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Research article

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A cross-sectional study determining the prevalence of musculoskeletal diseases in automotive factory workers

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Ethics committee approval was obtained from Health Sciences University Kocaeli Derince Training and Research Hospital (2019-110). All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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Abstract

Background/Aim: Work-related musculoskeletal disorders (WMSDs) develop due to exposure to physical and psycho-social factors in the work environment. The diagnostic criteria and prevalence of WMSDs are not well established. In this study, we aimed to determine which WMSDs occur in automotive industry workers and what the underlying risk factors may be.
Methods: A cross-sectional study was designed that included 200 automotive industry workers who were diagnosed with a WMSD by physical and radiological examination in the physical therapy and rehabilitation outpatient clinic in the past year. We recorded demographic data, risk factors and WMSD diagnosis names for the patients.
Results: In our study, the most common diagnosis was low back disorder (66.5%), followed by neck and shoulder (58%) and upper extremity (23%) disorders. There was a statistically significant increase in the occurrences of shoulder-neck diseases, upper extremity, and low back-lower extremity diseases in workers with inappropriate posture ($P < 0.001$). Workers who exerted heavy effort or performed repetitive motions were statistically more likely to experience upper extremity disorders ($P < 0.001$) as well as low back-lower extremity disorders ($P = 0.020$ and $P < 0.001$, respectively); there was no statistically significant change in the incidence of shoulder and neck diseases with heavy effort ($P = 0.538$).
Conclusion: WMSD is a serious health and economic problem. In our study, we found that low back and lower extremities and neck and shoulder problems are the most common types of WMSDs in individuals working in the automotive sector. Not using proper posture while working causes health problems in the shoulders, neck, upper extremities and low back and lower extremities. Employees in this sector should be encouraged to use good work ergonomics.

Keywords: Occupational musculoskeletal diseases, Work-related musculoskeletal diseases, Repetitive strain injury, Pain, Back pain, Knee pain

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Introduction

Work-related musculoskeletal disorders (WMSDs) are associated with exposure to physical and psycho-social risks during work activities and can develop from pain, movement restrictions and injuries. WMSDs usually don't have a single cause; rather, various factors play a role. Among physical causes and organizational risk factors, bending, movements requiring repetitive force, awkward (wrong) and static postures, vibrations, poor lighting, cold working environments, fast-paced work, prolonged sitting or standing in the same position, and carrying loads are especially problematic [1, 2]. These diseases often affect the low back, lower extremities and especially the upper extremities and neck [3]. In recent years, these disorders have garnered the attention of employees, employers, governments, health care systems and insurance companies in industrialized countries due to their increased frequency and associated cost. An increasing number of studies on WMSDs have focused on ergonomic programs and rehabilitation approaches, including risk factors, ergonomic training and ergonomic initiatives. These studies frequently conclude that there are great uncertainties about the diagnosis, follow-up and rehabilitation of WMSDs [3-5]. One of the most striking issues when we take a look at the research performed so far is that the majority of the studies performed by non-physicians group WMSDs by painful body parts [6, 7]. Another important issue is that most of the studies done by physicians include only disorders of the neck and upper extremities [8-10] and not the low back and lower extremities because they focused on office workers. However, WMSDs need to be considered in a wide range of workers, especially heavy industrial workers, who are more likely to develop WMSDs [11].

Since our hospital is in a busy industrial area with many factories and most of our patients are heavy industry workers, especially automotive industry workers, in our study, we aimed to determine which regions of the body are most commonly affected in these types of workers diagnosed with WMSD and what are the associated risk factors.

Materials and methods

Ethics committee approval was obtained from Health Sciences University Kocaeli Derince Training and Research Hospital (2019-110) before the study was initiated. A total of 200 automotive factory workers who came to the physical medicine and rehabilitation outpatient clinic in the past year and were diagnosed with WMSD based on physical and radiological examinations such as x-ray, magnetic resonance imaging, ultrasonography, electrodiagnostic method (electromyography) were included in the study. The workers worked in four main areas: assembly line, paint shop, welding shop and press shop. Considering the work done by the workers, the risk factors were divided into the following areas: inappropriate posture, heavy effort, static posture, repetitive movements and vibration. A form was created that included these main titles with additional risk factors from other studies in the automotive sector.

