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The impact of sedentary office work on lumbar spine load

Wpływ biurowej pracy siedzącej na obciążenie odcinka lędźwiowego kręgosłupa

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Abstract

Introduction and Objective. The aim of the study was to assess the impact of sedentary work on lumbar spine strain in office workers, taking into account anthropometric characteristics, health status, physical activity levels, and knowledge about workplace ergonomics.

Materials and Method. The study was conducted using a questionnaire that included questions about anthropometric features, health status, workplace and non-workplace ergonomics, the nature of lumbar spine pain complaints, and physical activity. The study group consisted of office workers (63 women and 18 men) aged between 22–64 years, in the city of Kraków, Poland.

Results. Most participants (92.6%) reported experiencing lower back pain, with 65.4% suffering from chronic conditions in this area for several years. Among those experiencing pain, 41% used physiotherapy, only 10 people engaged in physical activity, and 38.3% took no action. Medication was necessary for 20.9%. A higher BMI was correlated with more frequent and severe pain episodes on the VAS scale. Individuals with longer job tenure more often experienced pain radiating to the legs, and poor ergonomic habits were associated with higher levels of pain.

Conclusions. The study confirmed that sedentary office work significantly contributes to lumbar spine pain, particularly in the presence of poor ergonomics and lack of physical activity. Implementing preventive measures, such as improving workplace ergonomics and promoting regular physical activity, is essential for reducing pain and enhancing the quality of life of office workers. Despite widespread knowledge of work ergonomics, many companies and office workers in Kraków do not follow ergonomic principles, which remains a common problem in this group.

Key words

ergonomics, spine pain, office work, organization of the workplace

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Streszczenie

Wprowadzenie i cel pracy. Celem pracy była ocena wpływu pracy siedzącej na obciążenie odcinka lędźwiowego u pracowników biurowych z uwzględnieniem cech antropometrycznych pracowników, ich stanu zdrowia, poziomu aktywności fizycznej oraz wiedzy na temat ergonomii pracy.

Materiał i metody. Badanie zostało przeprowadzone przy pomocy kwestionariusza, który zawierał pytania dotyczące cech antropometrycznych badanych, ich stanu zdrowia, poziomu ergonomii w miejscu pracy i poza pracą, charakteru doświadczanych dolegliwości bólowych odcinka lędźwiowego kręgosłupa oraz podejmowanej aktywności fizycznej. Grupę badaną stanowili pracownicy biurowi z Krakowa (63 kobiety i 18 mężczyzn) w przedziale wiekowym 22–64 lata.

Wyniki. Większość uczestników (92,6%) zgłaszała ból lędźwiowy, a 65,4% z nich cierpiało na przewlekłe dolegliwości w tej części kręgosłupa od kilku lat. Spośród osób odczuwających ból 41% korzystało z fizjoterapii, tylko 10 osób uprawiało aktywność fizyczną, a 38,3% nie podejmowało żadnych działań; 20,9% badanych musiało stosować leki. Zauważono, że wyższy wskaźnik BMI koreluje z częstszymi i intensywniejszymi epizodami bólowymi ocenianymi na skali VAS. Osoby z dłuższym stażem pracy częściej doświadczały bólu promieniującego do nóg, a złe nawyki ergonomiczne były powiązane z wyższym poziomem bólu.

Wnioski. Badanie potwierdziło, że siedząca praca biurowa znacząco przyczynia się do bólu odcinka lędźwiowego kręgosłupa, szczególnie przy złej ergonomii i braku aktywności fizycznej. Wprowadzenie działań profilaktycznych, takich jak poprawa ergonomii stanowiska pracy i regularna aktywność fizyczna, jest kluczowe dla zmniejszenia dolegliwości bólowych i poprawy jakości życia pracowników biurowych. Mimo powszechnej wiedzy o ergonomii pracy wiele firm i pracowników biurowych w Krakowie nie przestrzega zasad ergonomicznych, co sprawia, że problem ten jest częsty w tej grupie.

