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INFLUENCE OF BODY POSITION DURING WORK ON THE APPEARANCE OF DISORDERS OF THE MUSCULOSKELETAL SYSTEM AMONG WORKERS IN THE TOBACCO INDUSTRY

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Disorders of the musculoskeletal system (MSDs) require special attention because they represent one of the leading causes of absence from work and disability in the world. In addition to affecting the quality of life itself, they greatly reduce the ability to work, and can occur at any age. They have multi-factorial etiologies, caused above all by the interaction of an unhealthy lifestyle and workplace conditions that vary in different occupations.

The aim of this research is to examine the prevalence of musculoskeletal system disorders among workers of the Nis Tobacco Industry (Nis TI), as well as the influence of the position of workers and other work-related factors on the occurrence of musculoskeletal disorders. Out of a total of 426 workers examined during the 2022 systematic examination, 69 (16.2%) workers had musculoskeletal disorders. Musculoskeletal disorders were more prevalent in workers in the direct production sector (standing position) 61 (88.41), in female workers (40.6%), and are also associated with overweight and old age of workers.

The high frequency of musculoskeletal disorders among Nis TI employees indicates that it is necessary to take adequate prevention, control and risk reduction measures for the occurrence of diseases and injuries of the musculoskeletal system, all with the aim of reducing the frequency of diseases, reducing the risk of disability, improving the quality of life and increasing work ability.

Key words: disorders of the musculoskeletal system, workers, tobacco industry, body position at work

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UTICAJ POLOŽAJA TELA TOKOM RADA NA POJAVU BOLESTI MIŠIĆNO-SKELETNOG SISTEMA KOD RADNIKA U DUVANSKOJ INDUSTRIJI

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Bolesti mišićno-skeletnog sistema zahtevaju posebnu pažnju jer predstavljaju jedan od vodećih uzroka odsustva sa posla i invalidnosti u svetu. Pored toga što utiču na sam kvalitet života, u velikoj meri umanjuju radnu sposobnost, a mogu se javiti u bilo kojoj životnoj dobi. Multifaktorske su etiologije, uzrokovani pre svega interakcijom nezdravog stila života i uslovima radnog mesta koji variraju kod različitih zanimanja.

Cilj ovog istraživanja je da ispita zastupljenost bolesti mišićnoskeletnog sistema kod radnika Duvanske industrije Niš (DIN), kao i uticaj položaja radnika i drugih faktora koji se dovode u vezi sa radom na pojavu oboljenja mišićno-skeletnog sistema. Od ukupno 426 radnika pregledanih tokom sistematskog pregleda 2022. godine, kod 69 (16,2%) radnika su registrovani poremećaji mišićno-skeletnog sistema. Bolesti mišićnoskeletnog sistema su bile zastupljenije kod radnika u sektoru direktne proizvodnje (stojeći položaj) 61 (88,41), kod radnika ženskog pola (40,6%), a dovodi se i u vezu sa prekomernom težinom i starošću radnika.

Visoka učestalost mišićno-skeletnih poremećaja među zaposlenima u DIN-u nam ukazuje da je potrebno preuzeti adekvatne mere prevencije, kontrole i redukcije rizika za nastanak oboljenja i povreda mišićno-skeletnog sistema, a sve sa ciljem da se smanji učestalost oboljevanja, smanji rizik od nastanka invaliditeta, poboljša kvalitet života i poveća radna sposobnost.

Ključne reči: poremećaji mišićno-skeletnog sistema, radnici, duvanska industrija, položaj tela pri radu

Introduction

Musculoskeletal system disorders (MSDs) are one of the most common causes of chronic pain, long-term disability, and inability to work. These disorders are closely related to functional disability and high consumption of health and social resources (1-3), imposing large costs on society for treatment, sick leave, retirement and significantly reducing productivity in working life (2). In EU member states, they represent a large part of lost working days and affect workers in all sectors and occupations. If MSDs are caused or aggravated primarily by work and the effects of the immediate work environment, they are designated as work-related MSDs (WMSDs) or occupational MSDs (4). WMSDs contribute significantly to reduced work productivity (5,6), and symptoms usually appear only after years of chronic exposure to risk factors (2).

