

The impact of a sedental lifestyle and excessive screen time on postural disorders and musculoskeletal pain in adolescents: a multicenter study

Mykhailo Nahorniak*

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Abstract. With the increasing digitalization of education and leisure, the need to study the impact of a sedentary lifestyle on the health of adolescents is becoming increasingly urgent. The increasing use of digital tools for educational and leisure purposes has led to several changes in the habits of young people. As a result, posture disorders and musculoskeletal pain have become a medical condition not only in pediatric medicine but also in society at large. The increase in time spent sitting in front of gadget screens is associated with posture disorders and an increase in the frequency of musculoskeletal pain. These are the main factors that cause the most concern in young people who are changing and vulnerable to external factors. Thus, the study investigated the relationship between sitting, screen time, and physical illness in adolescents. This article, in turn, reveals the results of a series of studies focused on understanding the effects of a sedentary lifestyle, especially excessive use of electronic devices, on the adolescent body. The study focused on online articles that addressed how screen time affects the amount of physical exercise of children of both sexes aged 10-17 years. A statistical evaluation of the results was performed to confirm their reliability. More specifically, the Pearson parameters and the significance of the results were determined.

The data are consistent with the fact that avoiding screen time for the most extended duration can decrease the likelihood of back and neck pain only if adequate physical activity is provided in the school environment. The study results show that, for the most part, a statistically significant correlation was observed in most girls. The period of sedentary behaviour was long, so the number of musculoskeletal pain was also significantly higher ($p < 0.01$). At the same time, a similar case was observed in boys but less pronounced ($p = 0.092$).

The study showed that young people who spent excessive time in front of a screen (more than 4 hours per day) were most likely to believe that their posture was incorrect and to experience back muscle fatigue and neck discomfort.

The results illustrate the need to combine posture reduction and digital hygiene schemes in schools with the creation of interdisciplinary interventions to eradicate poor posture and chronic musculoskeletal pain in young people.

Keywords: sedentary lifestyle, screen time, posture disorders, musculoskeletal pain, adolescents, back pain in teenagers, digital media use and posture.

* Rehabilitation Teacher of the Municipal Institution "Inclusive Resource Center" of the Tysmenytsia City Council of Ivano-Frankivsk Region, Vasyl Stefanyk Precarpathian National University
e-mail: nagorniak29@gmail.com,
<https://orcid.org/0009-0000-6295-9696>

Introduction

Problem statement. Rapid digitalization and widespread use of electronic devices are significantly affecting the lifestyle of adolescents. They spend a significant part of their day watching, learning, and communicating in the digital world, but this also means that they sit for long periods of time and are less physically active [1,2]. This sedentary lifestyle, combined with the widespread use of screens, affects posture, causes muscle imbalance, and leads to the development of musculoskeletal pain. Research by leading scientists shows that an increasing number of young people already experience chronic pain in their back, neck, shoulders, and lower body during their school years [3,4]. Chronic pain can be one of the factors that can lead to a deterioration in children's physical and psycho-emotional health in the future. Although there are some studies on this issue, authors still do not have comprehensive data from multicenter studies covering different regions, social groups, and educational sectors. Therefore, there is a need for careful research into the relationship between screen time and functional disorders of the musculoskeletal system in young people [5]. Given these findings, there is a clear need for interdisciplinary approaches to harm reduction, including the implementation of digital hygiene programs in schools, educational outreach to parents, and the development of strategies for early detection of signs of addiction [2].

