ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

DOI: 10.31609/jpmrs.2020-79500

Frequency and Risk Factors of Lower Limb Disorders in Work-related Musculoskeletal Disorders

Mesleki Kas İskelet Sistemi Hastalıklarında Alt Ekstremite Hastalıklarının Sıklığı ve Risk Faktörleri

Emine DÜNDAR AHİ[a], Hülya ŞİRZAİ[b]

[a]Clinic of Physical Medicine and Rehabilitation, Kocaeli Health and Technology University, Private Medar Hospital, Kocaeli, TURKEY
[b]Clinic of Romatem Physical Medicine and Rehabilitation, İstanbul, TURKEY

ABSTRACT Objective: Work-related musculoskeletal disorders (WMSDs) are a serious health and economic problem. Occupational health and safety is important for preventing these disorders. There are many reports about work-related upper limb musculoskeletal disorders, but few about the lower limb. Most of lower limb reports were based on self-reported scales. Our aim was to determine the frequency and risk factors of lower limb disorders in WMSDs in workers in heavy industry. **Material and Methods:** We included 110 male and female heavy industry workers among 1,268 patients diagnosed with a WMSD who were admitted to the physical medicine and rehabilitation (PMR) outpatient clinic between 2018 and 2020, and were diagnosed with a lower limb WMSD by physical and radiological examinations. We recorded demographic data, risk factors, and lower limb WMSD diagnoses for all patients. **Results:** The incidence of lower limb WMSDs (n=110) among all patients diagnosed with a WMSD in the PMR outpatient clinic was 8.67%. Of these lower extremity WMSDs, the most common site was the knee (83.6% of patients), followed by the feet-ankles (24.5%), and the hip joint (20.9%). In our study, the frequency of wearing special shoes/boots was statistically significantly higher in cases with WMSDs in the feet-ankles ($p<0.001$). **Conclusion:** WMSDs are seen in both the lower and upper extremities. Special shoes and boots designed for the working environment should include features that would help to reduce WMSDs of the feet-ankles.

Keywords: Occupational diseases; musculoskeletal disorders; lower limb; repetitive strain injury; occupational risk

ÖZET Amaç: Mesleki kas iskelet hastalıkları (MKİH) ciddi bir sağlık ve ekonomi problemidir. İş sağlığı ve güvenliği, bu hastalıkların önlenmesi için çok önemlidir. Üst ekstremite MKİH hakkında çok sayıda çalışma olmasına rağmen alt ekstremitede bu sayı çok azdır. Az sayıdaki bu çalışmaların çok büyük bir kısmı da anket çalışmalarından ibarettir. Amacımız, ağır sanayi işçilerinde MKİH'de alt ekstremite hastalıklarının sıklığını ve risk faktörlerini belirlemekti. **Gereç ve Yöntemler:** Çalışmaya, 2018-2020 yılları arasında fizik tedavi ve rehabilitasyon (FTR) polikliniğine başvuran, muayene edilen ve radyolojik tetkikler sonucu MKİH tanısı alan 1.268 hastadan, alt ekstremite MKİH tanısı konulan erkek ve kadın, 110 ağır sanayi işçisi dâhil edilmiştir. Hastaların demografik verileri, çalıştıkları yerdeki risk faktörleri ve hastalıkları kayıt edilmiştir. **Bulgular:** FTR polikliniğinde MKİH tanısı alan hastalardan, alt ekstremite MKİH tanısı konulanların sıklığı %8,67 (n=110) idi. Bunların görüldüğü bölgeler sırasıyla; diz (hastaların %83,6'sı), ardından ayak-ayak bilekleri (%24,5) ve kalça eklemi (%20,9) idi. Çalışmamızda, ayak-ayak bileği MKİH olan olgularda özel ayakkabı/bot giyme sıklığı istatistiksel olarak anlamlı derecede yüksekti ($p<0,001$). **Sonuç:** MKİH, hem alt hem de üst ekstremitelerde görülür. Çalışma ortamı için tasarlanmış özel ayakkabılar ve botlar, ayak-ayak bileklerindeki MKİH'yi azaltmaya yardımcı olacak özellikler içermelidir.

