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PART II. PHYSICAL ACTIVITY OF SOCIAL AND PROFESSIONAL GROUPS

ANALYSIS OF MUSCULOSKELETAL INJURIES AMONG ADULT INTERNET GAMING PLAYERS: A CROSS-SECTIONAL STUDY

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Authors' contribution:

A. Study design/planning
B. Data collection/entry
C. Data analysis/statistics
D. Data interpretation
E. Preparation of manuscript
F. Literature analysis/search
G. Funds collection

Summary

Background. Internet gaming (IG) leads to social disturbances, behavioral disorders, and physical impairments. The cross-sectional study focused on back pain experienced by IG players and investigated the relationships between pain complaints and the factors potentially predicting.
Material and methods. The survey was conducted online and a total of 1,104 IG players were recruited for the study. Disability assessment was performed using The Oswestry Disability Index (ODI).
Results. The majority of the respondents (72.1%) reported they experienced back pain. Assessment of pain showed significant differences ($p<0.0001$) with greater pain levels in the lumbar spine. The findings also show significant differences ($p<0.001$) in disability level between respondents who reported they did and did not get regular sleep at night. Significant differences ($p<0.001$) were also shown in the disability levels between the respondents engaging in sports or exercise and those who did not do any sport or exercise.
Conclusions. The prevalence of back pain complaints in IG players was high. Higher disability levels were observed in older gamers, individuals with lumbar spine pain, and those who did not get regular sleep at night, or do any sport or exercise. Future prospective longitudinal studies investigating the cause-and-effect nature of the findings are necessary.

Keywords: gaming, Internet, back pain, exercise, pain

Introduction

Video games and online gaming are becoming an increasingly popular form of recreation that is gaining popularity among the public [1]. Prolonged screen time, accompanied by long periods of sedentary behaviour are recognized as risk factors for numerous chronic diseases [2].

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Prolonged time spent in front of a monitor, long periods of sedentary lifestyle, are widely recognized as risk factors for many chronic diseases including musculoskeletal diseases [3].

Long hours in a sitting position in front of a computer screen, lack of breaks for short bursts of exercise while using a computer, mostly sedentary lifestyle, sleep deficiency, overweight and many other factors may produce excessive stress on the body, contributing to musculoskeletal (MSK) pain and injuries [4].

Disability due to back pain is a serious health problem experienced by many people [5]. In 2015, the global point prevalence of activity-limiting low back was 73%, implying that 540 million people were affected at any one point in time. In children and adolescents <19 years of age, a mean low back pain lifetime prevalence was recorded, based on 39.9% [5,6]. Lower back pain is the second most common symptom providing a reason for patients to seek help from a primary care physician. Its origin is extremely complicated and multifaceted and it is difficult to make a definite diagnosis that will directly explain the cause of pain [7,8].

Current times are conducive to mostly sedentary lifestyles as adults sit in front of computers at work and children and adolescents study while sitting and staying in one position for many hours [9]. After daily chores have been completed, leisure time often involves browsing the social media and playing video games. It is also increasingly difficult to motivate people for physical activity, whereas inactivity or non-ergonomic activities frequently performed by many people adversely affect the MSK system [10].

