Original article

UDC: 616.7:616-057
doi: 10.5633/amm.2025.0411

INFLUENCE OF WORK POSTURE ON THE OCCURRENCE OF DISORDERS OF THE MUSCULOSKELETAL SYSTEM AMONG WORKERS IN THE TOBACCO INDUSTRY

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Musculoskeletal system disordes (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. Their multi-factorial etiologies primarily caused by the interaction of an unhealthy lifestyle and workplace conditions that vary in different occupations.

This research aimed to examine the prevalence of musculoskeletal system disorders among workers of the Niš Tobacco Industry (Niš 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 were found to have 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 Niš 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.

*Acta Medica Medianae 2025;64(4):*95–103.

Key words: *musculoskeletal system disorders, workers, Tobacco industry Niš, working body position*

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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 high costs on society for treatment, sick leave, retirement, and significantly reducing productivity in working life (2). In the European Union (EU) member states, MSDs account for a significant proportion of lost working days and affect workers across 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). Work-related MSDs contribute significantly to reduced work productivity (5, 6), and symptoms usually appear only after years of chronic exposure to risk factors (2).

Musculoskeletal disorders are among the most common health conditions 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 were 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 fundamental structural component of the tumor 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, enabling them to function as a cohesive unit (3, 10, 11). The health of this system is essential for daily functioning, because disturbances in its parts can lead to various disorders. As many as 150 different types of MSDs have been reported in the literature (12), and include a wide range of inflammatory and degenerative diseases, including some lesser-known conditions causing pain and functional impairment. These include tendon inflammations (tendinitis and tenosynovitis), myalgias, nerve entrapment syndromes, degenerative disorders across different levels of the spinal column, etc. (2).

Musculoskeletal system disorders 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, such as genetic predisposition, environmental factors, workplace factors, occupational activities, and locations where individuals spend most of their time (3, 15). Work-related MSDs 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 MSD is high frequency and prevalent among workers who are primarily exposed to manual handling, repetitive and static work, vibrations, as well as poor psychological and social conditions (2). Also playthe key role in the development of these diseases individual characteristics and predispositions (16).

Early diagnosis and effective prevention of MSDs are essential from a socioeconomic perspective, and take 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 awareness among workers during their careers regarding strategies to prevent the of MSDs are crucial for extending their working life (4).

For the effective prevention of work related musculoskeletal disorders (WMSDs), the most important thing is the balance between the mechanical load at work and the carrying capacity of the musculoskeletal system (9), which implies the elimination and/or minimization of risks present at workplaces. Each workplace has unique risk factors that contribute to 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 eliminating or reducing job-related risks (8).

Aim

This research aimed 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, such as age, gender, length of service and length of exposure, work experience, and body mass index (BMI);

-Prevalence of MSDs; and

-Definition of preventive measures.

Materials and Methods

A 61-year-old female presented with The workers of the Niš Tobacco Industry (Niš TI) were observed in 2022. The results of systematic medical examinationis 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 edukationlevel, length of service, and duration of at the cuarent workplace (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 based on a detailed work history.

The method of work was retrospective and descriptive. Statistical analyzis was performed using IBM SPSS statistics verision 30.0.0. 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 workers (16.2%) were diagnosed with MSDs. According to gender and age structure, there were 338 men, aged 18 to 62 mean age (42.21 ± 10.63) and 88 women, aged 28 to 60 (50.82 ± 7.68). In the group of workers who were diagnosed with MSDs, the average age among male respondents was 44.11 ± 8.36, and among female respondents, 51.58 ± 5.77 (Table 1).

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

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

The influence of body position at work on the occurrence of MSDs was observed in workers who predominantly stood for more than 6 hours per workday hours, compared to workers who predominantly sat, as well as in workers who changed their position during work. A statistically significant difference was found in the group of workers who predominantly stand during working hours ($p < 0.05$) (Table 2).

According to the qualification structure, the largest number of workers was distributed 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 was observed in the direct production sector, where there is a higher prevalence of MSDs among female workers (Table 3).