Anahtar Kelimeler: Meslek hastalıkları; kas iskelet hastalıkları; alt ekstremite; tekrarlanan zorlama yaralanması; mesleki risk

Work-related musculoskeletal disorders (WMSDs) occur when muscle, tendon, skeleton, cartilage and nerve structures are affected due to work. The prevalence of WMSDs differs because there are no common definitions or diagnostic criteria worldwide, due to the wide range of working conditions.[1,2]

The term WMSD has been used in recent years for previously called repetitive strain injuries or cumulative trauma disorders. These disorders affect the

Correspondence: Emine DÜNDAR AHİ
Clinic of Physical Medicine and Rehabilitation, Medar Hospital, Kocaeli, TURKEY/TÜRKİYE
E-mail: eminedundarahi@gmail.com

Peer review under responsibility of Journal of Physical Medicine and Rehabilitation Science.

Received: 10 Oct 2020 ***Received in revised form:*** 09 Mar 2021 ***Accepted:*** 23 Mar 2021 ***Available online:*** 16 Aug 2021

back, upper and lower limbs and neck. If an early diagnosis is not made and appropriate treatment is not started, the treatment process can take longer and be costly. WMSDs generally result from a combination of physical factors including repetition, force, and awkward postures, as well as workplace environmental or organisational factors including excessive work pace or duration and inadequate breaks, in addition to a variety of psychosocial workplace characteristics and personal factors such as smoking and high body mass index (BMI).[3-7]

WMSDs cause a significant economic burden and loss of labour in Europe and America.[8,9]

Musculoskeletal disorders accounted for 21-28% of work absenteeism days in 2017/2018 in the Netherlands, Germany and the UK, and many multicentre, national and international studies have been reported.[10] However, most of these studies were related to low back, neck and upper limb problems and most were done on office workers, whereas workers in heavy industries such as air transportation, mining, food processing, leather tanning and heavy and light manufacturing (vehicles, furniture, appliances, electrical and electronic products, textiles, apparel and shoes) have a 3-4 times higher risk of developing WMSDs.[2,11-14]

In the literature, most studies have only examined WMSDs of the lower back, neck and upper extremities; there are few reports about the prevalence and risk factors of lower extremity WMSDs. Because lower extremity WMSDs are not well-recognised, there are significant problems with defining disorders, the degree of disability and paying compensation.[15,16]

Rotator cuff syndrome, lateral epicondylitis, and carpal tunnel syndrome are well-recognised upper limb WMSDs, whereas lower extremity WMSDs are generally limited to osteoarthritis. In addition, most studies have been performed using self-reported scales, without examination and diagnosis by a physician.[17-20]

The combined results of all lower limb WMSD studies performed in recent years demonstrate a deficiency in the literature regarding the prevalence and risk factors in the development of WMSD of the lower limbs.[6,15,21-23] Therefore, we conducted a retrospective study of the prevalence and possible risk factors in the occurrence of lower extremity WMSDs.

MATERIAL AND METHODS

The study was approved by the Ethics Committee of Kocaeli Derince Training and Research Hospital with number of 2020-24 and has been prepared in accordance with the Declaration of Helsinki principles. Of 1,268 heavy industry workers who attended the physical medicine and rehabilitation (PMR) outpatient clinic between January 2018 and December 2020, and were diagnosed with WMSDs using physical examination, X-ray, magnetic resonance imaging, ultrasonography and electromyoneurography, 110 were diagnosed with a lower limb WMSD and were included in the study. These workers worked in the automotive industry, heavy metal industry, and a rubber tyre factory. Workers whose complaints had been ongoing for at least 6 months were included in the study.