MSDs are among the most common diseases of the working population, affecting millions of workers worldwide (7). The prevalence of occupational MSDs varies between countries, sectors and demographics, and knowledge of prevalence is crucial to better understand the risks for different sectors and demographics. These data are publicly available and published mostly by developed countries (8). It is estimated that one third of all absences from work in industrialized countries are related to MSD (9). Thus, according to EU data from 2013, about 60% of workers reported some of the disorders related to MSD, i.e. three out of every five workers, and in 2015, the most common complaint related to back pain (43%) and pain in the upper limbs (41%). The prevalence of MSDs also varies depending on sociodemographic factors, so the rates of disorders are higher in women and increase significantly with age (4, 8).

The musculoskeletal system is the basic structural component of our body, which includes muscles, bones, joints and connective tissues. These components are interconnected through the fascial system, which envelops and supports both bones and muscles, allowing them to function as a unit (3, 10, 11). The health of this system is crucial for our daily functioning, because disturbances in its parts can lead to various disorders. As many as 150 different types of MSDs are reported in the literature (12) and include a wide range of inflammatory and degenerative diseases, including some lesser-known conditions of pain and functional impairment. These include tendon inflammations (tendinitis and tenosynovitis), myalgias, nerve entrapment syndromes, degenerative disorders at different levels of the spinal column, etc. (2).

MSDs usually present in the form of pain and temporary or permanent reduced mobility, which can seriously affect the ability to perform daily tasks, work and social activities (3, 13). They significantly increase the risk of developing chronic conditions such as osteoarthritis, osteoporosis and

sarcopenia, which can affect different parts of the body and cause painful syndromes or inflammatory diseases. Therefore, it is important to preserve the health of the musculoskeletal system, as well as recognize and minimize workplace risks in time to prevent long-term consequences (1, 14).

The occurrence and progression of these disorders are influenced by various factors, among which are genetic predisposition, environmental factors, workplace factors, activities we perform during work and where we spend most of our time (3,15). WMSDs are causally related to physical load resulting from occupational activity (9). It is believed that the intense and sudden action of these factors, such as mechanical injuries, can lead to professional injuries that are classified as traumatism. On the other hand, long-term repetition of the same movements, when their intensity and duration exceed tissue resistance, causes changes in the structure of joints, connective tissue, muscles and tendons (16). Chronic injuries can occur as a result of long-term workload, which workers often neglect and ignore due to rapid healing and relief of complaints (9). The risk of developing disorders, especially in the lower back, also depends on body posture, working position and movement, i.e. twisting or bending of the trunk. These postural requirements play a particularly important role when working in confined spaces (17). That is why it is not surprising that there is a high frequency and prevalence among workers who are exposed primarily to manual handling, repetitive and static work, vibrations, as well as poor

psychological and social conditions (2), and the key role in the development of these diseases is played by individual characteristics and predisposition (16).

Early diagnosis and effective prevention of MSD is essential from a socioeconomic point of view, and takes place in parallel with the improvement of the working conditions that underlie the occurrence of these conditions (3). An important role in disease recognition and early diagnosis is primarily played by general practitioners, to whom patients first turn for help due to their frequent symptoms, pain or functional limitations. However, the role of occupational medicine specialists, who in cooperation with companies and employers provide preventive services (17), is indispensable. Health promotion and raising the awareness of workers during their working life, about the ways and possibilities of preventing the occurrence of diseases and disorders, is crucial for extending their working life (4).

For the effective prevention of WMSDs, the most important thing is the balance between the mechanical load at work and the carrying capacity of the musculoskeletal system (9) and implies the elimination and/or minimization of risks present at workplaces. Each workplace has unique risk factors that may favor the occurrence of MSDs, so a careful assessment should be carried out to identify them, and individual factors such as demographic factors should also be taken into account when assessing risk

(8). In order to prevent WMSDs and to stimulate the satisfaction and productivity of workers, it is essential to apply the ergonomics of the workplace and work environment (2). Education and training are at a lower level of prevention of MSDs, because they are administrative interventions that change the behavior and competencies of workers in dealing with risks instead of removing or reducing job-related risks (8).

Aim

The aim of this research is to assess the prevalence of MSDs, with a special focus on:

- assessment of the influence of the body position at work on the incidence of MSDs,
- assessment of the impact of other factors: age, gender, length of service and length of exposure work experience and body mass index (BMI),
- prevalence of MSDs, and
- definition of preventive measures.