We included those workers who had complained of pain for at least 6 months. In addition to their demographic data, the patients were called by phone to determine how many years they had been working at the factory, their department, alcohol-cigarette habits, exercise habits and the treatment methods (physical therapy, exercise program, injection, medical therapy). This information was recorded in the same form.

We grouped WMSDs as neck-shoulder, upper extremity (elbow, hand-wrist) or low back-lower extremity (hip-knee-foot-ankle). Patients with chronic disease (such as diabetes mellitus, polyneuropathy, fibromyalgia, other rheumatological diseases, etc.), with a complaint period of less than 6 months or who worked in the factory for less than 2 years were not included in the study.

Statistical analysis

The IBM SPSS Statistics 17.0 software package (IB Corporation, Armonk, NY, USA) was used for the statistical analysis. Descriptive statistics were reported. Categorical variables were expressed as the number of cases and (%), while averages were expressed as the mean (standard deviation) or median (minimum - maximum) for numerical variables.

To determine whether there is a statistically significant correlation between working time and complaint time, Spearman's rank numbers were investigated with the correlation test. If the expected frequency is below 5 in at least 1/4 of the cells in the 2x2 cross tables, the categorical data is evaluated by Fisher's exact probability test; when the expected frequency is between 5 and 25, the continuity correction chi-square test is used; otherwise it is evaluated by Pearson's chi-square test. If RxC (if at least one of the categorical variables in the row or column has more than two results), the expected frequency is below 5 in at least ¼ of the cells in the cross tables, the categorical data in question are analyzed with the likelihood ratio test; otherwise it's evaluated by the square test. Results for $P < 0.05$ were considered statistically significant.

Results

The descriptive statistics regarding the demographic and clinical characteristics of the participants are given in Table 1.

Table 1: Demographic and clinical features of the cases

	n = 200
Age(year) (mean [SD])	31.1 (6.8)
Age range (years)	20-51
Gender (n [%])	
Female	35 (17.5%)
Male	165 (82.5%)
Education status (n [%])	
Primary education	25 (12.5%)
High school	139 (69.5%)
College	36 (18.0%)
Marital status (n [%])	
Married	127 (63.5%)
Single	67 (33.5%)
Divorced	6 (3.0%)
Number of children (n [range])	1 (0-3)
Body mass index (kg / m2) (mean [SD])	25.5 (3.75)
Working time (years) (n [range])	5 (1-25)
Complaint duration (months) (n [range])	12 (2-120)
Smoking history (n [%])	112 (56.0%)
Alcohol history (n [%])	22 (11.0%)
Exercising (n [%])	21 (10.5%)
Drug use (n [%])	160 (80.0%)
Use of orthoses (n [%])	39 (19.5%)
Physical Therapy (n [%])	156 (78.0%)
Injection (n [%])	29 (14.5%)

Table 2 shows the frequency of cases with respect to work area, inappropriate posture, heavy effort, static posture, and repetitive movements. It is noteworthy that 65% of the patients were assembly line workers. The most common inappropriate posture was binding-rising. Weight pulling and pushing was more common than lifting heavy weights. Among the static postures, standing all day was the most common posture.

Table 3 shows the frequency distributions of the cases in terms of the incidence of the different types of occupational musculoskeletal diseases (shoulder and neck, upper extremity, and low back/lower extremities).

