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WORK-RELATED MUSCULOSKELETAL DISORDERS AT A REFRIGERATOR FACTORY: PHYSICAL AND PERSONAL RISK FACTORS

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ABSTRACT

OBJECTIVE: In our study, we aimed to investigate the frequency of work-related musculoskeletal disorders(WMSDs) and risk factors in adult employees. Relationships between the demographic features and physicalfactors at working place and work-related musculoskeletal disorders have been investigated.

METHODS:250 people who has white-collar and blue-collar that works at a refrigerator factory in Manisa Industrial Site and are above 18 years old, who Works with morning-night job rotation and has interleave working area. Demographic features, additional disease informations (comorbidity), working conditions(work time, time spent at workplaceandjob) of employees that are included in study have been questioned. Standardized Nordic Musculoskeletal Questionnaire has been performed to search the WMSDs presence and body part distribution of the employees. Turkish translation of The Quick Exposure Check(QEC) has been used to measure the physical risk level of employees exposure.They will be filled by a doctor who joined the study and those who joined the questionnaire. Data from the questionnaire study was saved and investigated in SPSS (statistical package for social science) 15 program.

RESULTS: 208 of the employees (%83) were blue-collared and 42 (%17) were white-collared. %85 of theemployees were male and %15 were female. In our study WMSDs frequency was found as %72 (178 persons). The most affected body part was lumbar part(%20). It is followed by neck(%17) and shoulder(%12)parts. There was no difference of WMSDs frequencies between blue-collared and white-collared groups(p:0.971). WMSDs frequency was getting higher as the time spent in job(Year)(p:0.0000), age(p:0.000), presence of additional disease information(comorbidity) (p:0.026), smoking (box/year) (p:0.007), BMI(P:0.026). There was and inverse proportion between educational level(p:0.001), regular exercise(p:0.017) and WMSDs. As for the QEC, most of the exposures on body parts were high or very-high. When the moderate and above exposure levels are determined as risk levels in QEC, a relationship between body part complaints and exposure levels were found, excluding the neck. As the educational level went high, the number of doctor consultation were getting lower(p0.016). In our study, the working area(p:0.971), gender(p:0.874), smoking history(p:0.052) and vibration(p:0320) and WMSDs relation were not found.

CONCLUSİON: WMSDs frequency was %72.1 and significantly high at work place that exposure was accepted as moderate risk factor in respect to work health and security but in respectto QEC high and very high. In our study, the spine complaints (expecially lumbar and neck) of the employees were at forefront as essential musculoskeletal problem. In this study, a significant relationship between personal and physical (ergonomic) risk factors and WMSDs was found. Measures which will reduce ergonomic and correctable personal risk factors must be taken in order to avoid WMSDs.

KEYWORDS — Work Health, Work-Related Musculoskeletal System Disorders, Quick Exposure Check, Ergonomy, Working Area

1.INTRODUCTION and PURPOSE

Musculoskeletal Disorders (MSDs) are common problems in developed and developing countries and one of the main reasons behind disabilities occurring due to the exposure to recurring risks when performing work-related activities(1). It is estimated that the total incidence of work-related musculoskeletal system disorders in the world adds up to 3,337,000 cases annually(2). Work-related musculoskeletal disorders are most commonly accompanied by pain in the lower backregion and the hands, restricted movement and disabilities. Affecting soft tissues such as muscles, tendons, ligaments, and discs, work-related musculoskeletal disorders (WMSDs) are recognized as disorders occurring in the muscle system due to occupational conditions(3,4). Work-related physical, psychosocial, personal, and sociocultural elements play a role in the incidence of WMSDs and they have a multicausal etiology. These factors are interrelated(4, 5, 6, 7). The number of studies conducted in the city of Manisa on WMSDs is rather limited. This study aims to explore the incidence rate of WMSDs and relevant personal and physical risk factors of adult employees of a refrigerator factory operating in the organized industrial zone of Manisa.