Material and Methods

The workers of the Niš Tobacco industry (Niš TI) were observed during the year 2022. References and results of systematic reviews of workers employed in TI were used as a source of data. Systematic examinations of workers were carried out in the period from January to December 2022. During 2022, a total of 426 workers were examined. The analysis was performed according to gender, age and qualification structure, length of service and exposure work experience (work experience spent at the workplace to which the worker was assigned at the time of observation), body position at work and body mass index (BMI). The assessment of harmful factors of the working environment was obtained in the instructions for the examination of workers, that is, it was derived from the risk assessment act of TI workplaces. The impact of body position during work on the occurrence of MSDs among workers was analyzed from a detailed work history.

The method of work is retrospective and descriptive. Known and recognized software statistical packages (IBM SPSS Statistics 30.0.0.) were used for statistical processing. Relative numbers (structure indicators) were used from descriptive statistical methods, while Student's t-test was used for testing statistical hypotheses, at a statistical significance level of 0.05.

Results

Out of a total of 426 tobacco industry workers examined as part of a regular systematic examination in 2022, 69 (16.2%) workers were diagnosed with MSD. According to gender and age structure, there were 338 men, aged 18 to 62 (42.21 \pm 10.63) and 88 women, aged 28 to 60 (50.82

 \pm 7.68). In the group of workers who were diagnosed with MSD, the average age among male respondents was 44.11 \pm 8.36, and among female respondents 51.58 \pm 5.77 (Table 1).

	Table	1. Age	of	employees,	total	and	exposed	work	experience
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Gender Number of			A	ge	Total WEX	Exposed WEX	
		employees	min	max	mean		
a	М	338	18	62	42.21 ± 10.63	17.46±10.55	10.01 ± 9.43
Tot	F	88	28	60	50.82 ± 7.68	26.21± 8.88	20.24 ± 11.93
SD	М	41	27	60	44.11± 8.36	20.11 8.88	10.06 ± 8.00
ω	F	28	38	59	51.58 ±5.77	26.72 ± 7.63	20.35 ± 11.45

* Total WEX - total work experience, Exposed WEX - Exposed work experience

Among male workers, the largest number of patients belong to the age group between 40 and 49 years, while the largest number of women are in the age group of 50 to 59 years (Chart 1).

Chart	1. A	lge	structure	of a	all e	exar	nined	workers	and	workers	suffering	from
		2									5	

MSDs



In men, the total working experience (total WEX) was from 2 months to 40 years (17.46 \pm 10.55), and the exposed working experience (exposed WEX) was from 2 months to 38 years (10.01 \pm 9.43). In women, total WEX ranged from 5 months to 39 years (26.21 \pm 8.88), and exposed WEX from 5 months to 39 years (20.24 \pm 11.93) (Table 1).

The influence of body position at work on the occurrence of MSDs was observed in workers who mostly stand for more than 6 hours during working hours, then in workers who predominantly sit, as well as in workers who change their position during work. There is a statistically significant difference in the group of workers who predominantly stand during working hours (p<0.05) (Table 2).

Table 2. Influence of body position on the occurrence of musculoskeletal

 diseases

Body posistion	N (%)	Number of people with MSD n (%)	p - value
Standing	328 (77%)	61 (88,41%)	0.0386*
Combined	68 (15,96%)	7 (10,14%)	0.2120
Sitting	27 (6,33%)	1 (1,45%)	0.1033
Total	426	69	

*p<0,05

According to the qualification structure, the largest percentage of workers was distributed in the direct production sector 328 workers, in the technical services sector 68 workers and 27 workers in the quality control sector. A statistically significant difference is present in the direct production sector, where there is a higher prevalence of MSDs among female workers (Table 3).

Table 3. The difference in the incidence of MSDs according to gender andbody position at work

SECTOR / Job position	Body position	Gender Total number employees N (%)		number of ployees I (%)	MSD n (%)		p - value M/F	
SECTOR A -	Standing >	М	254	59,62%	35	17,78%		
DIRECT PRODUCTION	6h	F	74	17,37%	26	35,14%	0.0001*	
	• •							
SECTOR B - TECHNICAL	Combined	Μ	65	15,26%	6	9,23%	0.1845	
SERVICES		F	3	0.70%	1	33,33%		
SECTOR C -		М	8	1,88%	0	0%		
QUALITY CONTROL	Sitting > 6h	F	19	4,46%	1	5,26%	0.5270	
TOTAL			426	100%	69	16,2%		

*p<0,05

Analysis of the association between body mass index and musculoskeletal disorders shows that overweight individuals have a higher tendency to develop MSD. Two thirds of respondents 45 (65.22%) are overweight and have a BMI from 25.0 to 29.9, while 14 (20.29%) belong to the obese category. There were no malnourished persons with an index below 18.5 (Table 4).