Table 2: Frequency distribution of the cases with respect to work area, inappropriate posture, heavy effort, static posture, and repetitive movements

	n (%)
Working area	
Assembly line	130 (65.0)
Welding shop	38 (19.0)
Paint shop	29 (14.5)
Press shop	3 (1.5)
Inappropriate posture	
No	1 (0.5)
Working by bending the neck	35 (17.5)
Nonergonomic hand tool use	18 (9.0)
Bending rising	66 (33.0)
Arms up	21 (10.5)
Combined motions	59 (29.5)
Heavy effort	
No	64 (32.0)
0-5 kg transport	52 (26.0)
5-10 kg transport	10 (5.0)
10-25 kg transport	5 (2.5)
>20 kg transport	7 (3.5)
Weight push pull	62 (31.0)
Static posture	
No	2 (1.0)
Standing all day long	165 (82.5)
Sitting down all day long	21 (10.5)
Kneeling	12 (6.0)
Repetitive motion	
No	14 (7.0)
Working on the assembly line	91 (45.5)
Getting in and out of the vehicle	15 (7.5)
Vehicle wiping and sanding	13 (6.5)
Using a gun	11 (5.5)
Percussion or suppression work	7 (3.5)
Manual material handling	27 (13.5)
Frequently twisting-rotating	17 (8.5)
Step up and down	5 (2.5)

Table 3: Frequency distributions of the cases in terms of incidence of occupational musculoskeletal diseases

	n (%)
Shoulder and neck	
No	84 (42.0)
There is	116 (58.0)
CDH	61 (30.5)
Forward head posture	30 (15.0)
RCT/IMP	8 (4.0)
Biceps tendonitis	3 (1.5)
RCT/IMP + CDH	14 (7.0)
Upper limb	
No	154 (77.0)
There is	46 (23.0)
LE	15 (7.5)
DQT	15 (7.5)
CTS	4 (2.0)
Trigger Finger	4 (2.0)
Cubital Tunnel Syndrome	2 (1.0)
LE+CTS	4 (2.0)
LE+DQT	1 (0.5)
CTS, DQT	1 (0.5)
Low back and lower extremities	
No	67 (33.5)
There is	133 (66.5)
LDH	63 (31.5)
Lomber strain	31 (15.5)
Knee disorders	11 (5.5)
LDH + knee disorders	10 (5.0)
Thoracal Disc Hernia	5 (2.5)
LDH + Thoracal Disc Hernia	4 (2.0)
Ankle disorders	3 (1.5)
Lomber strain + knee disorders	3 (1.5)
Lomber strain + hip disorders	1 (0.5)
LDH + ankle disorders	1 (0.5)
LDH + knee + ankle disorders	1 (0.5)

CDH: Cervical Disc Hernia, RCT: Rotator Cuff Tendonitis, IMP: Impingement syndrome DQT: De Quervain Tenosinovitis, CTS: Carpal Tunnel Syndrome, LE: Lateral Epicondylitis LDH: Lumber Disc Hernia

Table 4 shows the comparisons made with regards to the frequency of musculoskeletal diseases in terms of inappropriate postures. There were statistically significant increases in the incidence of shoulder-neck, upper extremity, and low back and lower extremity diseases in response to inappropriate postures (P < 0.001). Shoulder and neck diseases were more common in the neck bending, arms up and combined motion groups (P < 0.001). Compared to all other inappropriate posture groups, upper extremity diseases were seen at a higher rate in the group using non-ergonomic hand tools (P < 0.001). Low back and lower extremity diseases were seen at a higher rate in the bent-up group compared to all other inappropriate posture groups (P < 0.001). In Figure 1, the incidence of musculoskeletal diseases in terms of inappropriate posture is shown in the bar graph.

Table 4: Comparisons of the frequency of musculoskeletal diseases in terms of inappropriate posture

	No disorder n (%)	There is disorder n (%)	P-value†
Shoulder neck			<0.001
Working by bending the neck	2 (5.7)	33 (94.3)	
Nonergenomic hand tool use	15 (83.3)[a]	3 (16.7)[a]	
Bending-rising	49 (74.2)[a]	17 (25.8)[a]	
Arms up	4 (19.0)[b,c]	17 (81.0)[b,c]	
Combined motion	14 (23.7)[b,c]	45 (76.3)[b,c]	
Upper extremity			<0.001
Working by bending the neck	32 (91.4)	3 (8.6)	
Nonergonomic hand tool use	2 (11.1)[a]	16 (88.9)[a]	
Bending-rising	64 (97.0)[b]	2 (3.0)[b]	
Arms up	15 (71.4)[b,c]	6 (28.6)[b,c]	
Combined motion	40 (67.8)[a,b,c]	19 (32.2)[a,b,c]	
Low back and lower extremities			<0.001
Working by bending the neck	19 (54.3)	16 (45.7)	
Nonergonomic hand tool use	15 (83.3)	3 (16.7)	
Bending-rising	0 (0.0)[a,b]	66 (100.0)[a,b]	
Arms up	12 (57.1)[c]	9 (42.9)[c]	
Combined motion	20 (33.9)[b,c]	39 (66.1)[b,c]	