By reviewing the literature and asking about the movement patterns of workers included in the study by calling on the phone, a list was created to determine possible risk factors, consisting of items such as kneeling, stepping up and down, using pedals, standing or walking all day, working by pushing with the knees, sitting constantly, wearing special shoes/boots and lifting weights. Lower extremity WMSD diagnoses included, for hip diseases: osteoarthritis, trochanteric bursitis, hamstring or gluteal muscular strain and joint swelling. Knee diseases included: ligament sprain, meniscopathy, osteoarthritis, patellar chondromalacia, effusion, bursitis (pes anserine, prepatellar, suprapatellar), and tendinitis (patellar). Disorders of the feet-ankles included; ligament sprain, effusion, tendinitis (achilles, peroneal), calcaneal spur and plantar fasciitis.

After the patients' files had been reviewed, their demographic data were recorded; how many years they had been working at the factory, repetitive movements that created risk factors at work, and alcohol, cigarette, and exercise habits.

Patients with chronic diseases such as diabetes mellitus, polyneuropathy, fibromyalgia, and other rheumatological diseases, with a complaint period of

<6 months and working in the factory for <2 years, were not included in the study.

STATISTICAL ANALYSIS

Data analysis was performed with the IBM SPSS Statistics 17.0 (IBM Corporation, Armonk, NY, USA) package program. The question of whether the distribution of continuous numerical variables was distributed close to normal was examined using the Kolmogorov-Smirnov test. Whether the assumption of homogeneity of variances was met was investigated by Levene's test. Descriptive statistics are expressed as mean±standard deviation or median (minimum-maximum) for continuous numerical variables, and categorical variables are shown as the number of cases and (%). As a result of the goodness of fit test, the significance of the differences between the groups in terms of continuous numerical variables in which parametric test statistical assumptions were provided was examined with the Student's t-test, and the significance of differences in terms of continuous numerical variables in which parametric test statistic assumptions were not provided was evaluated with the Mann-Whitney U test. Categorical variables were analysed by Pearson's chi-squared or Fisher's exact tests of probability. The effects of all possible factors thought to be determinant in predicting WMSD development were investigated by multivariate logistic regression analysis. As a result of univariate statistical analysis, all variables determined as $p<0.25$ were included in regression models as candidate factors. In addition, odds ratio, 95% confidence interval and Wald statistics were calculated for each variable. $p<0.05$ was considered statistically significant.

RESULTS

The frequency of lower limb WMSDs among all patients diagnosed with a WMSD in the PMR outpatient clinic was 8.67% during the past 2 years.

Descriptive statistics regarding the demographic and clinical characteristics of the 110 patients are shown in Table 1.

Frequency distributions of the lower extremity WMSDs are shown in Table 2.

TABLE 1: Demographic and clinical features of patients.

	n=110
Age (years)	33.8±7.2
Age range (years)	20-49
Sex	
Male	102 (92.7%)
Female	8 (7.3%)
Education status	
Primary education	18 (16.4%)
High school	70 (63.6%)
College	22 (20.0%)
Marital status	
Single	24 (21.8%)
Married	81 (73.7%)
Divorced	5 (4.5%)
Number of children	1 (0-3)
BMI (kg/m^2)	26.4±3.8
Working time (years)	8 (2-22)
Complaint duration (months)	24 (3-60)
Smoking history	66 (60.0%)
Alcohol history	19 (17.3%)
Regular exercise	17 (15.5%)
Risk factors	
Kneeling	45 (40.9%)
Stepping up and down	58 (52.7%)
Standing	70 (63.6%)
Working by pushing knees	8 (7.3%)
Permanent sitting	11 (10.0%)
Using a pedal	16 (14.5%)
Wearing special shoes/boots	24 (21.8%)
Weight lifting	58 (52.7%)

BMI: Body mass index.

In Table 3, the comparisons of demographic and clinical characteristics of the cases according to the groups with and without WMSD in the hip are presented. There were no statistically significant differences between the cases with WMSDs in the hip and the cases without, in terms of mean age, sex, education status, BMI, duration of work, duration of complaint, smoking history, alcohol history, regular exercise and frequency of risk factors ($p>0.05$).