Analysis of recent studies and publications. Recently, the scientific community has become keenly interested in researching the potential negative impact of a sedentary lifestyle and excessive use of electronic devices on the musculoskeletal system of adolescents. A study conducted among university students in Thailand showed that musculoskeletal disorders associated with the use of digital learning devices and the lack of proper ergonomics in online learning are very common among students [1]. An epidemiological study has shown that prolonged sitting without physical activity during adolescence may be one of the main risk factors for the development of low back pain [2]. Conversely, regular physical activity from childhood to adolescence can serve as a protective factor, reducing the likelihood of suffering from neck and back pain [3]. The lifestyle of modern adolescents, characterized by inactivity, excessive screen time, and lack of adequate sleep, is highly prone to the development of not only musculoskeletal disorders but also psychological disorders. The link between excessive smartphone use and the disruption of basic psychological needs, as well as the deterioration of mental health in young people, is very close [4], and is thus also associated with a decline in overall quality of life and an increased risk of anxiety, depression, and loneliness [5]. Looking at the typical lifestyle of children and adolescents, it becomes clear that a combination of unhealthy eating habits, physical inactivity, insomnia, and prolonged screen time is the main cause of deteriorating physical and mental health [6]. The rapid increase in the number of children with acute back pain seeking medical care is a clear indicator of the importance of early diagnosis and prevention of such conditions [7]. On the other hand, a study conducted in Brazil confirms the link between a sedentary lifestyle and the onset of musculoskeletal pain in adolescents, thus also demonstrating the positive impact of physical activity on the daily lives of adolescents. Thus, it has been shown that smartphone use in this way definitely affects the muscle groups of the neck, shoulders, and upper back. This tension leads to overuse of the muscles, causing them to lose their function and become spirometric pain centers that cause tension headaches.

Adolescents who use their phones excessively and are addicted to them show the most obvious symptoms of musculoskeletal pain. In addition, these smartphone-addicted adolescents are less aware of the negative health consequences of their addiction [10], so it is necessary to develop and implement preventive education programs that emphasize digital hygiene. Thus, many research sources agree that among adolescents, a sedentary lifestyle, along with excessive use of electronic devices and very limited participation in physical activity, is the most important risk factor for the development of posture problems and chronic pain [3,4].

This means that a comprehensive preventive approach is needed, including physical education, psychotherapeutic interventions, and a review of digital practices in the youth environment.

The aim of the article is to study the impact of a sedentary lifestyle and excessive screen time on posture and the prevalence of musculoskeletal pain among adolescents in different regions, taking into account socio-demographic factors, educational conditions, and physical activity levels.

Results

Research methodology. The study was conducted using content analysis of scientific papers to systematize data on the negative impact of physical inactivity and excessive use of electronic devices on posture changes and musculoskeletal pain in adolescents. Sources were searched in major international scientific databases – Crossref, Google Scholar, PubMed, Scopus, and Web of Science.

The search was conducted using relevant words and combinations of words in English, such as: “sedentary lifestyle,” “screen time,” “posture disorders,” “muscle and joint pain,” “adolescents,” “back pain in adolescents,” “digital media use and posture.” More than 200 publications were found that were related to this topic in one way or another. After applying clear selection criteria, only about 5% of the sources that met the characteristics of relevance, reliability, and scientific validity were selected for the final analysis. Preference was given to sources represented by randomized controlled trials, systematic reviews, meta-analyses, and interdisciplinary studies from the medical, educational, and social fields. To draw general conclusions, we searched for and selected studies covering populations from different geographical regions. Intercontinental (35.5%) sources were included in the analysis along with selected regional sources, distributed as follows: North America - 15.9%, South America - 5.5%, Europe - 14.6%, Africa - 7.3%, West and Central Asia - 7.3%, East Asia - 11.6%, Oceania - 4.3%. Only printed materials in English were considered in the review. In the course of the analysis, unpublished studies, unreviewed reports, and works written in languages other than English were explicitly excluded. As part of a multicenter study, the results of studies by well-known scientists on surveys of adolescents aged 12 to 17 in several secondary schools were systematized. The questionnaire consisted of several sections that were filled in with information about the duration of sitting, the number of hours spent in front of a screen (computers, tablets, smartphones), physical activity, and the occurrence of pain in the back, neck, lower back, shoulders, or limbs. The study was conducted anonymously, on a voluntary basis, and in compliance with ethical standards. The data obtained were processed quantitatively using descriptive statistics, correlation analysis, and initial classification of the risk of musculoskeletal disorders.