Table 4. Influence of body mass index (BMI) on incidence ofmusculoskeletal disorders

BMI	18,5 - 24,9	25.0 - 29,9	> 30	Total
Body position	(normal)	(owerweight)	(obese)	
Standing (N=61)	8 (72,73%)	42 (93,33%)	11 (78,57%)	61 (88,41%)
Combined (N=7)	2 (27,27%)	3 (6,67%)	2 (14,29%)	7 (10,14%)
Sitting (N=1)	0	0	1 (7,14%)	1 (1,45%)
Total	10 (14,49%)	45 (65,22%)	14 (20,29%)	69 (100%)

In male workers, BMI ranged from 20.37 to 35.43 (25.27 \pm 2.37), body weight (BW) from 70 to 108 kg (84.49 \pm 6.05), body height (BH) from 168 to 192 cm (183.05 \pm 4.57). In women, from 20.05 to 31.96 (25.15 \pm 3.2), BW from 56 to 92 kg (72.32 \pm 8.7), BH from 157 to 182 cm (69.71 \pm 4.83). In the group of workers suffering from MSDs, the average BMI was 27.86 \pm 2.63 for male workers and 27.27 \pm 3.1 for female workers (Table 5).

	Gender N		BMI						
			min	max	mean	SD			
DTAL	М	338	20.37	35.43	25,27	2,37			
Р¥-	F	88	20,05	31,96	25,15	3,2			
D	М	41	23.37	35.43	27.86	2.63			
W	F	28	20.08	31.96	27.27	3.1			

Table 5. Body mass index (BMI) of workers suffering from MSDs

MSDs were most prevalent in workers who work in a sitting position with complaints of lower back pain 24 (34.78%), cervical spine 18 (26.09%) and joint pain 10 (14.49%) (Table 6).

Table 6	Distribution	of MSDs	according	to	body	position	at worl
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Body position	Standing	Combined	Sitting
Diagnosis	(N=61)	(N=7)	(N=1)
M54.5 Dolor sacralis	24 (34,78%)	3 (4,35%)	
M47 Spondylosis vert. cervicalis	18 (26,09%)	2 (2,9%)	
M53.1 Sy cervicobrachialis	4 (5,8%)	1 (1,45%)	
M06.9 Arthritis reumatoides	4		1 (1,45%)
M25.5 Arthralgia	10 (14,49%)		
M81.9 Osteoporosis	3 (4,35%)		
M17 Gonarthrosis	2 (2,9%)	1 (1,45%)	

According to the gender structure, the most common diagnoses according to the ICD 10 classification in men were: pain in the lower back in 51.22%, followed by spondylosis of the cervical spine in 21.95% and arthralgia in 14.63%, while in women the most frequent diagnosis was spondylosis in the cervical spine in 39.29%, followed by lumboischialgia in 21.43% and arthralgia in 14.29% (Table 7).

Male (n=41)	Female (n=28)
21 (51,22%)	6 (21,43%)
9 (21,95%)	11 (39,29%)
3 (7,32%)	2 (7,14%)
/	1 (3,57%)
6 (14,63%)	4 (14,29%)
1	3 (10,71%)
2 (4,88%)	1 (3.57%)
	21 (51,22%) 9 (21,95%) 3 (7,32%) / 6 (14,63%) / 2 (4,88%)

Table 7. Distribution of MSDs according to ICD 10 classification and bygender

An inspection of the Risk assessment Act for workplaces where workers were assigned, found that all workplaces are without increased risk, and that the dynamics of work activities are of such intensity that the work is characterized as medium-hard physical effort. Data obtained from the work anamnesis shows that workers in the direct production sector during working hours mostly stand for more than 6 hours during a shift, workers in the quality control sector spend more than 6 hours in a sitting position, while workers in the technical sector have a combination.