Table 1. Age of employees, total, and exposed work experience

Gender		Number of employees	Age			Total WEX	Exposed WEX
			min	max	mean		
Total	M	338	18	62	42.21 ± 10.63	17.46 ± 10.55	10.01 ± 9.43
	F	88	28	60	50.82 ± 7.68	26.21 ± 8.88	20.24 ± 11.93
MSD	M	41	27	60	44.11 ± 8.36	20.11 ± 8.88	10.06 ± 8.00
	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*

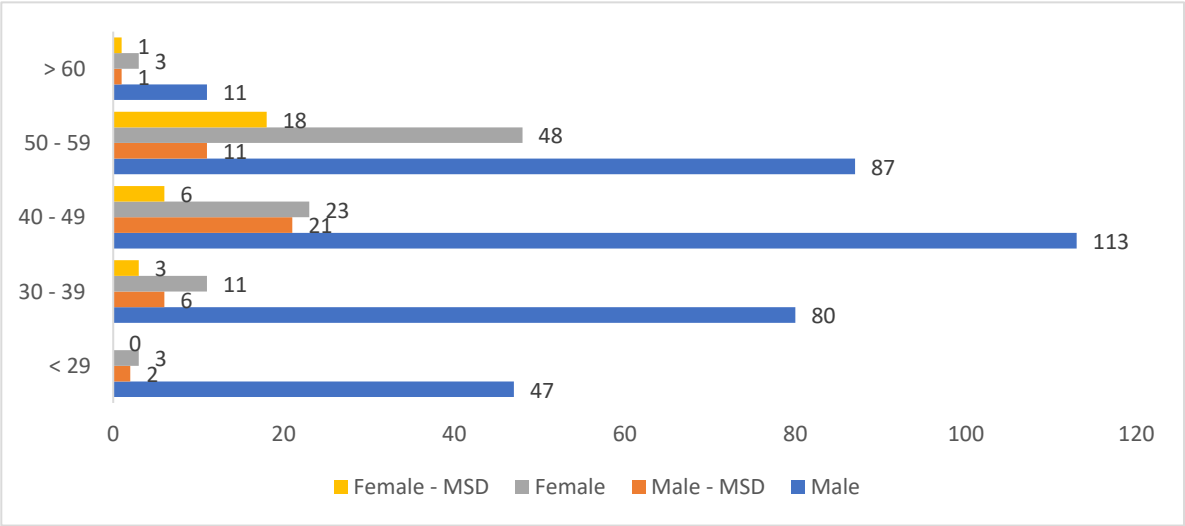

Figure 1. Age structure of all examined workers and workers suffering from MSDs

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

Body position	Number of employees 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

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

SECTOR/Job position	Body position	Gender	Total number of employees n (%)		MSD n (%)		p-value M/F
SECTOR A—DIRECT PRODUCTION	Standing > 6 h	M	254	59.62%	35	17.78%	0.0001*
		F	74	17.37%	26	35.14%	
SECTOR B—TECHNICAL SERVICES	Combined	M	65	15.26%	6	9.23%	0.1845
		F	3	0.70%	1	33.33%	
SECTOR C—QUALITY CONTROL	Sitting > 6 h	M	8	1.88%	0	0%	0.5270
		F	19	4.46%	1	5.26%	
TOTAL			426	100%	69	16.2%	

*p < 0.05

Analysis of the association between body mass index and musculoskeletal disorders showed that overweight individuals have a higher tendency to develop MSDs. Two-thirds of respondents, 45 (65.22%), were overweight and had a BMI from 25.0 to 29.9, while 14 (20.29%) belonged to the obese category. There were no underweight individuals with a BMI below 18.5 (Table 4).

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

Musculoskeletal disorders were most prevalent among workers who worked in a sitting position, and complained of lower back pain 24 (34.78%), cervical spine poin 18 (26.09%), and joint pain 10 (14.49%) (Table 6).

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

An inspection of the Risk Assessment Act for workplaces where workers are assigned found that rot all workplaces pose an increased risk and that the dynamics of work activities are of such intensity that the work is characterized as moderate physical effort. Data obtained from the occupational history show that workers in the direct production sector spend more than 6 hours standing during working hours, while workers in the quality control sector spend more than 6 hours in a sitting position. Workers in the technical sector have a combination of standing and siting positions.

Table 4. Influence of BMI on incidence of musculoskeletal disorders

BMI Body position	18.5–24.9 (normal)	25.0–29.9 (overweight)	> 30 (obese)	Total
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%)

Table 5. Body mass index of workers suffering from MSDs

	Gender	Number	BMI			
			min	max	mean	SD
TOTAL	M	338	20.37	35.43	25.27	2.37
	F	88	20.05	31.96	25.15	3.2
	M	41	23.37	35.43	27.86	2.63
	F	28	20.08	31.96	27.27	3.1

Table 6. Distribution of MSDs according to body position at work

Body position / Diagnosis	Standing (n = 61)	Combined (n = 7)	Sitting (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			1 (1.45%)
M25.5 Arthralgia	10 (14.49%)		
M81.9 Osteoporosis	3 (4.35%)		
M17 Gonarthrosis	2 (2.9%)	1 (1.45%)	