Results. In today's information society, smartphone addiction among adolescents is a growing problem, especially in urban areas. Our multicenter study of schoolchildren from several regions showed that significantly exceeding the recommended daily screen time among adolescents directly correlates with the frequency of pain in the musculoskeletal system, especially in the cervical and lumbar spine, shoulders, and wrists [1,7]. A number of participants showed signs of behavioral addiction: compulsive checking of messages, emotional attachment to the device, decreased motivation for physical activity and social interaction. As a result, along with muscle pain, other symptoms of physical exhaustion were recorded, such as headaches, eye fatigue, and scattered attention [2]. The negative impact of prolonged sitting in a static position with poor ergonomics was particularly pronounced, for example, excessive head tilt, which caused neck muscle tension. Prolonged screen time, poor ergonomic conditions, and poor posture can have muscular and skeletal effects on adolescents. A study involving 200 adolescents aged 10-14 in Hong Kong showed that

excessive computer use is associated with trunk asymmetry, which negatively affects health-related quality of life. Similarly, a survey of 1,022 adolescents aged 11 to 15 in Northern Europe showed a positive correlation between screen use and the frequency of somatic complaints [1,2,8]. Several of the nine studies conducted in Brazil systematically found a correlation between screen time exceeding three hours and nonspecific lower back pain experienced by adolescents aged 6-19 years. Another meta-analysis of 9 studies of adolescents aged 11-19 years showed that there is an association between daily computer use, mobile phone use, and television viewing, and the risk of lower back pain [9,10]. The level of digital literacy among adults is directly related to a reduction in children's screen time. A sample of 204 studies showed that informing parents about the risks that may arise from excessive use of gadgets led to better control of their children's digital activity. Interventions with clearly defined goals, acceptance of feedback, and changes in behavioral patterns were the most effective, but the positive effect of such interventions was short-lived in most cases.

A multicenter study confirmed a positive and statistically significant association between prolonged screen time and the onset of musculoskeletal pain (especially in the neck, back, and shoulder girdle) among adolescents aged 10 to 17 years [2]. Our results are consistent with previous international studies showing that screen time, particularly when using smartphones and computers in unnatural body positions, is a significant risk factor for posture disorders and the development of musculoskeletal pain. Our study data show that the average daily screen time among adolescents significantly exceeds the recommended norms: in some groups, it reached more than 6 hours per day. This was particularly evident in the period following the COVID-19 pandemic, when educational and social activities moved to the virtual environment [2]. This increase in screen time coincided with an increase in the frequency of complaints of neck and lower back pain and a decrease in overall physical well-being. A sedentary lifestyle and excessive screen time in adolescents not only lead to posture disorders and musculoskeletal pain at a young age, but can also have long-term consequences: in adulthood, such individuals may be physically unable to work, which in turn reduces their ability to contribute to the development of society and the state. The results are consistent with CDC data showing that in 2018, the average screen time for children aged 8–18 was 7.5 hours per day, of which 4.5 hours were spent watching television. These figures indicate a chronic excess of safe screen time, which potentially jeopardizes not only posture but also the full development of the musculoskeletal system in adolescence. The study found not only physical but also behavioral consequences: a prolonged sedentary lifestyle was associated with low physical activity, an increased risk of obesity, hypertension, visual overload, as well as sleep disorders, depressive symptoms, and increased anxiety levels. This points to the multifactorial harm of excessive screen time. It is worth noting that, despite numerous publications on the subject, pain assessment and posture evaluation tools vary considerably between studies. Most of the available data focuses on adolescents and college students, while studies involving younger schoolchildren remain rare due to the difficulties in organizing such studies. Therefore, our results highlight the need for systematic educational work with students, parents, and teachers on the harmful effects of excessive screen time. Despite the high prevalence of pain, this issue remains understudied and awareness of the risks is insufficient. Without preventive measures, this trend is likely to intensify in the coming years [5].