2.MATERIALS / METHOD

This study is based on the data obtained from a refrigerator manufacturer operating in the Organized Industrial Zone of Manisa Factory physician, factory manager and occupational health specialist were instructed about the design of the study and the questions and the information to be extracted.

The factory employs approximately 600 workers. Although it was aimed to include all the workers in this study, it was only possible to recruit 250 workers due to social reasons, inconvenient shift schedule and unwillingness to participate in the study.

Among the inclusion criteria were being at least 18 years or older and an employment history at the factory minimum 1 year; working in the night or day shift; working in the manufacturing areas of the factory or working in the offices at least for 1 year.

Among the exclusion criteria was the anatomical body part which was traumatized is the same with the symptomatic part. Data used in the research was obtained from interviews without physical assessment.

Age, gender, body mass index (BMI), marital status (married/ single/ divorced/widower), place of residence (city-district), education (illiterate/elementary/high school/ undergraduate/ graduate), smoking habits (quitter/ smoker/ nonsmoker and packs per year) , additional disorders, if any, and demographic information of the participants were recorded. The level of exercise was defined with the question, 'Did you exercise in the last 3 months 2-3 times a week?' (Including 30 min. brisk walk) and the

answer of yes was accepted as regular exercise. The participants are assessed as white-collar (engineer, secretary, public relations, healthcare personnel) and blue-collar (worker, technician, team leader). Work history with and without insurance was recorded for general career and the career at the factory.

Standardized Nordic Musculoskeletal Questionnaire (SNMQ) was used. This questionnaire maps nine different parts of the body (feet-ankles, knees, femur-thighs, hands-wrists, lower back, elbows, back, shoulders, neck) and questions the statements concerning symptoms occurred in the last 12 months and last 7 days with yes/no questions(8,9).

The Turkish version of the Quick Exposure Check, translated by Özcan E. et al. (10) was used in order to measure the physical risk levels the participants are exposed to. Total scores are obtained for lower back (mobile and immobile), shoulder-arm, wrist-hand and neck. Exposure levels are also defined for vehicle operation habits, vibration, busy working schedule and stress.

Statistical Assessment

SPSS (Statistical Package for the Social Sciences) version 15.0 was used in the statistical analysis of the data obtained from the research. Data was then subjected to Shapiro-Wilk and Kolmogorov- Smirnov tests of normality and a regular distribution was found. Demographic data (age, gender, education, career length, etc.) obtained from the employees was analyzed using amount and percentage analysis methods. Data from both groups were analyzed using chi-square test and independent groups t-test. Qualitative variables are given as ratios while quantitative variables are given as medians (minimum-maximum) as part of the definitive statistics. $p<0.05$ was reported as statistically significant.

3.RESULTS

Most of the 250 adults participated in the study were men (85.2%). The average age of the participants was 35,2± 6.73(23-58). 33.6% of the participants were overweight or obese. Most of the participants were married (77.6%) and were residing in central Manisa (85%). 58 out of 250 participants (23.2%) held a Bachelor's degree or higher.

Questions about smoking habits revealed that 40.4% of the participants were non-smokers while 59.6% were smokers or had a history of smoking. The average pack per year was found to be 4.7 (0 to 20 years) from 173 (69%) participants who provided detailed information about their smoking habits. 42% (16,8%) of the participants were white-collar and 208 (83,2%) were blue-collar. It was found that 45 participants (18%) exercised regularly (Table 1).

Table 1. Demographic Characteristics of the Participants

Characteristic	Number/%	Average (year)/SD(min-max)
Age (year) Total	250(100)	35.2± 6.73(23-58)
Gender Female Male	37(%14,8) 213(% 85,2)	
BMI General Total Slim Normal Overweight Obese	250(100) 11 (4,4) 115 (62) 68 (27,2) 16 (6,4)	
Marital Status Married Single Divorced	194 (77,6) 44(17,6) 12(%4,8)	
Place of Residence City District	214(% 85,6) 36(%14,4)	
Education Elementary High School Graduate Postgraduate	53 (%21,2) 139(%55,6) 45(%18) 13(%5,2)	
Exercise Regular Irregular	45 (%18,0) 205(%82)	
Smoking History Has a Smoking History Doesn't Have a Smoking History Pack/year (n:173)	149(% 59,6) 101(% 40,4) 4.7(0-20)	
Field of work White-collar Blue-collar Worker Technician Team leader	42(%16,8) 208(% 83,2) 193(%77,2) 8(% 3,2) 7 (%2,8)	