† Pearson's Chi-Square test; the differences between which groups are indicated with letters; a: The difference between the groups with the posture that bends the neck is statistically significant (P < 0.05), b: The difference between the groups using the nonergenomic hand tool is statistically significant (P < 0.001), c: The difference between the bending and rising posture group was statistically significant (P < 0.01).

Table 5 shows the comparisons made with regards to the frequency of the occurrence of musculoskeletal diseases in terms of heavy effort. While there was no statistically significant increase in the incidence of shoulder and neck diseases in response to heavy effort (P = 0.538), a statistically significant increase was found in the incidence of upper extremity diseases (P < 0.001). This effect was due to the group carrying 0-5 kg rather than the group not expending heavy effort or pushing/pulling weight (P < 0.001). There was a statistically significant increase in the incidence of low back and lower extremity diseases in response to heavy effort (P = 0.020); this was due to the higher incidence of low back and lower extremity diseases in the group pushing and pulling weight compared to the group carrying 0-5 kg (P = 0.004).

Table 6 shows the comparisons made with regards to the frequency of the occurrence of musculoskeletal diseases in terms of static posture. Static posture was found to be a statistically significant risk factor for the incidence of shoulder-neck (P = 0.014) and low back-lower extremity (P = 0.002) diseases. Compared to the kneeling group, it was the more common occurrence of shoulder and neck diseases in the group working sitting all day long (P = 0.013), whereas low back and lower extremity diseases were seen more common in the kneeling group compared to the groups without static posture, standing all day and sitting all day (P = 0.032).

Table 5: Comparisons of the frequency of musculoskeletal diseases in terms of heavy effort

	No disorder n (%)	There is disorder n (%)	*P*-value†
Shoulder neck			0.538
No	23 (35.9)	41 (64.1)	
0-5 kg transport	21 (40.4)	31 (59.6)	
>5 kg transport	10 (45.5)	12 (54.5)	
Weight push-pull	30 (48.4)	32 (51.6)	
Upper extremity			<0.001
No	57 (89.1)	7 (10.9)	
0-5 kg transport	26 (50.0)[a]	26 (50.0)[a]	
>5 kg transport	17 (77.3)	5 (22.7)	
Weight push-pull	54 (87.1)[b]	8 (12.9)[b]	
Low back and lower extremities			0.020
No	22 (34.4)	42 (65.6)	
0-5 kg transport	24 (46.2)	28 (53.8)	
>5 kg transport	9 (40.9)	13 (59.1)	
Weight push-pull	12 (19.4)[b]	50 (80.6)[b]	

Pearson's Chi-Square test, the differences between which groups are indicated with letters: a: The difference between the group without heavy effort is statistically significant ($P < 0.001$), b: The difference between 0-5 kg transporting group is statistically significant ($P < 0.01$).

Table 6: Incidence of musculoskeletal diseases in terms of static posture

	No disease	Diseased	*P*-value †
Shoulder-neck			0.014
None	0 (0.0%)	2 (100.0%)	
Standing all day	70 (42.4%)	95 (57.6%)	
Sitting all day	5 (23.8%)	16 (76.2%)	
Kneeling	9 (75.0%)[a]	3 (25.0%)[a]	
Upper extremity			0.057
None	2 (100.0%)	0 (0.0%)	
Standing all day	122 (73.9%)	43 (26.1%)	
Sitting all day	20 (95.2%)	1 (4.8%)	
Kneeling	10 (83.3%)	2 (16.7%)	
Low back-lower extremity			0.002
None	2 (100.0%)	0 (0.0%)	
Standing all day	58 (35.2%)	107 (64.8%)	
Sitting all day	7 (33.3%)	14 (66.7%)	
Kneeling	0 (0.0%)[a,b,c]	12 (100.0%)[a,b,c]	

† Likelihood Ratio test, the differences between which groups are indicated with letters: a: The difference between the group that sits all day long is statistically significant ($P < 0.05$), b: The difference between the group that does not have static posture is statistically significant ($P = 0.011$), c: The difference between the group that works all day standing up is statistically significant ($P < 0.05$) the difference is statistically significant ($P = 0.009$).