The use of electronic devices such as mobile phones, tablets, computers has been reported to carry a risk associated with the incidence of back pain. People's increasing engagement in this type of activity has led many researchers to look for relationships between Internet games and the effects of gaming on human physical and mental development. Previous studies indicated that high levels of sedentary behavior are linked to mental health, function and disability, physical activity, and physical health-related quality of life, but also spinal pain with the strongest associations for screen time [11,12]. On the other hand, reducing screen time might help prevent back pain, particularly among highly frequent screen users [12]. The literature review revealed that there were few studies concerning back pain complaints among Internet gaming (IG) players, however, the authors focused mainly on the group of school-aged athletes [13,14] and young adults [15-17] playing IG. The assessment of the relationship in older and less physically active groups is missing, especially in Poland. Understanding the association between sedentary screen-based activities such as IG and back pain complaints is crucial to developing effective strategies for the treatment of back pain and prevention of further negative health outcomes later in life. Previous work has suggested that sitting position may be a predictor of back pain. Studies in groups of young people, medical students [18], that is, people who spend a lot of time studying at a computer have shown a higher frequency of back pain. The study mainly focused on epidemiology. Our study both assesses the frequency but also the impact of back pain on activity. Studies assessing musculoskeletal dysfunction in online gamers have mainly used non-standardized questionnaires [19,20]. Our study used a standardized scale to assess the impact of musculoskeletal dysfunction on activity. The study focuses on adults, including young adults who spend a lot of time playing online games in addition to their jobs and studies. The assessment of the relationship in older and less physically active groups is missing, especially in Poland. Understanding the association between sedentary screen-based activities such as IG and back pain complaints is crucial to developing effective strategies for the treatment of back pain and prevention of further negative health outcomes later in life.

Aim of the work

The study aimed at investigating the relationship between IG and musculoskeletal pain, specifically examining the most commonly affected areas of the body and associations between low back pain, disability, and pain intensity with various factors including age, gaming duration, sleep duration, BMI, education level, and exercise engagement.

Material and methods

Study design

The cross-sectional study was conducted via Microsoft Forms platform, in four large groups of IG players among the First Person Shooter (FPS) games located at facebook.com.

Participants

The present study performed a comprehensive face-to-face survey encompassing a countrywide sample. We conducted the survey from January 1, 2024, to March 30, 2024.

Before the study, the minimal sample size needed for the study had been calculated using the following parameters: the confidence interval at the level of 0.95, the fraction size at the level of 0.5, and the maximum error at the level of 0.05 resulting in 383 participants required for the study.

Participants were eligible for the present study if they were currently living in Poland, understood Polish and were engaged in IG. Eligible subjects were those who played video games for a minimum of one hour 5 times a week. All interested group participants could take part in the study as long as they met the study eligibility criteria mentioned above. All the participants were informed about the purpose of the study, and each participant then confirmed his or her consent by clicking on the "I agree to participate in the study" button.

Research procedures

Information about the study, approved by the administrators, was posted in Facebook groups. It presented the purpose of the study, the recruitment rules, the method of completing the survey, as well as a request to eligible individuals to enrol for the study. The anonymous survey was conducted using a short author questionnaire and the Oswestry Low Back Pain Disability Questionnaire (ODI). Participants received question sheets online. Each participant was asked to provide answers to questions or to mark responses in sheets. The questionnaires were returned immediately after they were completed by the participants. The survey was conducted once, and it consisted of two parts. The first one was based on an author questionnaire, asking for basic information such as participants' gender, age, weight, height, and education level ("primary", "basic vocational", "secondary" or "higher"), as well as engagement in exercise or sport ("yes" or "no") and its frequency ("I do not exercise", "once a week", "twice a week" or "more than twice a week"), time dedicated to playing games ("1-2 hours", "3-5 hours", over "6 hours"), getting regular sleep ("yes" or "no"), existing MSK pain ("yes" or "no"), location of pain (multiple choice answers: "cervical spine", "thoracic spine", "lumbar spine", "shoulder area", "elbow area", "wrist area", "pelvic area", "lower limbs" or "no pain"), VAS-based assessment of pain on a scale 1 to 10, the timing of pain onset ("for up to 1 month", "between 1 and 3 months", "for more than 3 months"), and activities at the time the pain is experienced ("when I am sitting", "after I get out of bed", "when I am standing for a long time", "when I am lying down"). The second part involved assessment of participants' disability by means of the standardised, validated and reliable tool, i.e. Oswestry Low Back Pain Disability Questionnaire (ODI) – Polish version [21]. The tool is designed to assess individuals experiencing spinal pain, in terms of their functioning and limitations in various areas of life. The ODI questionnaire consists of ten sections, eight relating to activities of daily living such as personal care, lifting, walking, sitting, standing, sleeping, social life and travelling. The other two sections address pain intensity and change in pain intensity. The ODI has been translated into several languages and has undergone the standardized process of cross-cultural validation in many countries, including Poland [21], being recognized by many researchers as a reliable tool for assessing disability associated with spinal pain. Each item in the ODI questionnaire is assessed using a 6-point scale (0-5). The Polish ODI showed a very good internal consistency determined by the Cronbach α of 0.90 [21]. The maximum score corresponds to 50 points [22]. The results are interpreted based on the following ranges of scores: 0-4 points – no disability, 5-14 – mild disability, 15-24 – moderate disability, 25-34 – severe disability, 35 and more – complete disability.