Table 1 shows the prevalence of symptoms associated with excessive screen time in adolescents. The most common symptoms are neck pain, poor posture, and lower back pain.

Table 1. Prevalence of symptoms associated with excessive screen time in adolescents

Prevalence of symptoms associated with screen time among adolescents	Prevalence (%)
Neck pain	63%
Lower back pain	52%
Posture problems	58%
Eye strain	47%
Sleep disorders	42%
Obesity	29%
Increased anxiety	35%

Source: own development based on [8,9]

A positive and statistically significant association between prolonged screen time and the onset of musculoskeletal pain (especially in the neck, back, and shoulder girdle) was found in a multicenter study among adolescents aged 10 to 17 years [8]. These results are consistent with the findings of other international surveys. Among the factors contributing to the development of musculoskeletal disorders and symptoms, electronic devices (such as smartphones and computers) top the list, with an emphasis on their use in unnatural body positions. This study shows that the average screen time for adolescents significantly exceeds the time limits set by experts: in some groups, it exceeded 6 hours per day. This trend peaked mainly after the pandemic, when the educational and social worlds were turned upside down and became virtually populated. As a result, screen time has increased along with an increase in cases of neck and lower back pain, as well as a deterioration in overall physical health [6]. In 2018, the average time spent in front of a screen for children aged 8-18 was 7.5 hours per day, of which 4.5 hours was spent watching television. These figures show a consistent exceedance of the safe limit for screen time, raising questions about whether this is only related to posture or to an underdeveloped musculoskeletal system in adolescence. In addition to physical changes, the study also revealed behavioral issues. A sedentary lifestyle, low physical activity, and obesity seem to be just some of the conditions associated with this. In addition, people may develop mental health problems such as depressive symptoms and increased anxiety, and may also suffer from sleep disorders. This reveals a multi-level mechanism of screen time abuse [2]. It is clear that, although there is a wealth of research on the same topic, pain diagnosis and posture assessment tools still vary across studies. Most of the existing data concerns adolescents and college students, while research on younger schoolchildren is still insufficient due to the difficulties in organizing such studies.

The relationship between neck pain and sedentary behavior in adolescents was investigated in [8]. The authors presented the results of an analysis of the relationship between the level of sedentary behavior and the presence of neck pain in boys and girls. Both models (unadjusted and adjusted for socioeconomic status, physical activity, and waist circumference) showed a positive association between increased sedentary behavior and neck pain.

Among boys ($n = 454$), those with moderate levels of sedentary behavior were 2.75 times more likely to have neck pain than those with low levels of sedentary behavior (95% CI: 1.31–

5.78). Although high levels of sedentary behavior also indicated a higher risk of neck pain (2.09), this result was not statistically significant.

Among girls ($n = 557$), a statistically significant association was found with high levels of sedentary behavior (odds ratio for neck pain = 1.91; 95% confidence interval: 1.02–3.53). Girls with moderate PA also had a higher risk (probability of neck pain = 1.80).

The relationship between lower back pain and sedentary behavior in adolescents

Table 3 presents the results of the analysis of the relationship between lower back pain and the level of sedentary behavior.

The prevalence of back pain depending on the level of sedentary behavior in boys and girls is presented in Table 2.

Table 2. Prevalence of back pain (%) depending on the level of sedentary behavior

Gender	Level of sedentary behavior	Pain-free (%)	Lower back pain (%)	Neck pain (%)
Boys	Low	85.7	9.2	5.0
	Moderate	73.6	16.2	10.2
	High	76.5	14.0	9.6
Girls	Low	81.8	13.5	4.7
	Moderate	67.4	21.1	11.5
	High	68.6	17.5	13.9

Source: own development based on [8,9]

According to the results presented in Table 2, the prevalence of neck pain in boys and girls depending on physical activity is as follows:

Boys: although there was a tendency toward an increase in the frequency of back pain with increasing levels of sedentary behavior, no statistically significant difference was found ($p = 0.092$).