In Table 4, comparisons of demographic and clinical characteristics according to the groups with and without WMSD in the knee are presented.

Among the cases with and without WMSDs in the knee, there were no statistically significant differences, respectively, in terms of sex, education

TABLE 2: Frequency distributions of work-related musculoskeletal disorder diagnoses in the lower extremity.

	Number of cases	Percentage
Hip		
No disease	87	79.1
WMSD	23	20.9
Trochanteric bursitis	8	7.3
Osteoarthritis	7	6.4
Muscular (hamstring, gluteal) strain	5	4.5
Joint swelling	5	4.5
Knee		
No disease	18	16.4
WMSD	92	83.6
Ligament sprain	78	70.9
Meniscopathy	72	65.5
Osteoarthritis	9	8.2
Chondromalacia patella	9	8.2
Bursitis	7	6.4
Effusion	7	6.4
Tendinitis	6	5.5
Iliotibial band syndrome	4	3.6
Feet-ankles		
No disease	83	75.5
WMSD	27	24.5
Ligament sprain	11	10.0
Tendinitis	11	10.0
Effusion	7	6.4
Plantar fasciitis	6	5.5
Calcaneal spur	3	2.7
Total	110	100.0

WMSD: Work-related musculoskeletal disorder.

level, BMI, working time, smoking or alcohol history, regular exercise, working with knees, sitting continuously, using pedals and lifting weights (p>0.05). The average age of the WMSD cases was higher and median complaint times were longer compared to cases without WMSD in the knee (p=0.046 vs. p=0.005).

Risk factors such as kneeling and stepping up and down were more common in WMSD cases compared to those without WMSDs in the knee (p<0.001 vs. p=0.005), while risk factors such as standing and wearing special shoes and boots were rarely seen (p=0.003 vs. p<0.001).

Table 5 shows comparisons of demographic and clinical features of the cases according to the groups with and without feet-ankles WMSDs. There were no statistically significant differences in age, sex, education status, BMI, duration of work, duration of complaint, smoking or alcohol history, regular exercise, stepping up and down, standing, working with knees, sitting and using pedals (p>0.05). However, the frequency of wearing special shoes/boots was statistically significantly higher in WMSD cases compared to cases without WMSDs in the feet-ankles (p<0.001), and the incidence of risk factors such as kneeling and lifting weights was statistically lower (p=0.023 vs. p<0.001).

Table 6 shows the effects of all possible factors thought to be determinative in distinguishing cases with and without WMSD, evaluated with multivariate logistic regression analysis.

All variables with p<0.25 as a result of univariate statistical analysis were included in multivariate logistic regression models as possible

TABLE 3: Demographic and clinical features of patients according to the groups with and without work-related musculoskeletal disorders in the hip.

	No disease (n=87)	WMSD (n=23)	p value
Age (years)	33.6±6.8	34.6±8.7	0.634†
Sex			0.200‡
Male	79 (90.8%)	23 (100.0%)	
Female	8 (9.2%)	0 (0.0%)	
Education status			0.674¶
Primary education	14 (16.1%)	4 (17.4%)	
High school	57 (65.5%)	13 (56.5%)	
College	16 (18.4%)	6 (26.1%)	
BMI (kg/m²)	26.3±3.6	27.0±4.7	0.485†
Working time (years)	8 (2-22)	8 (2-21)	0.331§
Complaint duration (months)	24 (3-60)	18 (6-60)	0.938§
Smoking history	50 (57.5%)	16 (69.6%)	0.292¶
Alcohol history	16 (18.4%)	3 (13.0%)	0.759‡
Regular exercise	14 (16.1%)	3 (13.0%)	>0.999‡
Risk factors			
Kneeling	37 (42.5%)	8 (34.8%)	0.502¶
Stepping up and down	47 (54.0%)	11 (47.8%)	0.597¶
Standing	56 (64.4%)	14 (60.9%)	0.756¶
Working by pushing knees	6 (6.9%)	2 (8.7%)	0.672‡
Permanent sitting	7 (8.0%)	4 (17.4%)	0.237‡
Using a pedal	12 (13.8%)	4 (17.4%)	0.740‡
Wearing special shoes/boots	19 (21.8%)	5 (21.7%)	0.992¶
Weight lifting	42 (48.3%)	16 (69.6%)	0.069¶