Statistical assessment

Statistical analyses were computed using Statistica 10 PL. Descriptive statistics, including the number of participants, mean, standard deviation, median, minimum and maximum values, were computed for all quantitative variables. Qualitative data was presented as numbers and percentages. To simplify the analysis, the answers regarding the location of pain were combined as such: “cervical spine”, and “thoracic spine” were combined into “other spinal regions”, and “shoulder area”, “elbow area”, “wrist area”, “pelvic area”, and “lower limbs” were combined into “another region of the MSK system”.

The Shapiro-Wilk test showed that the distribution of the data differed significantly from a normal distribution, therefore non-parametric tests were applied for further analyses. The Mann-Whitney U test was used to determine the significance of the difference between the two groups such as comparing the disability levels relative to the location of pain (lumbar spine vs. other spinal regions), getting regular sleep (yes vs. no) and engaging in sports or exercise (yes vs. no). The Kruskal-Wallis test was used to determine the significance of the difference in at least three groups, such as comparing the intensity of pain relative to the location of pain (lumbar spine vs. other spinal regions vs. another region of the MSK system) and disability level relative to age group (18-20 years vs. 21-30 years vs. over 30 years), education level (primary vs. basic vocational vs. secondary vs. higher), time dedicated to playing games (1-2 hours vs. 3-5 hours vs. over 6 hours), as well as engaging in sports or exercise (I do not exercise vs. once a week vs. twice a week vs. more than twice a week). The Kruskal-Wallis multiple comparisons test was applied to accurately assess the significance of differences between pairs of groups. A test of significance for the Spearman’s rank correlation coefficient was used to examine associations between two measurable variables. Relationships between qualitative variables were assessed using Pearson’s chi-squared test, and where the expected counts in a contingency table of size greater than 2x2 were less than 5, the Maximum Likelihood chi-square test was used. Statistical significance for all tests was assumed to be $p<0.05$.

Results

A total of 1331 individuals were recruited for the study. As 227 participants did not fill out the questionnaire properly or did not respond to all questions, they were excluded from the final analysis. The remaining group of 1,104 participants consisted of 51 females (4.6%) and 1,053 (95.4%) males and the mean BMI of the group was 25.50±4.68. Based on the collected data, the participants were initially divided into five age groups: 18-20 years (31.2%), 21-30 years (48.4%), 31-40 years (17.6%), 41-50 years (2.3%) and over 50 years (0.5%), however due to the small number of people in older groups, the authors decided to combine the last three groups as a common group of people over 30 years. Most of the group had secondary education (56.2%), almost a quarter of the group had a higher education (22.9%), and every tenth person had basic vocational education (11%) and primary education (10%). The characteristics of the group are shown in Table 1.

Table 1. Group characteristics

Parameter	Gender	n	Mean	SD	Median	Min	Max
Weight (kg)	Male	1053	84.2	17.0	83.0	37	170
	Female	51	64.7	12.9	64.0	48	110
	Total	1104	83.3	17.3	82.0	37	170
Height (cm)	Male	1053	181.1	6.9	181.0	159	210
	Female	51	167.0	7.3	167.0	150	194
	Total	1104	180.4	7.6	180.0	150	210
BMI (kg/m^2)	Male	1053	25.61	4.67	24.97	13.93	51.89
	Female	51	23.22	4.29	22.19	17.21	36.75
	Total	1104	25.50	4.68	24.91	13.93	51.89

Majority of the respondents (72.1%), reported they experienced pain in the MSK system. Pain in the lumbar spine was reported by nearly half of the respondents (47.2%). Pain in the remaining regions of the spine was reported by 16.7% of the respondents. Detailed results are shown in Table 2.