There was no statistically significant difference between blue-collar and white-collar workers in terms of age, BMI, and smoking habits ($p>0.05$). The correlation between working settings and gender showed that male gender was significantly higher in number among blue-collar workers (p:0.023). The correlation between gender and BMI, age, exercise and smoking history showed that the BMI of male workers was significantly higher than female workers (p:0.026). There was no statistically significant difference between gender and age, BMI, and smoking habits (p 0.05).

83 of the 250 participants (33.2%) had comorbidities and cardiovascular and endocrinopathy (diabetes mellitus and thyroid) were the most common disorders being found in almost half (15.2%) of the participants with comorbidities.

The participants' average career span was 11,2 ±6,6 years (white-collar, 11.5±8.9 years; blue-collar, 11.2 ± 6.1 years) and the average employment history at the factory was 7,4 ±5,02 years (white-collar, 8.3±8.3 years; blue-collar, 7.2± 4.05 years) The workweek ranged between 40 to 50 hours and the average weekly hours was 43.6±3.1 hours. There were no differences in terms of hours per week, career span and factory employment span.

178 participants (71.2%) were found to experience a WMSD in the last month. 30 out of 178 participants (12%) were white-collar while 148 were blue-collar and there was no statistically significant difference between white-collar and blue-collar workers in terms of WMSD incidence (p:0.567). Among these, 60% had complaints about multiple anatomical regions and this was the most common case.

A review of the relationship between age, gender, BMI, exercise, smoking habits, education, comorbidity and the incidence of WMSD in the last month, it was found that incidence of WMSD increases with the increasing comorbidity (p: 0.026), pack per year (p: 0.007), age and BMI (p: 0.026). It was found that the incidence of WMSD decreases with the increasing education level (p:0.001). Regular exercise was found to have a statistically significant impact on the WMSD (p:0.017) while not exercising was found to have an effect on neck (p:0.014) and hand-wrist (p:0.039) pain. There was no statistically significant relationship between gender and WMSD . (p: 0.847)(Table 2)

Table 2: The Relationship Between WMSD and Demographic Characteristics

	WMSD			
Characteristic	Yes(n:178)	No (n:72)	Total (n:250)	P-value
	Average/SD/min-max			
Age (year)	36±6,7(23-58)	31± 5,3 (23-49)	35±6.7(23-58)	0.000*
	Number/%	Number/%	Number/%	

Gender Female Male	27(73) 151(70.9)	10(27) 62(29.1)	37(100) 213(100)	0.847
BMI Slim Normal Overweight Obese	6(54.6) 117(71) 50(74) 15(94)	5(45.4) 48(29) 18(26) 1(6)	11(100) 165(100) 68(100) 16(100)	0.026*
Education Elementary Education High School University Postgraduate	45(85) 101(72.7) 25(55.6) 7(54)	8(15) 38(27.3) 20(44.4) 6(46)	53(100) 139(100) 45(100) 13(100)	0.001*
Exercise Regularly Not Regularly	25(55.6) 153(74.6)	20(44.4) 52(25.4)	45(100) 205(100)	0.017*
Smoking Habits Smoker or quitter Non-smoker	111(74.5) 67(66.4)	38(25.5) 34(33.6)	149(100) 101(1090)	0.376
Comorbidity Yes None	67(80.7) 111(66.5)	16(19.3) 56(33.5)	83(100) 167(100)	0.026*

A comparison between WMSD and career span, factory employment span and workweek showed that there was a significant relationship between WMSD and career span, factory employment span (p:0.00) while there was no significant relationship between WMSD and workweek (p:0.893). With respect to the gender, factory employment span was higher in male participants (p: 0.017) when compared to female participants.