Słowa kluczowe

ergonomia, ból kręgosłupa, praca biurowa, organizacja stanowiska pracy

INTRODUCTION

Ergonomics is a science that deals mainly with the problem of how to optimally adapt the workplace to the individual. Its aim is to protect workers from the risk of accidents at work and to create conditions conducive to easier, safer and more productive work [1]. The ergonomic approach to employees considers not only exogenous factors but also those originating from within – endogenous factors such as current health status, chronic diseases, and allergies.

An essential aspect is the preparation of an appropriate workspace for office workers, as they spend most of their work time in static positions, which can lead to pain syndromes, musculoskeletal problems, and occupational diseases characteristic of specific static jobs, such as spinal pain syndromes, carpal tunnel syndrome, and tendon enthesopathies of the forearm muscles [2]. Prolonged sitting is a factor that increases sick leave, which, combined with factors such as monotony, monotypy, and static exertion, leads to the development of conditions known in English as Work-Related Musculoskeletal Disorders (WMSDs) [3]. Kraków is the third-largest city in Poland, characterized not only by cultural values but also by a vast office base. Kraków is a city in the Małopolskie Province with the highest employment rate, and with a high percentage of employees who are public authority representatives, specialists, and office workers [4]. A common characteristic of these occupational groups is sedentary work.

The aim of the study was to determine the impact of sedentary work on lumbar spine strain in office workers, taking into account their anthropometric characteristics, health status, physical activity level, and knowledge about workplace ergonomics.

MATERIALS AND METHOD

The survey was conducted using a proprietary questionnaire among 150 employees whose work was office-based, with all participants working in Kraków. The study group consisted of 90 women and 60 men. Participants were informed about the purpose and method of the study and gave their consent. The survey was fully anonymous and did not include personal data of the participants. The proprietary questionnaire consisted of five parts: (I) general information, (II) health interview, (III) pain (occurrence and nature), (IV) work and ergonomic interview, and (V) assessment of physical activity level. Respondents were asked to rate their pain intensity on a Visual Analog Scale (VAS), where 0 indicated no pain and 10 indicated the worst imaginable pain.

Exclusion criteria included past spinal injuries and surgeries, spinal diseases, such as degenerative disc disease, scoliosis, intervertebral disc dehydration with herniations confirmed by MRI, diseases related to reduced bone density, such as osteoporosis, and metabolic diseases such as diabetes and gout.

The interviews conducted with the participants revealed exclusion criteria in some volunteers: 40 had disc herniation, 8 had diabetes, 4 had gout, 7 had bone tissue diseases, and 10 reported having undergone spinal surgery in the past. These individuals were not included in the study. Ultimately, after verifying the respondents' answers, 18 men (22.2%) and 63 women (77.8%) were included in the study. The recruitment, qualification, and final analysis process is presented in Figure 1.

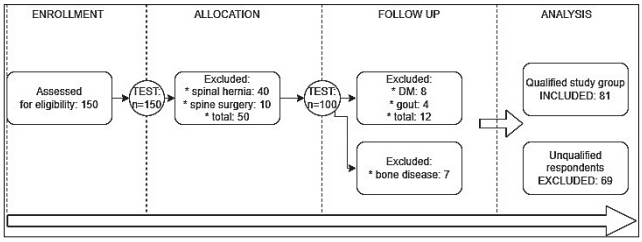

Figure 1. Patient flow diagram

Statistical analysis. The relationship between qualitative variables was compared using the Chi-square test. Due to the type of distribution, the comparison of quantitative variables between the selected groups was performed using the non-parametric Mann-Whitney U test (for 2 groups) or the Kruskal-Wallis test (for 3 groups) with *post-hoc* analysis (Dunn's test with Bonferroni correction). The relationship between 2 quantitative variables was verified using Spearman's rank correlation coefficient. In all tests, a p-value of <0.05 was considered statistically significant.