Table 7. Distribution of MSDs according to ICD 10 and by gender

Diagnosis	Male (n = 41)	Female (n = 28)
M54.5 Dolor sacralis	21 (51.22%)	6 (21.43%)
M47 Spondylosis vert. cervicalis	9 (21.95%)	11 (39.29%)
M53.1 Sy cervicobrachialis	3 (7.32%)	2 (7.14%)
M06.9 Arthritis reumatoides	/	1 (3.57%)
M25.5 Arthralgia	6 (14.63%)	4 (14.29%)
M81.9 Osteoporosis	/	3 (10.71%)
M17 Gonarthrosis	2 (4.88%)	1 (3.57%)

Discussion

A total of 426 employees of the Niš Tobacco Industry responded to the regular systematic examination in 2022. Musculoskeletal disorders were identified in 69 (16.2%) cases, namely in 41 (12.13%) of 338 men and in 28 (31.82%) of 88 examined women. The mean age of male workers who were diagnosed with MSDs 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 ± 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 was a statistically significant difference in the prevalence of MSDs in the group of workers who predominantly stood 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 was also present in the direct production sector, where there was a higher prevalence of MSDs among female workers ($p < 0.0001$), which can be explained by the difference in anatomical and physiological structure, as well as the difference in physical endurance between the men and women. Among the MSDs in men, lower back pain was the most common (51.22%), followed by spondylosis of the cervical spine (21.95%) and arthralgia (14.63%), while in women, the most common diagnosis was spondylosis of the cervical spine (39.29%), followed by lower back pain (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%) were overweight, while almost 20% belonged to the obese group. All workplaces, according to the Risk Assessment Act, are characterized as workplaces without increased risk with moderate 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 risks 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 accounted for 20% of disability cases, white in Germany they accounted for 23.3% of all sick leave in 2010. Given the prevalence of this diagnosis in the working population and the numerous pieus of evidence that physical exertion can not only cause but also worsen MSDs, 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, MSDs 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 MSDs 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 prolonged maintenance and repetition of incorrect body positions (21). Previous studies have showen that risk factors, such as working posture, long working hours, repetitive and intense movements, work experience, age, gender, and worning 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 work-related diseases and defining the risk factors that favor their occurrence provides 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 among 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 well-being 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., prolongded standing at work. A statistically significant difference in the 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 lower back pain, which can be related to lifting heavy loads. Overweight and older age may also be related to the high rate of MSDs in tobacco workers.

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Originalni rad **UDC: 616.7:616-057**
doi: 10.5633/amm.2025.0411

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

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Bolesti mišićno-skeletnog sistema zahtevaju posebnu pažnju, s obzirom na to da predstavljaju jedan od vodećih uzroka odsustva sa posla i invaliditeta u svetu. Pored toga što utiču na sam kvalitet života, u velikoj meri umanjuju radnu sposobnost. Mogu se javiti u bilo kojoj životnoj dobi. Mada su uzroci njihove pojave različiti, nastaju prvenstveno usled interakcije nezdravog stila života i uslova na radnom mestu, koji se razlikuju u zavisnosti od zanimanja.

Cilj ovog istraživanja bio je da ispita zastupljenost bolesti mišićno-skeletnog sistema među radnicima Duvanske industrije Niš (DIN), kao i uticaj položaja tela radnika i drugih faktora u vezi sa radom na pojavu oboljenja mišićno-skeletnog sistema. Od ukupno četiristo dvadeset šest radnika pregledanih na sistematskom pregledu 2022. godine, kod šezdeset devet (16,2%) radnika registrovani su poremećaji mišićno-skeletnog sistema. Bolesti mišićno-skeletnog sistema bile su zastupljenije kod radnika u sektoru direktne proizvodnje (stojeći položaj) – 61 (88,41%) i kod žena (40,6%). Takođe, dovode se u vezu i sa prekomernom telesnom težinom i sa starošću radnika.

Visok stepen učestalosti mišićno-skeletnih poremećaja među zaposlenima u DIN-u ukazuje na to da je potrebno preduzeti adekvatne mere prevencije, kontrole i redukcije rizika za nastanak oboljenja i povreda mišićno-skeletnog sistema kako bi se smanjila učestalost oboljevanja i rizik od nastanka invaliditeta, ali i poboljšao kvalitet života i povećala radna sposobnost.

*Acta Medica Medianae 2025; 64(4):*95–103.

***Ključne reči**: poremećaji mišićno-skeletnog sistema, radnici, Duvanska industrija Niš, položaj tela u toku rada*