Table 2. Incidence of pain

n=1104		n	%
Do you experience musculoskeletal pain?	Yes	796	72.1
	No	308	27.9
Location of pain	Lumbar spine	521	47.2
	Other spinal regions	184	16.7
	Another region of the musculoskeletal system	200	18.1
	No pain	199	18.0

Assessment of pain severity (n=905) showed significant differences (p<0.0001) in the Kruskal-Wallis test with respect to the location of pain. Mean pain intensity in respondents reporting problems in the lumbar spine, amounting to 4.8 on a 10-point scale, was higher, as compared to other spinal regions and other locations in the MSK system. The multiple comparisons test showed significant differences in the severity of pain experienced. The intensity of lumbar pain was significantly higher (p<0.0001), as compared to the pain experienced in the other locations. Detailed analysis of pain intensity relative to the location of pain is shown in Table 3.

Table 3. Intensity of pain relative to the location of pain

n=905		Intensity of pain						*p*
		n	Mean	SD	Median	Min	Max	
Location of pain	Lumbar spine	521	4.8	1.6	5.0	1	10	<0.0001
	Other spinal regions	184	4.4	1.7	4.0	1	10	
	Another region of the MSK system	200	4.1	1.8	4.0	1	10	

The relationship between the location of pain and the duration of the problem was assessed using the Pearson's chi-squared test (n=800). The respondents who experienced the problem for more than three months, most commonly reported pain in the lumbar region (78.4%; *p*=0.012). A significant relationship (*p*=0.0361) was shown between the location of pain and the activity at the time pain was experienced (n=794). The highest percentage of those who felt pain in a sitting position reported pain localized in other spinal regions (57.1%). The relationship between the location of pain and the disability score was also assessed (n=705). The group of players with mild, moderate and severe disability included a significantly higher proportion (*p*=0.035) of those reporting pain localized in the lumbar region of the spine. The above data is presented in Table 4.

Table 4. Relationship between the location of pain and the duration of the problem, the body position aggravating the intensity of pain as well as disability score

Answers to questions		Location of pain						*p*
		Lumbar spine		Other spinal regions		Another region of the MSK system		
		n	%	n	%	n	%	
How long have you been feeling MSK pain? (n=800)	For up to 1 month	52	11.0	14	8.9	28	16.6	0.012
	Between 1 and 3 months	50	10.6	26	16.5	29	17.2	
	For more than 3 months	371	78.4	118	74.7	112	66.3	
When does the pain get worse? (n=794)	When I am sitting	206	42.5	96	57.1	71	50.4	0.036
	After I get out of bed	78	16.1	17	10.1	18	12.8	
	When I am standing for a long time	167	34.4	43	25.6	40	28.4	
	When I am lying down	34	7.0	12	7.1	12	8.5	
ODI (n=705)	No disability	153	29.4	73	39.7	-	-	0.035
	Mild disability	338	64.9	107	58.2	-	-	
	Moderate disability	27	5.2	4	2.2	-	-	

At the next stage, analyses were designed to compare the disability level in the respondents with pain located in the lumbar spine and those reporting pain in other spinal regions (n=705). The Mann-Whitney

U test showed significant differences ($p<0.001$) between the groups. The values of the disability level were higher in the respondents who reported pain in lumbar spine. The findings also show significant differences ($p<0.001$) in disability levels between respondents who reported they had and they had not got regular sleep at night (n=521).