WMSD: Work-related musculoskeletal disorders; BMI: Body mass index; †Student's t-test; ‡Fisher's exact probability test; ¶Pearson's chi-squared test; §Mann-Whitney U test.

TABLE 4: Demographic and clinical characteristics of patients according to the groups with and without work-related musculoskeletal disorders in the knee.

	No disease (n=18)	WMSD (n=92)	p value
Age (years)	30.7±6.6	34.4±7.2	0.046†
Sex			0.349‡
Male	18 (100.0%)	84 (91.3%)	
Female	0 (0.0%)	8 (8.7%)	
Education status			0.389¶
Primary education	2 (11.1%)	16 (17.4%)	
High school	14 (77.8%)	56 (60.9%)	
College	2 (11.1%)	20 (21.7%)	
BMI (kg/m^2)	26.2±2.9	26.5±4.0	0.708†
Working time (years)	6 (2-18)	8 (2-22)	0.118§
Complaint duration (months)	12 (6-36)	24 (3-60)	0.005§
Smoking history	12 (66.7%)	54 (58.7%)	0.528¶
Alcohol history	3 (16.7%)	16 (17.4%)	>0.999‡
Regular exercise	3 (16.7%)	14 (15.2%)	>0.999‡
Risk factors			
Kneeling	0 (0.0%)	45 (48.9%)	<0.001¶
Stepping up and down	4 (22.2%)	54 (58.7%)	0.005¶
Standing	17 (94.4%)	53 (57.6%)	0.003¶
Working by pushing knees	0 (0.0%)	8 (8.7%)	0.349‡
Permanent sitting	0 (0.0%)	11 (12.0%)	0.206‡
Using a pedal	1 (5.6%)	15 (16.3%)	0.463‡
Wearing special shoes/boots	12 (66.7%)	12 (13.0%)	<0.001‡
Weight lifting	8 (44.4%)	50 (54.3%)	0.442¶

WMSD: Work-related musculoskeletal disorders; BMI: Body mass index; †Student's t-test; ‡Fisher's exact probability test; ¶Pearson's chi-squared test; §Mann-Whitney U test.

factors. As a result of the univariate statistical analysis, factors thought to differentiate patients with hip WMSDs, such as permanent sitting and lifting weights, were examined. Although the sex variable was also a candidate factor, it was excluded from the model since there were no cases of a woman with a WMSD of the hip. The probability of a hip WMSD was 4,825 times more likely (95% CI=1.303-17.864) in those who lifted weights at work (p=0.018). In addition, as a result of permanent sitting, the probability of a hip WMSD was statistically increased [OR=7.238, 95% CI=1.322-39.629 vs. p=0.023].

As a result of the univariate statistical analysis, factors thought to differentiate patients with knee WMSDs, such as age, duration of complaint, stepping up and down, standing, and wearing special shoes/boots, were examined. Since there are multiple connections between complaint time and working time, the working time is excluded from the model. In addition, these variables were excluded from the model as WMSD was observed in all of the knees of those whose jobs involved kneeling. There was a statistically significant and inverse relationship between wearing special shoes/boots [OR=0.025, 95% CI=0.003-0.180, p<0.001] and standing [OR=0.022, 95% CI=0.001-0.592, p=0.023] and the probability of a WMSD in the knee. When a correction was made according to other factors, the probability of WMSD in the knee continued to increase statistically with the prolongation of the complaint period [OR=1.092, 95% CI=1.002-1.189, p=0.044].