A review of the distribution of WMSD in 9 anatomical parts showed that lower back pain was the most common complaint in the last one year and neck, shoulder, back, hand-wrist, knee, foot, elbow, thigh pain follows, respectively.

Table 3 shows the restriction in mobility due to WMSD and the frequency of WMSD symptoms in the last year and the last week. Complaints about neck and lower back seem to be more common.

Table 3	Distribution of the WMSDs in Anatomical Parts According to SNMQ		
Anatomical Region	Complaints of pain or disturbance in the past 12 months	Musculoskeletal Complaints (pain or disturbance) which affect normal activities in the past 12 months	Complaints of pain or disturbance in the past 7 days
	Number/%		
Neck	90(50)	43(23.0)	47(19)
Shoulder	67(37)	23(9.0)	20(8.0)
Back	59(33)	20(8.0)	16(6.0)
Elbow	37(20)	10(4.0)	11(4.0)
Wrist/hand	57(31)	16(6.0)	22(9.0)
Lower back	106(59)	46(18)	47(19.0)
Hip/ Thigh	36(20)	6(2.1)	5(2.0)
Knee	47(26)	9(4.0)	11(4.0)
Foot/ankle	40(22)	2(0,9)	9(3.0)

SNMQ: Standardized Nordic Musculoskeletal Questionnaire, WMSD: Work-related musculoskeletal disorder

There was no difference between blue- and white-collar workers in terms of WMSD incidence (p:0.971). The most common symptoms of pain in blue-collar workers were found in lower back, neck, back, and shoulder while in blue-collar workers they were found in neck, back, lower back, and shoulder, in order of prevalence. It was found that back pain was significantly more common in white-collar workers when compared to blue-collar workers (p:0.009).

According to the QEC survey, neck was found to be the region which is most exposed during work. It was followed by lower back. Spine exposure was mostly found at a medium and high level. Neck exposure was high while lower back exposure was medium and high. The lowest level of exposure was found in hand-wrist region. Work stress and busy work schedule were found at a medium level while exposure to vibration and vehicle operation were mostly high. Maintaining a position for more than 2 hours and carrying/pushing/pulling weights over 5kg accounted for 50% of the cases each.

Table 4: QEC Risk Exposure Assessment (n:250)

	Low (n/%)	Medium (n/%)	High-Very High(n/%)
Lower back	10 (%4)	110(%44)	130(%52)
Neck	8(%3.2)	63(%25.2)	179(%71.6)
Shoulder	17(%6.8)	151(%60.4)	82(%32.8)
Wrist/hand	40(%16)	114(%45.6)	96(%38.4)
Stress at Work	21(%8.4)	134(%53.6)	95(%38)
	Low	Medium	High
Vehicle operation	242(%96.8)	2(%0.8)	6(%2.4)
Vibration	199(%79.6)	48(%19.2)	3(%1.2)
Busy work schedule	78(%8.4)	135(%53.6)	37(%38)
	Yes	No	
Maintaining a position for more than 2 hours	119(%47.6)	131(%52.4)	
Carrying-pushing-pulling a weight over 5kg	130(%52)	120(%48)	

QEC: Risk Exposure Assessment

When field of work and maintaining a position for longer periods of time or carrying-pushing-pulling a weight over 5kg were compared, it was found that maintaining a position for longer periods of time was significantly higher for white-collar workers (all maintain a position)(p0.00) while carrying-pushing-pulling a weight over 5kg was significantly higher for blue-collar workers (n=78 (48%)) (p0.000). Workers with higher mobility had more lower back pain complaints (p: 0.00) while maintaining the same position for more than 2 hours did not have a significant effect on lower back and neck pain (p: 0.599).

There was a significant relationship between WMSD and carrying-pushing-pulling a weight over 5kg (p: 0.001) and it was specifically correlated with lower back pain (p: 0.00).