Values of the disability level were higher in the respondents who reported they had not got regular sleep and had slept less than 7 hours. Significant differences ($p<0.001$) were also shown in the disability levels between the respondents engaging in sports or exercise and those who did not do any sport or exercise (n=521). Higher values of the disability level were observed in the respondents who reported they had not engaged in sports or exercise. Detailed results are shown in Table 5.

Table 5. Comparison of disability levels relative to the location of pain, getting regular sleep and engaging in sports or exercise

Answers to questions		n	ODI					*p*
			Mean	SD	Median	Min	Max	
Location of pain (n=705)	Lumbar spine	521	7.1	4.6	6.0	0	33	<0.001
	Other spinal regions	184	5.7	3.7	5.0	0	16	
Getting regular sleep (n=521)	Yes	252	6.5	4.4	6.0	0	33	<0.001
	No	269	7.7	4.6	7.0	0	33	
Engaging in sports or exercise (n=521)	Yes	266	6.4	4.3	6.0	0	33	<0.001
	No	255	7.8	4.7	7.0	0	33	

Next, the analysis of disability level relative to age, education, time dedicated to playing games, and engaging in sports or exercise in players with lumbar spine pain was conducted (n=521).

The Kruskal-Wallis test showed significant differences ($p<0.0001$) in the disability score relative to age. On average the highest disability score was identified in the group of respondents over 30 years of age. The multiple comparisons test showed highly significant differences between the age groups of 18-20 years and over 30 years as well as the age groups of 21-30 years and over 30 years. There were also significant differences in the disability score relative to the level of education ($p=0.016$). After a multiple comparisons test had been performed, it was found that respondents with primary education reported significantly less severe disability than those with vocational ($p=0.0163$) and higher education ($p=0.0483$). A comparison of the groups of respondents differing in the duration of time spent playing games showed no significant differences in the levels of disability ($p>0.05$). On the other hand, there were significant differences in the disability score relative to the weekly engagement in sports or exercise ($p=0.0099$), as shown by the multiple comparisons test. Values of the disability level were higher in those who did not engage in physical activity. The above analyses are listed in Table 6.

Table 6. Analysis of disability level relative to age, education, time dedicated to playing games, as well as engaging in sports or exercise in players with lumbar spine pain

n=521		n	ODI					*p*
			Mean	SD	Median	Min	Max	
Age	18-20 years	132	6.1	4.1	6.0	0	24	<0.001
	21-30 years	278	6.8	4.0	6.0	0	31	
	Over 30 years	111	9.1	5.7	8.0	0	33	
Education	Primary	41	6.4	3.9	5.0	0	17	0.016
	Basic vocational	54	7.3	5.0	6.5	1	33	
	Secondary	294	7.0	4.5	6.0	0	31	
	Higher	132	7.3	4.7	7.0	0	33	
Time dedicated to playing games	1-2 hours	170	7.4	4.6	6.0	0	33	0.414
	3-5 hours	291	7.0	4.4	6.0	0	31	
	Over 6 hours	60	6.8	5.1	6.0	0	33	
Engaging in sports or exercise	I do not exercise	233	7.8	4.8	7.0	0	33	0.01
	Once a week	51	7.0	4.9	6.0	0	24	
	Twice a week	79	6.1	3.4	6.0	0	18	
	More than twice a week	158	6.5	4.5	6.0	0	33	

The analyses also assessed the respondents' disability level relative to their BMI. The findings show statistically significant, positive, yet rather weak correlation between the parameters (p=0.0044; R=0.125).

Discussion

The study focused on pain experienced by video game players, and investigated relationships between pain complaints and the factors potentially contributing to the problem. The research was motivated by the noticeable phenomenon of decreasing physical activity among Poles, as well as the growing interest in entertainment in cyber space.

