related musculoskeletal disorders of the upper limb. Joint Bone Spine 2002;69(6):546-55.
3. Kilbom s, Armstrong T, Buckle P, Fine L, Hagberg M, Haring-Sweeney M et al. Musculoskeletal Disorders: Work-related Risk Factors and Prevention. Int J Occup Environ Health. 1996;2(3):239-46.
4. Melhorn JM, Gardner P. How we prevent prevention of musculoskeletal disorders in the workplace. Clin Orthop Relat Res 2004;(419):285-96.
5. Buckle P. Ergonomics and musculoskeletal disorders:overview. Occup Med (Lond) 2005;55(3):164-7.
6. Nazmi B. Mesleksel kas iskelet sistemi hastalıkları. İş Sağlığı ve Güvenliği Derg 2007;34:10-3.
7. Stellman JM. Encyclopaedia of occupational health and safety: ILO;1998.
8. Punnett L, Wegman DH. Work-related musculoskeletal disorders:the epidemiologic evidence and the debate. J Electromyogr Kinesiol 2004;14(1):13-23.
9. Yildirim Y, Gunay S, Karadibak D. Identifying factors associated with low back pain among employees working at a package producing industry. J Back Musculoskelet Rehabil 2014;27(1):25-32.
10. Devereux JJ, Vlachonikolis IG, Buckle PW. Epidemiological study to investigate potential interaction between physical and psychosocial factors at work that may increase the risk of symptoms of musculoskeletal disorder of the neck and upper limb. Occup Environ Med 2002;59(4):269-77.
11. Rodríguez Y, Viña S, Montero R. A method for non-experts in assessing exposure to risk factors for work-related musculoskeletal disorders--ERIN. Ind Health 2013;51(6):622-6.
12. Erdinc O, Hot K, Ozkaya M. Turkish version of the Cornell Musculoskeletal Discomfort Questionnaire:cross-cultural adaptation and validation. Work 2011;39(3):251-60.
13. McAtamney L, Nigel Corlett E. RULA:a survey method for the investigation of work-related upper limb disorders. Appl Ergon. 1993;24(2):91-9.
14. Roman-Liu D. Comparison of concepts in easy-to-use methods for MSD risk assessment. Appl Ergon 2014;45(3):420-7.
15. Telles S, Dash M, Naveen KV. Effect of yoga on musculoskeletal discomfort and motor functions in professional computer users. Work 2009;33(3):297-306.
16. Fagarasanu M, Kumar S. Musculoskeletal symptoms in support staff in a large telecommunication company. Work 2006;27(2):137-42.
17. Rudakewych M, Valent-Weitz L, Hedge A, editors. Effects of an ergonomic intervention on musculoskeletal discomfort among office workers. Proceedings of the Human Factors and Ergonomics Society Annual Meeting;2001:SAGE Publications Sage CA:Los Angeles, CA.
18. Menzel NN, Brooks SM, Bernard TE, Nelson A. The physical workload of nursing personnel:association with musculoskeletal discomfort. Int J Nurs Stud 2004 Nov;41(8):859-67.
19. Tamrooiy, Farzane Rahnamaye, et al. "A survey on prevalence of musculoskeletal disorders in dentists of Tehran and their posture assessment by RULA method." Int Res J Appl Basic Sci 9.5 (2015):666-671.
20. Mean, Vathna, et al. "Investigation on musculoskeletal symptoms and ergonomic risk factors at metal stamping industry." Advanced Engineering Forum. Vol. 10. Trans Tech Publications Ltd, 2013.
21. Jansen K, Luik M, Reinvee M, et al. Musculoskeletal discomfort in production assembly workers. Acta Kinesiologiae Universitatis Tartuensis 2012:18;102-10.
22. Choobineh A, Tabatabaee SH, Behzadi M. Musculoskeletal problems among workers of an Iranian sugar-producing factory. Int J Occup Saf Ergon 2009;15(4):419-24.
23. Yildirim Y, Gunay S, Karadibak D. Identifying factors associated with low back pain among employees working at a package producing industry. J Back Musculoskelet Rehabil 2014;27(1):25-32.
24. Wijnhoven HA, de Vet HC, Picavet HS. Explaining sex differences in chronic musculoskeletal pain in a general population. Pain 2006;124(1-2):158-66.
25. Leclerc A, Gourmelen J, Chastang JF, Plouvier S, Niedhammer I, Lanoë JL. Level of education and back pain in France:the role of demographic, lifestyle and physical work factors. Int Arch Occup Environ Health 2009;82(5):643-52.
26. Karimi N, Moghimbeigi A, Motamedzade M, Roshanaei G. Evaluation of Related Risk Factors in Number of Musculoskeletal Disorders Among Carpet Weavers in Iran. Saf Health Work 2016;7(4):322-25.
27. Nahit ES, Hunt IM, Lunt M, Dunn G, Silman AJ, Macfarlane GJ. Effects of psychosocial and individual psychological factors on the onset of musculoskeletal pain:common and site-specific effects. Ann Rheum Dis 2003;62(8):755-60.