Looking into the relationship between the field of work and the exposure levels obtained from QEC, it was found that lower back, shoulder, and vibration exposure of blue-collar workers were significantly more than white-collar workers in blue-collar workers, while stress at work, maintaining a position for longer periods and neck exposure were significantly more in white-collar workers. Although a statistically significant relationship was not found between hands, vehicle operation, busy working schedule and field of work, vehicle operation exposure was more in blue-collar workers.

Considering the exposure levels of the anatomical regions of the workers for medium and higher pain as found by the QEC survey and the complaints of the workers in the last year, medium and higher levels of exposure was a risk factor in lower back, shoulder and hands, while high and very high levels of exposure was a risk factor in neck (p0.00). (Table 5)

Table 5: Relationship BetweenQEC Risk Level and Pain

Anatomical Region	Risk (according to the motions of the body)			
	Low	Medium, High-Very High	Total %100	P-value
	Number/ %			
Neck Pain Yes No Total	2(2.3) 6(3.8) 8(3.2)	88(97.7) 154(96.2) 242(96.8)	90 160 250	0.510
Lower Back Pain Yes No Total	1(1.0) 9(6.2) 10(4)	105(99) 135(93.8) 240(96)	106 144 250	0.034*
Shoulder Pain Yes No Total	1(1.5) 16(8.7) 17(6.8)	66(98.5) 167(91.3) 233(93.2)	67 183 250	0.044*
Hand Pain Yes No Total	3(5.2) 37(19.1) 40(16)	54(94.8) 156(80.9) 210(84)	57 193 250	0.012*

There was no statistically significant relationship between forklift operation (p:0.081) and vibration (p:0.320) and WMSD incidence. A comparison of the busy working schedule and pain in specific anatomical regions with respect to the QEC survey showed that upper extremities (p:0.000) and spine (p:0.000) were significantly affected. A significant relationship was found between stress at work and upper extremity and neck pain (p:0.000) according to the QEC survey.

4. DISCUSSION

Work-related musculoskeletal disorders (WMSDs) were evident in the 71.2% of the participants. The impact of physical factors and personal characteristics on the musculoskeletal pain was reported. In this context, a survey inquiring demographic characteristics (age, gender, education, etc.), Standardized Nordic Musculoskeletal Questionnaire (SNMQ), and Quick Exposure Check (QEC) were submitted to the workers by a physician. Lower back and neck problems were found to be the most common in this study. White-collar workers more often had neck and back pain, while blue-collar workers more often had lower back, neck and shoulder pain. The study conducted by Aghilinejad M. et al. (11) reported 93% WMSD ratio in the last year for an aluminum factory operating in Iran. Pınar et al. (12) reported 39.3% WMSD ratio in the last year for the defense industry in Turkey and found that lower back and knee pain were most common in the anatomical distribution. A study focusing on the automotive industry found that lower back pain was more common in blue-collar workers and neck pain in white-collar workers(13). All these results from the literature support our findings.

According to the SNMQ, especially spine problems (lower back-neck) lead to restriction in activity and acute pain (pain in the last week).As spine is central to body motion, this exposure had an extensive impact on the functions.Pınar et al. (12) reported that lower back, knee, back and neck pain lead to restriction in activity in the last one year in the defense industry of Turkey.

In this study, WMSD was found in 72% of the female participants and 70.8% of the male participants which was not a statistically significant difference. According to the data obtained from European Agency for Safety and Health at Work, WMSD risk and incidence are higher in male workers in many countries and industries (14). The WMSD incidence in male workers (88%) of a clothing factory operating in Thailand were higher than female workers (79%) and female workers complained more from back and lower back pain while male workers complained more from knee and hand-wrist pain (15). In this study, it was emphasized that the cumulative effect may explain the higher WMSD incidence ration in male participants as their career span and employment span in the facility were longer. This may also explain our finding which signified no difference between genders in terms of career span. According to the European risk assessment report, WMSD risk increases with the older age (16). In our population, the average age for WMSD was found to be 36±6.7(23-58). Older age was correlated with the increased WMSD incidence. Parot-Schinkel et al. (17) reported an average age of 38±10 and it was suggested that WMSD incidence increases depending on the increased cumulative effect of trauma with older age. When the relationship between regular exercise and musculoskeletal system pain was explored we found that WMSD incidence decreases in all anatomical regions with regular exercise and it has a positive impact on especially neck and hand-wrist regions. As part of a study conducted in an automotive factory, 70 patients with pain in lower back, neck and other anatomical regions were informed about ergonomic measures, exercise methods and musculoskeletal disorders. The follow-up study reported decreased amount of complaints and the importance of exercise was emphasized(13).