RESULTS

The basic characteristics of the study group are presented in Table 1. Among the respondents, 48.1% indicated that they had been working in their profession for more than 7 years, 25.9%: 3–7 years, and 25.9% had been working for up to 3 years.

Table 1. Anthropometric characteristics of the surveyed employees

Features	Amount/%	Age	Weight [kg]	Height[cm]	BMI
Male	18(22.2%)	28(SD=4.5)	84.5(SD=13.2)	181.5(SD=7.8)	25.6
Female	63(77.8%)	35(SD=9.9)	66.5(SD=11.7)	167(SD=4.9)	23.8

It was indicated that 92.6% (n=75) of the respondents reported experiencing lumbar spine pain, and as many as 65.4% (n=53) reported struggling with lumbar spine pain for several years. Of the respondents complaining of lumbar spine pain, about 41% (32 people) manage the pain through visits to physiotherapists, and only 10 people engage in physical activity. Thirty-one respondents (38.3%) reported that they had not taken any action to combat the pain, and 17 people (20.9%) indicated that despite taking action, they were forced to use pharmacotherapy.

Forty-three people (53.1%) reported that pain occurs during the workday, 23 respondents (28.4%) also reported pain while lying down, and as many as 75.3% (n=61) indicated that work causes them excessive lumbar spine strain.

Respondents asked to rate their pain intensity on the VAS scale most frequently indicated values between 4 and 6 (Fig. 1). Nearly 70% of respondents (n=57) reported that the pain radiates to the lower limbs, and 41% of respondents (n=33) also reported that lumbar spine pain hinders the performance of basic daily activities.

In the next stage, questions were asked about working conditions, and 74.1% of respondents (n=60) indicated that they had an ergonomic chair with adjustable height and backrest. Respondents in 41.3% (n=35) declared that they keep their wrists resting on the edge of the desk, 33.7% (n=27) keep their wrists suspended in the air, and 25% (n=20)

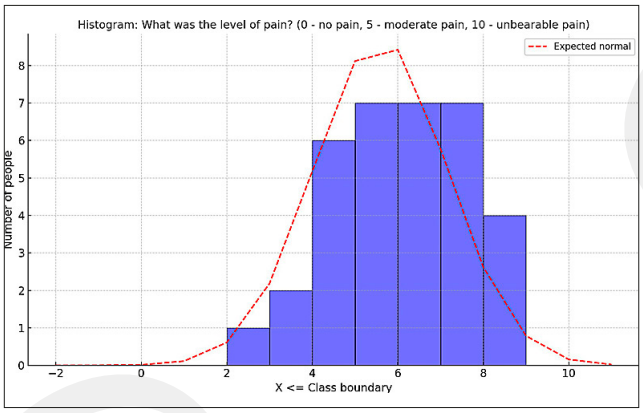

Figure 2. Distribution of the variable: degree of pain intensity assessed on the VAS scale

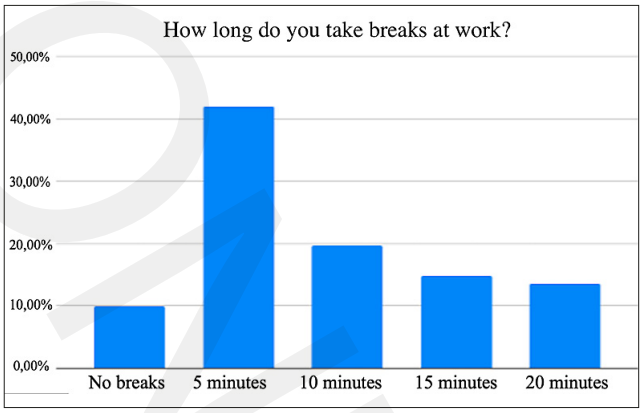

Figure 3. Distribution of responses to the question about the length of breaks during work

rest their wrists on a pad. Furthermore, 42.5% (n=34) of respondents rested their forearms on the edge of the desk, 30% (n=24) rested their forearms on the edge of the desk. Among the respondents, 22.5% (n=18) reported that they are fully positioned on the desk, while only 5% of respondents (n=4) reported that they keep their forearms on armrests. About 43.8% of the surveyed office workers (n=35) declared that they have their keyboard positioned above elbow level, 42.5% (n=34) at elbow level, and 13.8% (n=11) below that level.