As a result of the univariate statistical analysis, factors thought to be effective in differentiating patients with WMSDs in feet-ankles, such as alcohol history, kneeling, standing, special shoes/boots and

TABLE 5: Demographic and clinical characteristics of patients according to the groups with and without work-related musculoskeletal disorders in the feet-ankles.

	No disease (n=83)	WMSD (n=27)	p value
Age (years)	34.2±7.6	32.7±6.0	0.286†
Sex			>0.999‡
Male	77 (92.8%)	25 (92.6%)	
Female	6 (7.2%)	2 (7.4%)	
Education status			0.674¶
Primary education	14 (16.9%)	4 (14.8%)	
High school	54 (65.1%)	16 (59.3%)	
College	15 (18.1%)	7 (25.9%)	
BMI (kg/m^2)	26.6±3.9	26.0±3.5	0.532†
Working time (years)	8 (2-22)	8 (2-18)	0.691§
Complaint duration (months)	24 (3-60)	18 (6-60)	0.408§
Smoking history	51 (61.4%)	15 (55.6%)	0.587¶
Alcohol history	12 (14.5%)	7 (25.9%)	0.239‡
Regular exercise	13 (15.7%)	4 (14.8%)	>0.999‡
Risk factors			
Kneeling	39 (47.0%)	6 (22.2%)	0.023¶
Stepping up and down	46 (55.4%)	12 (44.4%)	0.321¶
Standing	50 (60.2%)	20 (74.1%)	0.194¶
Working by pushing knees	7 (8.4%)	1 (3.7%)	0.677‡
Permanent sitting	10 (12.0%)	1 (3.7%)	0.288‡
Using the pedal	14 (16.9%)	2 (7.4%)	0.348‡
Wearing special shoes/boots	3 (3.6%)	21 (77.8%)	<0.001¶
Weight lifting	54 (65.1%)	4 (14.8%)	<0.00¹¶

WMSD: Work-related musculoskeletal disorders; BMI: Body mass index; †Student's t-test; ‡Fisher's exact probability test; ¶Pearson's chi-squared test; §Mann-Whitney U test.

TABLE 6: Investigation of the combined effects of all possible factors thought to be determinant in predicting work-related musculoskeletal disorder development with multivariate logistic regression analysis.

	OR	95% CI	Wald	p value
Hip				
Permanent sitting	7.238	1.322-39.629	5.206	0.023
Weight lifting	4.825	1.303-17.864	5.555	0.018
Knee				
Age	1.123	0.959-1.314	2.082	0.149
Complaint duration (months)	1.092	1.002-1.189	4.039	0.044
Stepping up and down	1.737	0.321-9.394	0.411	0.522
Standing	0.022	0.001-0.592	5.168	0.023
Wearing special shoes/boots	0.025	0.003-0.180	13.333	<0.001
Feet-ankles				
Alcohol history	1.907	0.216-16.827	0.338	0.561
Kneeling	0.192	0.028-1.299	2.862	0.091
Standing	4.420	0.727-26.877	2.604	0.107
Wearing special shoes/boots	109.494	14.406-832.196	20.592	<0.001
Weight lifting	0.115	0.019-0.712	5.408	0.020

OR: Odds ratio; CI: Confidence interval.

lifting weights, were examined. Regardless of the other factors, it was observed that wearing special shoes or boots triggered the probability of a WMSD in the feet-ankles [OR=109.494, 95% CI=14.406-832.196, p<0.001]. However, a statistically significant and reverse correlation was found between weight lifting history and WMSDs in the feet-ankles [OR=0.115, 95% CI=0.019-0.712, p=0.020].

DISCUSSION

The main aim of this study was to determine the frequency and risk factors for developing lower extremity WMSDs, given the previous emphasis on osteoarthritis.