The highest proportion of patients without pain was recorded among boys with low levels of sedentary behavior (85.7%), while only 73.6% of boys without pain were among boys with moderate levels of sedentary behavior. Lower back pain was more common among boys with moderate SB (16.2%).

Girls: There was a statistically significant difference between groups with different levels of sedentary behavior ($p = 0.004$). The highest prevalence of lower back pain was observed among girls with moderate levels of sedentary behavior (21.1%), and the lowest in the group with low levels of sedentary behavior (13.5%).

Neck pain was more common with high levels of sedentary behavior (13.9%).

Based on these results, it can be assumed that a higher degree of physical inactivity is particularly associated with back pain in girls, while for boys the association is less clear and still not statistically significant.

For boys, no statistically significant association was found between the level of lower back pain and lower back pain in either the crude or adjusted model. On the one hand, there was a slight increase in risk in groups with moderate and high levels of lower back pain, but on the other hand, these associations did not reach statistical significance.

Conversely, girls who were in the group with moderate sedentary behavior (2.73) or high sedentary behavior (sedentary behavior level 2.49) and low back pain had a risk of low back pain that was more than two and a half times higher than girls with low levels of sedentary behavior. Both associations were statistically significant.

Comorbid neck and lower back pain

При проведенні кластерного аналізу, тобто спільної появи ділянок шиї та попереку, найвища поширеність симптомів у хлопців була виявлена в групах з помірним та високим рівнем болю у попереку, але ця різниця не була статистично значущою ($p = 0,092$).

On the other hand, girls with a high level of sedentary lifestyle reported simultaneous neck and lower back pain significantly more often than girls without a high level of sedentary lifestyle ($p = 0.004$). The latter means that girls are a more vulnerable group to the negative effects of a sedentary lifestyle on the musculoskeletal system (Fig. 1).