In the next group of questions, 48.7% of respondents (n=39) answered that the work they do is sometimes associated with increased stress, and only 10% (n=8) that it is not associated with any increased stress. As many as 41.3% of respondents (n=33) indicated that their job is associated with increased stress.

The vast majority of respondents answered that while sitting, they cross one leg over the other and rest their buttocks on the front edge of the chair (Tab. 2).

Table 2. Anthropometric characteristics of the employees

Characteristics	Category	Age (years)	Weight (kg)	Height (cm)
Men	Min	23	65	171
	Max	42	115	198
	Median	27.5	81	178.5
Women	Min	22	45	155
	Max	64	99	177

According to the respondents' declarations, 31 respondents (38.3%) of office workers maintain a correct vertical position, while 50 (61.7%) workers answered that they 'often slouch' while standing.

The distribution of responses to the question about the length of breaks during work is presented in Figure 2.

Statistical analysis of the obtained results indicated the presence of a correlation between BMI and the number of pain episodes during the day (r_s=0.582; p<0.0001). Body Mass Index (BMI) was also positively correlated with pain intensity assessed on the VAS scale (r_s=0.600; p<0.001). As BMI values increased, the number of daily pain episodes and pain intensity on the VAS scale also increased. It was also indicated that higher BMI values increased the frequency of radicular symptoms, such as radiation to the lower limbs (p=0.0002). Higher BMI values (25–29) are characteristic of pain radiating to the lower limbs, which was not observed for lower BMI values (21–24). It was also indicated that the presence of pain radiating to the limbs was reported with varying frequency depending on the length of service (p<0.0001). Employees with up to 3 years of service and 3–7 years of service did not report radiation to the lower limbs (100%), these reports only appeared in the group of employees with more than 7 years of service (64.1%). The factor of length of service was also positively correlated with pain intensity (r_s=0.519; p<0.000001).

Declarations regarding knowledge of workplace ergonomics differed among groups with different lengths of service (p<0.0001) in the independence test (Chi-square). Employees with up to 3 years and 3–7 years of service answered 100% that they knew and used ergonomic principles. Employees with more than 7 years of service responded differently – 12.8% knew the principles of ergonomics, while 87.18% did not know these principles.

Employees who reported more pain episodes during the day significantly more often declared that the pain limited their ability to work. It was indicated that the factor significantly affecting pain intensity assessed on the VAS scale is the maintained standing position (p<0.0001). Identified errors in workplace ergonomics were significant factors affecting pain intensity. Declarations regarding incorrect distance from the monitor (r_s=-0.514; p<0.0001). Other differentiating factors included: wrist position while typing (p<0.0001), forearm position during work (p<0.0001), and keyboard position (p<0.0001).

Statistical analyses of the ergonomics of office workers' workplaces revealed that monitor positioning at the workstation significantly affects the degree of lumbar spine pain on the VAS scale. Setting the monitor at a distance of less than 80 cm or more than 80 cm affects a higher degree of pain on the VAS scale, compared to employees working with the monitor positioned between 50–80 cm from the body line, where the degree of pain intensity on the VAS scale was significantly lower.

Office workers who kept their wrists suspended in the air exhibited pain intensity values of 6–8 on the VAS scale, while employees resting their hands on a pad or the edge of the desk exhibited values of 2–5 on the VAS scale, these differences being significant (p<0.0001). The subjective assessment of pain intensity depending on the declared positions of wrist positioning during work is presented in Figure 4.