In our study, which included 110 patients, lower extremity WMSD was most common in the knee (83.6% of patients), followed by the feet-ankles (24.5%), and the hip joint (20.9%). In a meta-analysis involving 27 papers in Iran in 2017, the knee had the highest prevalence of lower extremity WMSDs with 42.1%. However, the lower extremity diagnoses were not mentioned, and the patients were not examined by a physician; the painful area was studied using a self-reported survey.[22]

In our study, ligament sprain and meniscopathy were most common in the knee, followed by osteoarthritis and patellar chondromalacia. This is because the average age of factory workers was younger than the age of onset of osteoarthritis (33.8±7.2), and automotive workers kneel while working in the vehicle and constantly step up and down as they enter and exit the vehicle.

The mean age of patients with WMSDs in the knee was higher and the median duration of complaints was longer than in other patients (p=0.046 vs. p=0.005). The reason for this is the biological age-related changes in the joint structures that occur as a result of cumulative exposure to various risk factors.[23] In our study, the most important risk factors in patients with knee WMSDs were kneeling and stepping up and down (p<0.001 vs. p=0.005). In previous lower extremity WMSD studies, in addition to these two risk factors, weight lifting, the squatting position, continuous driving and walking were emphasised.[21,23]

In our study, the frequency of wearing special shoes/boots was statistically significantly higher in cases with WMSDs in the feet-ankles (p<0.001). This

may be due to the fact that, although special boots are given in accordance with the workers' shoe sizes, they are made with a hard material to protect the toes against any work accident and are heavy.

In our study, the probability of a hip WMSD was 4,825 times (95% CI=1.303-17.864) more likely in workers who lift weights (p=0.018). Similarly, a study involving 114 people in 2000 revealed that regular occupational weight lifting increased the likelihood of hip osteoarthritis.[18] Lau et al. reported the most important associations for hip and knee osteoarthritis were previous trauma, obesity, work-related stepping up and down, and weight lifting.[17] In our study, no relationship was found between BMI and lower extremity WMSDs. The reason for this may be that automotive factory workers, who constituted the vast majority of our study participants, were relatively short in height and low in weight, to facilitate assembly of the vehicle by moving in and out of the vehicle easily.

In addition, the probability of a WMSD occurring in the hip was statistically increased as a result of constant sitting [OR=7.238, 95% CI=1.322-39.629 vs. p=0.023]. The reason for this may be that constantly seated workers tended to be machine operators sitting in the same position with an inappropiate posture while they work; furthermore, they tended to always use the same-side muscles.

CONCLUSION

WMSDs occur in both the lower and upper extremities. In the lower limbs, there may be diseases other than osteoarthritis and special protective working shoes and boots should be made more appropriately to reduce WMSDs of the feet-ankles. The causes for the onset of all WMSDs include inappropriate posture, frequent repetitive movements and overexertion; an occupational health and safety culture should be adopted in these areas of the working environment.

A limitation of our study is that only patients who were admitted to our PMR outpatient clinic and were diagnosed with lower extremity WMSDs were included in the study. Longer follow-up studies are needed, in which all heavy industry workers are examined for musculoskeletal health.