Table 7: Comparisons of the frequency of musculoskeletal diseases in terms of repetitive motion

	No disorder n (%)	There is disorder n (%)	*P*-value†
Shoulder neck			0.084
No	8 (57.1)	6 (42.9)	
Working on the assembly line	36 (39.6)	55 (60.4)	
Getting in and out of the vehicle	5 (33.3)	10 (66.7)	
Vehicle wiping and sanding	3 (23.1)	10 (76.9)	
Using a gun	7 (63.6)	4 (36.4)	
Percussion or suppression work	1 (14.3)	6 (85.7)	
Manual material handling	10 (37.0)	17 (63.0)	
Frequently twisting-rotating	10 (58.8)	7 (41.2)	
Step up and down	4 (80.0)	1 (20.0)	
Upper extremity			<0.001
No	12 (85.7)	2 (14.3)	
Working on the assembly line	88 (96.7)	3 (3.3)	
Getting in and out of the vehicle	15 (100.0)	0 (0.0)	
Vehicle wiping and sanding	5 (38.5)[a,b,c]	8 (61.5)[a,b,c]	
Using a gun	2 (18.2)[a,b,c]	9 (81.8)[a,b,c]	
Percussion or suppression work	1 (14.3)[a,b,c]	6 (85.7)[a,b,c]	
Manual material handling	25 (92.6)[d,e,f]	2 (7.4)[d,e,f]	
Frequently twisting-rotating	1 (5.9)[a,b,c,g]	16 (94.1)[a,b,c,g]	
Step up and down	5 (100.0)[d,e,f,h]	0 (0.0)[d,e,f,h]	
Low back and lower extremities			< 0.001
No	5 (35.7)	9 (64.3)	
Working on the assembly line	26 (28.6)	65 (71.4)	
Getting in and out of the vehicle	4 (26.7)	11 (73.3)	
Vehicle wiping and sanding	6 (46.2)	7 (53.8)	
Using a gun	10 (90.9)[a,b,c,d]	1 (9.1)[a,b,c,d]	
Percussion or suppression work	3 (42.9)[e]	4 (57.1)[e]	
Manual material handling	3 (11.1)[d,e]	24 (88.9)[d,e]	
Frequently twisting-rotating	10 (58.8)[b,g]	7 (41.2)[b,g]	
Step up and down	0 (0.0)[e,h]	5 (100.0)[e,h]	

† Likelihood ratio test, the differences between which groups are indicated with letters: a: The difference between the group with no repetitive movement is statistically significant ($P < 0.05$), b: The difference between the group working on the assembly line is statistically significant ($P < 0.05$), c: Difference between getting in and out of the vehicle is statistically significant ($P < 0.01$), d: The difference between vehicle wiping and sanding group is statistically significant ($P < 0.05$), e: The difference between gun using group is statistically significant ($P < 0.05$), f: The difference between the percussion or supression working group is statistically significant ($P < 0.05$), g: The difference between the group handling the manual material is statistically significant ($P < 0.001$), h: The difference between the group doing frequently twisting and rotating is statistically significant ($P < 0.05$).