Respondents who rested their forearms on the edge of the desk exhibited pain intensity on the VAS scale ranging

Table 3. Evaluation of the correctness of the sitting position as declared by the surveyed employees

Answers	Amount	[%]
They crossed their legs while sitting	57	70.3
I don›t cross my legs. I often rest my buttocks on the front edge of the chair	12	14.9
I often rest my buttocks on the front edge of the chair and cross my legs	10	12.3
They put their leg behind the knee while sitting	2	2.5

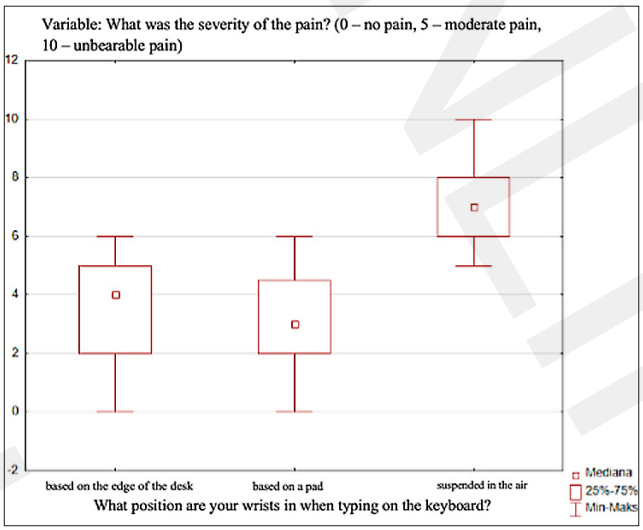

Figure 4. Subjective assessment of pain intensity on the VAS scale depending on the declared positions of the wrists during work

from 2–5. Employees who kept their forearms suspended in the air marked VAS pain values between 6–7. Respondents who keep their forearms fully positioned on the desk had VAS pain values between 3–5, and employees who kept their forearms on the armrests most often indicated a value of 5. These indications differed significantly (p=0.05) (Fig. 5).

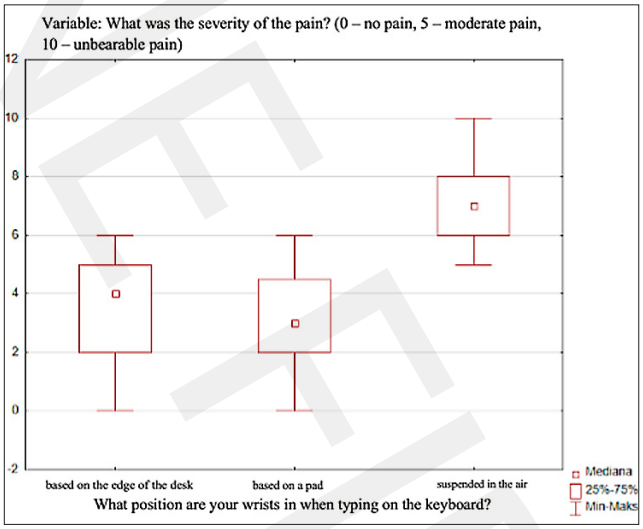

Figure 5. Impact of forearm positioning while typing on the keyboard on pain intensity on the VAS scale

Office workers whose keyboard was positioned at elbow level indicated pain intensity values of 2–4 on the VAS scale, employees whose keyboard is positioned above elbow level indicated pain intensity values in the range of 5–7 on the VAS scale, while office workers whose keyboard is positioned below elbow level exhibit pain intensity values on the VAS scale in the range of 2–6. Employee indications differed significantly, confirming the impact of keyboard positioning on pain intensity assessed subjectively (p<0.0001).

Among the considered factors was also physical activity, the type and its frequency. The study participants indicated that the declared frequency of physical activity was a significant factor affecting the subjective intensity of perceived pain (p<0.0001) and the frequency of pain episodes (p<0.0001). In the group of physically active people who indicated the occurrence of one pain episode per day, there were 36 people. Constant pain occurred only in people who were not physically active, i.e., in 9 office workers. Meanwhile, 17 physically active and 16 physically inactive office workers experienced several pain episodes during the day. The assessment of the impact of physical activity on pain complaints showed that physically active people exhibited pain intensity values on the VAS scale in the range of 2–5, while employees who were not physically active indicated pain intensity values on the VAS scale in the range of 6–7. Moreover, physically active people exhibited fewer pain episodes during the day than those declaring a lack of physical activity (p<0.0001).