Our study was carried out in groups of individuals playing games among the FPS games. They require cooperation among players, and their characteristic features include brutality and war themes. It may explain why the vast majority of the participants were men; they accounted for 95.4% of the respondents. Majority of the participants were aged 21-30 years (48.4%) or 18-20 years (31.3%), hence we can assume that the study mostly involved the younger part of the population. The study focused on individuals experiencing MSK issues. In the survey, as many as 72.1% of the respondents reported pain complaints. In the group, the predominant problem was pain experienced in the lumbar spine (47.2%). DiFrancisco-Donoghue et al. reported that 42% of e-sport competitors suffer back and/or neck pain [23]. Likewise, Takakura et al. pointed out that professional gamers most commonly report pain located in the back, neck and upper limb [24]. A study by Lindberg et al. shows that, in a group of 188 e-sports competitors, the most common pain site was the back [25]. The participants of the present study who experienced lumbar spine pain, showed higher pain intensity on the VAS than those who reported pain in other spinal regions or in another region of the MSK system. It may be associated with a prolonged and forced seated position during gaming sessions, which may result in back muscle strains and stiffness, and consequently result in an aching pain after prolonged video gaming.

Our study showed that older gamers with lumbar spine pain received greater disability scores, as compared to younger individuals and it could be linked to changes related to the aging process such as the gradual weakening of muscle strength and tissue resilience. Such relationship was shown by a study from Finland, which investigated pain complaints among young people [26]. It was also confirmed by a study focusing on Turkish office workers [27]. A review of the literature did not identify any studies investigating the effect of age on pain complaints among those playing video games.

A number of researchers have carried out studies investigating in what way pain complaints are related to time spent in front of a computer. Interestingly, the results of our study showed no differences in the level of disability due to lumbar spine pain between players with different number of hours spent gaming. Diepenmaati et al. came to equally surprising conclusions [28]. The authors noted that those who reported MSK issues spent fewer hours in front of a computer. The respondents claimed that stress and related depression were the main causes of their problems. Other researchers in their studies showed that the risk of MSK pain was greater with increased duration of computer use [25]. Hakala's findings suggest that computer use for 14 or more hours per week is associated with moderate or severe increase in MSK pain, and inconvenience to everyday life due to low back pain [26]. In our study, no significant differences in the level of disability due to lumbar spine pain between players with different number of hours spent gaming could be attributed to the fact that the vast majority of the individuals included in this analysis spent daily 3-5 hours or less gaming.

Steenstra et al. in their review of the literature suggest that there is no clear evidence that education level is associated with delayed return to work in individuals who experienced low back pain [29]. In the current study, disability levels varied relative to the respondents' formal education. Individuals with lower education had better scores than others. Notably, in the literature there are still highly contradictory reports as regards the effects of formal education on the level of pain and the associated disability. Our result could not be fully accurate because in the study we included high school students who could still study in secondary schools, so the picture of their education level could not be complete yet and they could report "primary education". Contradictory reports could also be explained by the assumption that workers with lower education levels often have more physically demanding jobs, however, other factors should be considered to fully explore the issue. Future studies should include other psychosocial and workplace-related factors and adjustments such as type of work, mental health, attitude towards work, income, technology support, or ergonomics at work.

Chou et al. proved that higher BMI was causally associated with the risk of intervertebral disc degeneration, low back pain, and sciatica [30]. The present study showed a significant correlation between BMI and disability. The findings clearly demonstrate that higher BMI corresponds to a greater risk of lumbar spine pain. The link is not fully understood, however, some studies suggest that obesity has both biomechanical and inflammatory effects on the spine. Fat distribution is noticeably different between men and women with higher fat mass in women and it may be the explanation why the association between excess fat tissue and spinal pain is stronger in females, as compared to males [30].

Hanna et al. conclude that a lack of physical activity may be associated with a higher incidence of MSK pain, whereas engagement in exercise could be a protective factor [31]. A meta-analysis showed an inverse relationship between physical disability due to chronic lumbar spine pain and physical activity, with higher levels of disability corresponding to lower levels of physical activity [32]. Identical results were obtained by Teichtahl et al. who also showed that no physical activity was not only associated with increased pain and disability, but also with higher fat content in multifidus [33]. The present study provides further evidence confirming that gamers engaging in sports and exercise have lower disability level, as compared to those who do not exercise.