REFERENCES

1. Hoe VC, Urquhart DM, Kelsall HL, et al. Ergonomic design and training for preventing work-related musculoskeletal disorders of the upper limb and neck in adults. Cochrane Database Syst Rev. 2012;15;2012:CD008570. Update in: Cochrane Database Syst Rev. 2018; 23;10:CD008570. [PubMed] [PMC]
2. Punnett L, Wegman DH. Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. J Electromyogr Kinesiol. 2004;14:13-23. [Crossref] [PubMed]
3. Yassi A. Repetitive strain injuries. Lancet. 1997;29;349:943-7. [Crossref] [PubMed]
4. Bao SS, Kapellusch JM, Merryweather AS, et al. Relationships between job organisational factors, biomechanical and psychosocial exposures. Ergonomics. 2016;59:179-94. [Crossref] [PubMed]
5. Thiese MS, Hegmann KT, Kapellusch J, et al. Associations between distal upper extremity job physical factors and psychosocial measures in a pooled study. Biomed Res Int. 2015:643192. [Crossref]
6. da Costa BR, Vieira ER. Risk factors for work-related musculoskeletal disorders: a systematic review of recent longitudinal studies. Am J Ind Med. 2010;53:285-323. [Crossref] [PubMed]
7. Bernard BP. Musculoskeletal Disorders and Workplace Factors. A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back. National Institute for Occupational Safety and Health, Cincinnati, OH: US Department of Health and Human Services; 1997. p.97-141. Epidemiologic studies evaluating work-related neck/shoulder disorders [Link]
8. Bevan S. Economic impact of musculoskeletal disorders (MSDs) on work in Europe. Best Pract Res Clin Rheumatol. 2015;29:356-73. [Crossref] [PubMed]
9. Occupational injuries and illnesses, 2010. Bureau of Labor Statistics. Available from: Oct.20.2011. [Link]
10. Luger T, Maher CG, Rieger MA, et al. Work-break schedules for preventing musculoskeletal symptoms and disorders in healthy workers. Cochrane Database Syst Rev. 2019;7: CD012886. [Crossref] [PubMed] [PMC]
11. Hoe VC, Urquhart DM, Kelsall HL, et al. Ergonomic interventions for preventing work-related musculoskeletal disorders of the upper limb and neck among office workers. Cochrane Database Syst Rev. 2018;3;10: CD008570. [PubMed] [PMC]
12. Buckle P, Devereux J. Work-related neck and upper limb musculoskeletal disorders. Bilbao: European Agency for Safety and Health at Work; 1999. [Link]
13. Monaco MGL, Uccello R, Muoio M, et al. Work-related upper limb disorders and risk assessment among automobile manufacturing workers: a retrospective cohort analysis. Work. 2019;64:755-61. [Crossref] [PubMed]
14. Schneider E, Irastorza X. OSH in Figures: Work-related Musculoskeletal Disorders in the EU - Facts and Figures. European Agency for Safety and Health at Work. Luxembourg: Publications Office of the European Union; 2010. [Link]

15. D'Souza JC, Franzblau A, Werner RA. Review of epidemiologic studies on occupational factors and lower extremity musculoskeletal and vascular disorders and symptoms. J Occup Rehabil. 2005;15:129-65. [Crossref] [PubMed]
16. Özcan E, Kesiktaş N. Mesleki kas iskelet hastalıklarından korunma ve ergonomi. İş Sağlığı ve Güvenliği Dergisi. 2007;34:6-9. [Link]
17. Lau EC, Cooper C, Lam D, et al. Factors associated with osteoarthritis of the hip and knee in Hong Kong Chinese: obesity, joint injury, and occupational activities. Am J Epidemiol. 20001;152:855-62. [Crossref] [PubMed]
18. Yoshimura N, Sasaki S, Iwasaki K, et al. Occupational lifting is associated with hip osteoarthritis: a Japanese case-control study. J Rheumatol. 2000;27:434-40. [PubMed]
19. Coggon D, Croft P, Kellingray S, et al. Occupational physical activities and osteoarthritis of the knee. Arthritis Rheum. 2000;43:1443-9. [Crossref] [PubMed]
20. Miranda H, Viikari-Juntura E, Martikainen R, et al. A prospective study on knee pain and its risk factors. Osteoarthritis Cartilage. 2002; 10:623-30. [Crossref] [PubMed]
21. Okunribido OO, Lewis D. Work-related lower limb musculoskeletal disorders - a review of the literature. Annual Conference of the Ergonomics Society. Contemporary Ergonomics and Human Factors; 2010. [Link]
22. Parno A, Sayehmiri K, Parno M, et al. The prevalence of occupational musculoskeletal disorders in Iran: a meta-analysis study. Work. 2017;58:203-14. [Crossref] [PubMed]
23. Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. Lancet. 2019;27;393:1745-59. [Crossref] [PubMed]