Finally, it should be noted that participants who declared the use of physiotherapy services had significantly lower pain indications on the VAS scale (p<0.000001). In the group of people experiencing pain radiating to the lower limbs, 100% of the respondents (25) did not use physiotherapy services.

DISCUSSION

The presented research is an attempt to indicate how office work affects the health of employees, what problems office workers face, and what factors modify the frequency of back pain. Despite a number of campaigns conducted to promote pro-health behaviour and improve the ergonomics of office work, this topic is still important. One of the most important elements confirming this thesis is the frequency of declarations by the people surveyed in this study about episodes of lumbar pain. The results of the self-reported work are alarming and directly indicate that the topic addressed cannot be downplayed. There is a need to improve the ergonomics of office workplaces and introduce preventive measures to reduce the risk of musculoskeletal complaints in office workers.

The issue and etiology of musculoskeletal pain in office workers was also addressed by Calik et al. [5] who presented correlations between musculoskeletal problems and computer work made using a questionnaire. After analyzing all the responses, it was shown that computer work increases the severity of lower and especially upper back pain, and that lower back pain statistically significantly reduces the ability to perform activities of daily living. In addition, the nature of the pain increased with the duration of the work, which may be related to the sensitization of the central nervous system with the duration of the disease. They also showed that improper monitor positioning and sitting position were associated with more frequent neck and upper back pain, with no significant correlation with lower back pain, which may be due to the superficial analysis of posture in the studies, which focused on the overall impact of ergonomics,

whereas the present study looks in detail at factors affecting back complaints. [5]

When comparing specific features of ergonomics at work, the results obtained by Aytutuldu et al. [6] on the correlation between workplace ergonomic elements, such as the distance between the eyes and the screen, foot support, comfort of the foot surface under the desk, height of the chair, arm and backrest, alignment between the keyboard, mouse and wrist, as well as seniority and pain complaints, were largely consistent with the findings of the current study.

An analysis of office ergonomics was also undertaken by AlOmar et al. [7], who studied the risk factors associated with chair, monitor, phone, keyboard and mouse positioning, as assessed by the ROSA questionnaire for assessing musculoskeletal strain at computer workstations. The study showed that high ergonomic risk, as assessed by the ROSA index, correlates with musculoskeletal complaints, especially in older people with longer work experience and excessive body weight. These results are consistent with those obtained in the current analysis, especially with regard to work position and pain areas, with the exception of shoulders, wrists/hands and elbows. The results are also consistent with the findings of Augustyniuk et al. [8], Zejda et al. [9], and Mikolajczyk et al. [10], who also found that the severity of lumbar spine pain correlates with seniority. In addition, the same studies indicate that prolonged computer work and improper keyboard positioning increase the risk of aggravating pain, which was also confirmed in the current study.

Improper positioning and ergonomics at work influences the maintenance of head forward tilt, shoulder protraction and the abolition of lumbar lordosis, thus to a long-term hunched position which influences the discomfort felt in the lower back, and reduces the ability to stabilize the lower lumbar region during work in people suffering from chronic lumbar pain. This was described in a study by Jung et al. [11], who suggest that when sitting in a hunched position for long periods of time, lower back discomfort increases, regardless of muscle fatigue, and adolescent patients with LBP are more likely to adopt such positions while sitting.

However, it is worth noting the multi-factoriality of the substrate of LBP in people struggling with chronic pain. Not only work, but also many other factors such as pregnancy, endocrine diseases, metabolic diseases, osteoporosis, sarcopenia, and many others, contribute to the increased incidence of lower back pain [12,13,14,15]. Bento et al. [16] also mentioned in their work that factors such as older age, low education, hypertension and smoking were associated with LBP in men.