Discussion

A total of 426 employees of the Nis Tobacco Industry responded to the regular systematic examination in 2022. MSDs were registered in 69 (16.2%) cases, namely in 41 (12.13%) of 338 men and in 28 (31.82%) of 88 examined women. The average age of male workers who were diagnosed with MSD was 44.11 ± 8.36 , of which 51.22% belonged to the age group between 40 and 49 years old, while the average age of women was 51.58 \pm 5.77, and the highest percentage was between 50 and 59 years old (64.29%). Statistically, there was a significant difference in the exposed working experience. On average, women spent 20.35 ± 11.45 years in the workplace, and men significantly less, 10.06 ± 8.00 years. There is a statistically significant difference in the prevalence of MSDs in the group of workers who predominantly stand during working hours (p<0.05), which indicates the importance of the influence of body position during work on the expression of MSDs. A statistically significant difference is also present in the direct production sector, where there is a higher prevalence of MSDs female workers (P<0.0001), which can be explained by the among difference in anatomical and physiological structure, as well as the difference in physical endurance between the opposite sexes. Among the MSDs in men, pain in the lower back is the most common in 51.22%, followed by spondylosis of the cervical spine in 21.95% and arthralgia in 14.63%, while in women the most common diagnosis is spondylosis in the cervical spine in

39.29%, followed by pain in the lower back in 21.43% and arthralgia (14.29%). Analyzing the significance of the influence of body mass index, it is noted that overweight people have a greater tendency to suffer from MSDs. Two thirds of respondents 45 (65.22%) are overweight, while almost 20% belong to the obese group. All workplaces according to the Risk Assessment Act are characterized as workplaces without increased risk with medium physical effort.

According to data from the European Agency for Safety and Health at Work (EU-OSHA), in France, for example, postural and joint loads (74.6% of men and 73.9% of women), followed by standing or upright work in place (48.6% of men and 42.9% of women), walking during work (47.5% of men and 34.5% of women) and manual handling of loads (44.1% of men and 29.0% of women) were cited as the most common occupational risk for MSDs. In addition to work involving high physical demands, both organizational and psychosocial risk factors can also affect the health of the musculoskeletal system of workers (18). In a large number of European countries, pain in the lower back is not classified as an occupational disease, except in cases where it is caused by an injury at work. For example, in the Czech Republic in 2012, MSDs were accounted for 20% of disability cases and 23.3% of all sick leave in 2010 in Germany. Given the prevalence of this diagnosis in the working population and numerous evidences that physical exertion can not only cause but also worsen MSD, these disorders

represent a global social problem and require prevention in the early stages, which primarily includes technical prevention and good work organization (19). According to the EU Report from 2013, in 22 of the 29 countries that participated in the survey, risk prevention is considered a priority. Of these, in 16 countries disorders of the musculoskeletal system were singled out as a key focus in disease prevention (20).

A review study by Jacques-Bret et al., showed that the highest prevalence of MSD was recorded in the lower back (over 60%), as well as in the shoulders and upper extremities (35-55%) in surgeons and dentists, which is associated with long-term maintenance and repetition of incorrect body positions (21). It was found that risk factors, such as working posture, length of working hours, repetitive and intense movements, work experience, age, gender and work in stressful conditions, are significantly associated with the occurrence of MSDs, which emphasizes the need for preventive measures and ergonomic adaptation of the work environment (22). The situation is particularly pronounced in low- and middle-income countries, where limited reporting systems make it difficult to monitor and solve this problem (23).

Monitoring the prevalence of illnesses at the workplace and defining the risk factors that favor their occurrence provide us with valuable data that we can use to create and implement adequate prevention measures to

reduce the risk of illness and/or injuries at work. Occupational health professionals should consider the implementation of appropriate ergonomic measures that can play a key role in the prevention and management of MSDs in this occupational group. Education of workers, implementation of programs to raise the awareness of workers about healthy lifestyles and organizing sports activities are just some of the measures that can significantly affect the improvement of the physical and psychological wellbeing of workers. Therefore, it is important to carry out further research in practice, in order to examine all specific causative factors and to develop intervention strategies to improve occupational health.

Conclusion

Workers employed in the direct production sector of the Tobacco industry in Niš have a greater tendency to develop musculoskeletal disorders, which indicates the influence of non-physiological body positions, i.e. long standing during work. A statistically significant difference in incidence of MSDs also exists between the sexes, as indicated by our results, where the prevalence of MSDs is significantly higher in women. Women are more likely to suffer from spondylosis of the cervical spine, which is probably caused by long-term non-physiological body posture during work, while male workers are more prone to pain in the lower back, which can be related to lifting heavy loads. The overweight and age of subjects may also be related to the high rate of MSDs in tobacco workers.

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