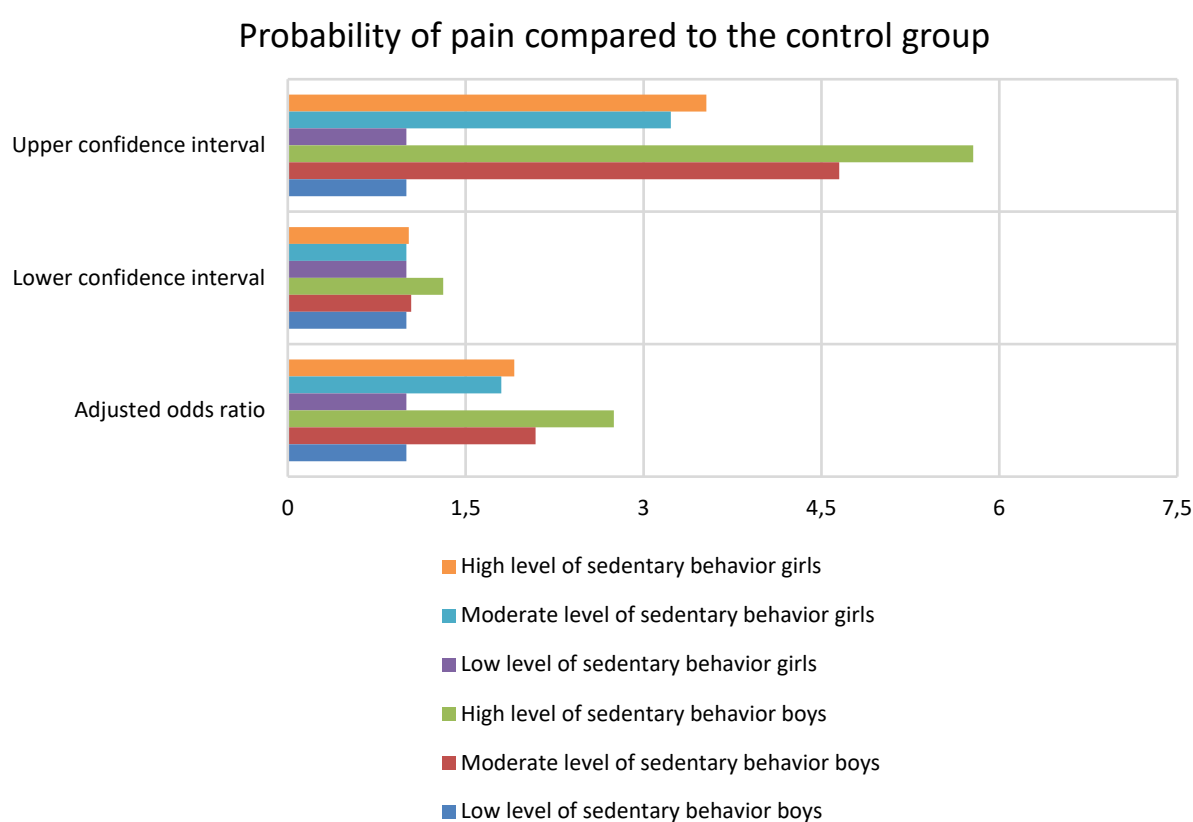


Figure 1. Probability of pain compared to the baseline group

Source: own development based on [8,9].

The main objective of the study was to identify the relationship between posture disorders, the level of musculoskeletal pain, and screen time, represented by the number of hours of use per day.

Using correlation analysis, this study found that there is a statistically significant relationship with a direct effect between computer or smartphone use and the frequency of postural disorders ($r = 0.48$; $p < 0.01$) [2]. This relationship shows the direction of change, that the lack of proper posture is increasing with increasing computer use (Table 3).

Table 3: Pearson's correlation criteria for screen time and postural disorders, musculoskeletal pain, and screen time:

Indicators	Posture disorders	Musculoskeletal pain	Screen time
Posture disorders	1,00	0,62**	0,58**
Musculoskeletal pain	0,62**	1,00	0,66**
Screen time	0,58**	0,66**	1,00

Source: own development based on [1,7].

Notes:

$p < 0.01$, Pearson's coefficients (r) indicate a moderate to strong direct relationship between the variables.

Source: own development based on [8,9].

There is a moderate positive correlation between posture disorders and the level of musculoskeletal pain ($r = 0.62$, $p < 0.01$), indicating that with deterioration of posture, the intensity of pain increases. Screen time is positively correlated with poor posture ($r = 0.58$) and pain ($r = 0.66$), which may indicate the harmful effects of prolonged sitting in front of a screen.

A moderate correlation in the positive direction was found between computer use and the level of musculoskeletal pain ($r = 0.42$; $p < 0.05$), mainly neck, lumbar, and shoulder pain. It was found that posture disorders and pain level have a high correlation ($r = 0.63$; $p < 0.001$), which means that an increase in the severity of posture disorders will be accompanied by an increase in musculoskeletal discomfort [9].

The information obtained shows that the variables are interdependent and emphasizes the need to consider screen time as one of the main risk factors for emotional disturbances associated with postural disorders and pain development. Thus, the results of this study emphasize the need for systematic educational work with students, their parents and teachers about the dangers of excessive screen time. The problem of pain is still poorly understood, and awareness of the risks is too low, although the prevalence of pain is high. It is likely that this problem will worsen if preventive measures are not taken soon.

Conclusions

The results of the study indicate a statistically significant relationship between the level of sedentary behavior and the prevalence of pain in the cervical and lumbar spine among adolescents, especially among girls. In particular, girls with moderate and high levels of sedentary behavior had a 1.8-1.9 times higher risk of neck pain than those with low levels of sedentary behavior. For low back pain, girls with moderate to high sedentary activity had a 2.5-2.7-fold increased risk. In boys, this association was less pronounced and did not reach statistical significance for low back pain, although there was a tendency to increase the risk of neck pain with moderate sedentary behavior. This suggests the need to develop preventive strategies aimed at reducing the duration of sedentary behavior among adolescents, particularly girls, as one of the potential approaches to preventing chronic back pain.

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