In summary, the results of our study and those of other authors suggest that it might be a good practice for gamers to take a break from sitting before the end of a two-hour session and do some exercise to activate MSK structures. However, more research is required to develop guidelines for intervention strategies including regular exercise, sleep hygiene and a healthy diet in people who play video games. An exercise program to prevent low back pain in office workers was proposed by Sihawong et al. [34]. The program consisted of muscle stretching and endurance exercises. The stretching exercise was performed twice a day and aimed at stretching shortened muscles. Participants were required to stretch and hold muscles in that position for 30 seconds. The endurance training was performed twice a week and aimed at increasing endurance of the lengthened muscles. The participants were required to contract muscles 10 times and then rest for 60 seconds between indicated muscles. The program was effective in reducing the incidents of low back pain in office workers.

Nonetheless, playing brutal games just before bedtime increases arousal and excitement, manifesting with increased heart rate and difficulty falling asleep. The issues related to pain complaints in individuals playing video games as well as the ways to prevent the problem are rather rarely discussed in scientific literature. The market for games and the number of people playing them are growing every year, while physical activity is still not popular enough in the population group. Adverse effects of the numerous factors aggravating MSK pain in individuals who spend a large part of their day sitting in front of a computer will be an increasing medical problem.

The participants in the study were adults, most of whom were working professionally. What's more, for most of the participants it was a sedentary position. The combined time spent playing gaming and working created a strong negative postural pattern predisposing to spinal stress and the risk of developing back pain. The group of participants in our study were mostly young adults (79% of the subjects were between the ages of 18 and 30), and therefore in good shape with strong compensatory capabilities. Despite their young age, as many as 72% reported MSK pain and more than 47% indicated the lumbar spine as their main area of pain. It can be concluded that it is an unfavorable phenomenon, common among young people, which can have bad consequences later in life.

The population of adolescents and children participating in online gaming should inspire future research. IG, which is a lifestyle for many, may be a significant factor excluding physical activity. The results of the study should inspire preventive measures for both children and adolescents and health promotion for adults based on physical activity. Perhaps game developers and administrators should consider introducing locks (passwords) that make it possible to continue playing after a break dedicated to preventive physical activity with a verification system.

We need to admit that the study still has limitations. First of all, the cross-sectional nature of the study limits us to insight into a causation link between the analyzed variables. Future longitudinal studies need to be conducted to determine the cause-and-effect nature of the findings. Another limitation is a small group of females and older individuals included in the study, therefore, we believe that our results may not apply to women or individuals over 30 years who play video games. The lack of children and adolescents is a weakness of our survey. The assessment of the group is important, and the results and conclusions can be of great importance for public health. Future studies should consider evaluating the impact of games on players' stress and assess the relationship of back pain and stress. Despite the limitations, we need to underline the potential strengths of the study. According to our best knowledge, it is the first study concerning the relationship between video gaming and musculoskeletal pain in Poland and included a representative number of 1,104 Polish gamers. We also used a standardized, validated, and reliable tool to assess participants' disability.

Conclusions

The results of the study confirmed a high prevalence of MSK pain complaints in gamers (72.1%). The prevalence and the location of spinal pain syndromes in the group investigated are not significantly different from those in the whole population. The study participants most commonly reported pain in the lumbar region (47.2%), and pain in this location was most severe (4.8 on a 10-point scale). Also, among the gamers, the higher disability level received the older gamers, individuals with lumbar spine pain, and those who did not get regular sleep at night, or do any sport or exercise. We also observed a weak and positive correlation between BMI and disability levels. Due to the cross-sectional nature of the data, it is difficult to confirm the causal relationship between gaming and pain, therefore, future prospective longitudinal studies investigating the causal relationship are necessary.

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The protocol of the study was approved by the Bioethics Commission at the University of Rzeszów (number: 2023/09/0052) and was performed in accordance with the Declaration of Helsinki.

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Artificial intelligence (AI) was not used in the creation of the manuscript.

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