Although there was no statistically significant change in the incidence of shoulder and neck diseases associated with repetitive motion ($P = 0.084$), there was a statistically significant increase in the incidence of upper extremity diseases ($P < 0.001$) (Table 7). The effect on the upper extremities was due to the vehicle wiping and sanding, using a gun, percussion or suppression work and frequently twisting-rotating groups ($P < 0.05$) rather than the groups that do not have repetitive movement (working on the assembly line, getting in and out of the vehicle, manual material handling and step up and down. There was also a statistically significant increase in the incidence of low back and lower extremity diseases ($P < 0.001$) associated with repetitive motion. Low back and lower extremity diseases were rarely encountered in the group using a gun compared to all other subgroups except for the frequent twisting-rotating group ($P < 0.05$). In addition, lower back and lower extremity diseases were seen statistically less often in the working on the assembly line and frequently twisting-rotating groups compared to the manual material handling group ($P = 0.032$ and $P = 0.002$, respectively).

Discussion

In our study, WMSDs were seen most frequently in assembly line workers, which is due to the repetitive movements performed by such workers. Previous studies have shown that repetitive movements are among the most important risk factors for the occurrence of WMSDs [12]. Clinicians should keep in mind that a WMSD may be the cause of the complaints in a patient exposed to repetitive, compelling, prolonged uneven postures or vibration [13].

In our study of automotive workers with WMSDs, low back-lower extremity disorders were most common, followed by neck-shoulder and then upper extremity disorders. In the study conducted by Deros et al. [7] at an automotive factory in Malaysia, the most common WMSDs in order of frequency were low back, foot and ankle and upper back diseases. The fact that WMSDs are seen more frequently in these regions of the body supports the conclusion that exposure to trauma with repetitive movements and inappropriate posture cause this type of disease.

In our study, shoulder-neck diseases were found more frequently in individuals who sat all day, and low back-lower extremity disorders were more frequent in individuals who kneel a lot. The forklift operator of the sitting group, who performs continuous neck rotation, explains the first observation, and biomechanical overload in the kneeling group is felt to be responsible for the second conclusion. The common reasons for neck and back pain in forklift users include static stationary position while driving (hands and feet are held fixed on handles and pedals), repeated exposure to awkward body postures for short and long periods (trunk twisting and rotation) especially during reverse maneuvers, and exposure of the whole body to vibration while driving [14].

Performing repetitive bending and standing movements while working increases the incidence of low back-lower extremity diseases. This may be due to biomechanical damage to the tissues around the joints that results from overuse load on the joints [15].

Upper extremity diseases were found to be higher in the groups that wiped vehicles, sandblasted, used guns, hit-squeezed, and twisted frequently compared to the groups working on the assembly line, handing manual materials, and step and down by pressing. Because these patients apply continuous long-term hammer use, repetitive supination and pronation of the forearm, strong wrist extension/or arm extended grip, excessive use of the thumb and ulnar or radial deviation of the wrist, prolonged use of hammer, repetitive supination and pronation of the forearm, strong wrist extension / or arm extension grip.

In 2018, in a systematic review of studies of office workers with WMSDs, Hoe et al. [16] found that ergonomic measures alone were not sufficient to resolve patients' complaints; additional breaks from work were needed. Since repetitive motion and poor ergonomics are the most important factors in the etiopathogenesis of WMSDs, even if the ergonomics are optimal, increasing the number of breaks can decrease the total number of repetitive movements, providing additional relief. The workers in our study worked 8 hours a day and rested for 50 minutes, including 30 minutes for a meal break and 20 minutes of additional break time. The workers could be scheduled to work in 2-hour shifts with 20-minute breaks in between.

The limitation of our study is that the risk assessment was performed only in individuals who were seen at our outpatient clinic and were diagnosed with WMSD. There is a need for WMSD risk assessment studies to be carried out on all factory employees to determine what measures would best protect the health of employees in such environments.

Conclusion

WMSD still has no clear diagnostic criteria, which causes serious diagnostic and prevalence differences among countries and sectors. In automotive factories, which are a branch of heavy industries, WMSDs are frequently observed due to the inconvenient postures and repetitive movements required. Therefore, an occupational health and safety culture should be adopted in these lines of work. Ergonomic measures should be increased in the sections where WMSDs are frequently seen, and the number and duration of breaks should be increased if necessary. Inter-department rotations can prevent a worker from constantly doing the same movement. In this way, the incidence of WMSDs can be reduced.

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