Similar conclusions were reached by Ali et al. [17] and Spyropoulos et al. [18]. The former authors [17] showed that a sizable proportion of bank employees in Bangladesh experienced lumbar pain (LBP), and the significant risk factors were age, BMI, length of work, reduced physical activity and extended working hours, which significantly increased the likelihood of LBP. Spyropoulos et al. [18] confirmed the influence of increased BMI and trunk forward leaning on lumbar pain severity, also emphasizing the importance of upper limb position, which is reflected in the results of the presented analysis, where distance from the workstation correlated with pain severity on the VAS scale.

Besharati et al. [19] studied the pain intensity of various body segments in Iraqi office workers, and showed that pain complaints mainly affected such areas as the neck, shoulders and lumbar spine. Significant pain problems in the wrists and knees were also indicated, suggesting a wide range of musculoskeletal problems in this occupational group.

After the Covid-19 pandemic, there has been an increase in the number of remote workers, who often work in conditions that do not comply with ergonomic standards, which can affect their health, especially when working for long periods of time. Modern research points to poor ergonomic conditions, lack of movement, overweight and their impact on overload and spinal diseases. Musculoskeletal discomfort and pain in office workers are the result of physical (poor postures, static work, repetitive movements, non-ergonomic workstations), psychological (stress, mental strain) and organizational (improper work-rest cycle, lack of occupational enrichment) factors. Accordingly, improvements in working conditions, appropriate job design and effective ergonomic interventions, including workplace analysis, risk control, medical management and training to prevent WMSD, are recommended [18, 19, 20].

Martyniuk et al. [21] and Kaluzhna et al. [22] also concluded that passive spending of time aggravates the progression of osteoarthritis, physical activity and ergonomics in daily life can have a positive effect on halting the progression of the disease, and lowering the pain threshold by affecting the secretion of endorphins into the cerebrospinal fluid.

Makhsous et al [23] found a positive effect of the off-loading position i.e. placing a pillow at the height of the lumbar region obtaining a reduction in muscle tension, pressure on the intervertebral discs and sciatic nodules, and a reduction in the asymmetrical activity of the lumbar paraspinal muscles.

Depa et al [24] noted that physical activity in youth affects the infrequency of pain attacks, and in their study, active subjects had less intense complaints. It is concluded that regular physical activity reduces the severity of back pain, which is supported by both own results and previous studies [24].

Early intervention, i.e. prevention of overload diseases of the spine in workers performing static work, should be carried out before permanent pathological compensations occur. A major advantage of such a prevention programme is the early identification of specific clinical signs that may indicate the progression of osteoarthritis, because these symptoms very often go unnoticed due to the non-specific mechanical nature of pain that changes over time and depends on mechanical activity, often downplayed and ignored by office workers [25].

CONCLUSIONS

As the BMI index increases, the number of daily pain episodes and the intensity of pain assessed on the VAS scale also increase. High BMI values are characteristic of employees whose pain radiates to the lower limbs. Office workers with long work experience, i.e., over 7 years, are characterized by pain complaints radiating to the lower limbs, high pain intensity values on the VAS scale, and less knowledge about workplace ergonomics.

An incorrect standing position, including 'slouching', affects pain intensity. Other factors that exacerbate pain include incorrect monitor distance, i.e., more than 80 cm or less than 50 cm, and wrists and forearms suspended in the air and an improperly positioned keyboard, i.e., above and below elbow level.

Physically active employees are characterized by much lower pain intensity and fewer daily pain episodes. Study participants who used physiotherapy services did not experience pain radiating to the lower limbs. Respondents who experienced pain radiating to the lower limbs indicated much higher pain intensity.

Despite widespread knowledge of work ergonomics, many companies and office workers in Kraków do not follow ergonomic principles, which remains a common problem in this group.

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