In this study, it was shown that increasing career span and employment span in the last facility increases the number of complaints originating from musculoskeletal system. An increasing amount of complaints originating from musculoskeletal system was found for those who had a career span around 10 years. The reason behind this is increasing number of recurring micro-traumas and continued exposure to risk elements. Other studies also reported that complaints originating from musculoskeletal system increases with increasing career span and employment span(17, 18).

Quick Exposure Check revealed a high and very high exposure level for lower back, neck, shoulder and hand-wrist regions, although the workplace selected for this analysis was found to be in the medium risk group. The assessment which accepted medium, high and very high exposure as a risk showed significant relationship except neck pain. When high and very high exposure was taken as a risk, on the other hand, a significant relationship was also found for neck pain. Which in return showed that medium level of exposure does not lead to neck pain. The fact that lack of relationship with neck pain except the case of stress at work as part of the QEC survey led us to think psychosocial risk factors are important in neck pain(19, 20). Choobineh et al. (21) and Stankevitz et al (22) have found high and very high exposure in their studies conducted in a sugar factory and in Sri-Lanka, respectively. They have associated their findings with symptoms in lower back, neck, shoulder and hand-wrist (21, 22).

In our study, there was no relationship between local and general body vibration and vehicle operation and spine and upper extremity pain. This finding can be explained with the small number of vibrating tools and short-term exposure to the vibration in the relevant factory.

Carrying weights over 5 kg and maintaining a position for longer periods pose a risk for neck and lower back pain. We have investigated these factors. In our study, blue-collar workers were more commonly carrying/pushing/pulling weights over 5 kg when compared to white-collar workers. Participants did not show a significant difference in field of work (blue- and white-collar) in terms of lower back and neck pain. A relationship between carrying weights over 5 kg and lower back pain was found for all the participants. In the context of field of work, there was a statistically significant relationship between blue-collar work and carrying weights over 5 kg (p:0.000). However, white-collar workers are not analyzed for this factor as they were not carrying weights over 5 kg as part of their job. On the other hand, white-collar workers were more commonly exposed to maintaining a position (posture) for more than 2 hours. Maintaining a for more than 2 hours was not associated significantly with neck and lower back pain. We believe the reason behind this finding is that two different postures, standing and sitting, were not assessed in this study. For example, a welding worker works in a stationary

position sitting while paint worker works in a stationary position standing. The correlation between standing while working and lower back pain was previously reported and a relationship between stationary posture and the burden of carrying the load of the body and neck and lower back pain was suggested(23, 24). According to the study conducted on an automotive factory, blue-collar workers were more commonly exposed to carrying weights over 5kg and standing for periods over 2 hours while neck pain and stationary position were more common in white-collar workers(13). These findings showed us that exposure originating from varying working conditions lead to different symptoms.

RESULT & RECOMMENDATIONS

This study explored the risk factors available in a refrigerator factory located in the Organized Industrial Zone of Manisa which may cause musculoskeletal system problems (1, 24). Although all the measures are taken in working spaces work-related musculoskeletal disorders are still common.

Musculoskeletal disorder incidence ratio (71.2%) was found at a high level in this study. Spinal problems especially lower back pain were commonly observed in participants. The results of this study showed that, the exposure levels (high and very high) of the employees as per QEC survey are high as to require additional measures. Measures which will reduce ergonomic and correctable personal risk factors must be taken in order to avoid WMSDs.

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