

# The Effects of Physical Activity and Use of Digital Devices on Musculoskeletal Disorders in Adolescents

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**ABSTRACT: Background and Purpose:** Neglecting to identify and adhere to preventive measures and necessary treatments for musculoskeletal disorders is a significant factor in the manifestation of additional symptoms and future problems. Hence, this study was designed to examine the effects of physical activity and the use of digital devices on skeletal-muscular disorders among adolescents.

**Methods:** The descriptive-correlational method was utilized in a cross-sectional study. The sample size was calculated to be 362 students (including 171 girls). Data was collected using standard questionnaires. T tests and structural equation modeling were used to analyze data.

**Results:** The average BMI of the participants was 22.49, suggesting that the students fell within the nearly normal range of BMI. Results demonstrated a significant inverse relationship between physical activity and neck scores, shoulder scores, and upper back scores. Moreover, results demonstrated a significant direct relationship between use of digital devices and neck scores, shoulder scores, and upper back scores.

**Conclusions:** The findings of this study indicate that the neck, shoulder, and back area are the most commonly affected regions by skeletal-muscular disorders in teenagers. Also, physical activity can help increase the participation rate of teenagers and yield more effective results. Additionally, utilizing different methods for assessing posture is also advised.

**Keywords:** Physical activity, digital device, lordosis, neck, adolescents

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## INTRODUCTION

Musculoskeletal disorders encompass a range of painful conditions affecting the muscles, tendons, joints, and nerves, with a particular impact on areas such as the neck, upper back, and waist. The World Health Organization has highlighted that a person's work environment, in addition to sociological, psychological, and social factors, can contribute to the development of work-related musculoskeletal disorders ([Abdoshahi & Ghorbani 2022](#); [Ohler et al. 2010](#); [Ramachandra et al. 2013](#); [Taghva et al. 2020](#)). If left untreated, these disorders can result in increased days of work disability. Musculoskeletal disorders are also prevalent among students. Early diagnosis of such disorders enables parents and students to be informed about preventive measures and necessary treatments. Disruptions in the spinal structure can lead to complications like pain, deformity, and impaired performance. Neglecting to identify and adhere to preventive measures and necessary treatments for musculoskeletal disorders is a significant factor in the

manifestation of additional symptoms and future problems (Afsanepurak et al. 2012; Sadeghipor & Aghdam, 2021a, 2021b; Taso et al. 2014).

The rise in the number of individuals utilizing handheld digital devices and smartphones, particularly among those aged 10 to 20, has resulted in various complications (Letvak et al. 2012; Masten, 2001; Shafaei et al. 2024). These include musculoskeletal issues, addiction to smartphones, damage to social relationships, isolation, anxiety, and depression. Consequently, the destructive process of physical problems in users has been accelerated (American Psychological Association, 2014; Sadeghipor et al. 2021; Vasconcelos et al. 2013). Users who frequently engage with handheld digital devices such as computers, laptops, digital games, and smartphones are prone to experiencing upper limb skeletal-muscular disorders due to prolonged incorrect body positioning. Additionally, the force exerted on the neck and shoulder muscles, particularly during repetitive tasks with a low load, such as prolonged smartphone usage, is another significant cause of skeletal disorders in the upper body (Bandura, 1997; Baniasadi, et al. 2018; Chaharbaghi, et al. 2022; Chris, et al. 2010; Conner & Davidson, 2003; Zaborova et al. 2023). This force activates multiple motor units with a low threshold, leading to pressure and strain on the neck and shoulder area when individuals addicted to smartphone usage bend their neck and head while staring at their phones. Consequently, disturbances arise in these regions.

Based on the conducted research, it has been found that intermittent computer and smartphone usage, along with repetitive movements involving certain muscles, can lead to acute injuries in the upper body. These injuries can have negative effects, particularly in the neck and shoulder areas, and can impact the quality of muscle contractions in these regions (Dana et al. 2021, 2023; Sadeghipor et al. 2021). Over time, the repetition and accumulation of injuries in these areas can result in abnormalities in the neck, affecting muscles such as the pectoral muscles, deep flexor muscles, lower extensor muscles, and upper thoracic muscles. The main contributing factors to this abnormality are yet to be determined. This abnormality can lead to an increased lordosis angle of the neck, causing the head to be positioned forward of the vertical line on the side plane (Davidson, 2003; Ellis et al. 2013; Faircloth, 2017; Seyedi Asl et al. 2016, 2021). However, there is limited research on the effects of digital device usage on skeletal-muscular disorders in adolescents. Therefore, the primary objective of this study was to investigate the impact of using digital devices on skeletal-muscular disorders among adolescents (Ghorbani et al. 2020a, 2020b).

To prevent the occurrence of these disorders and simultaneously maintain the productivity and efficiency of teenagers, it is crucial to identify their capacities, limitations, and status, and take the necessary measures to prevent skeletal-muscular disorders. Employing the principles of ergonomics is an effective approach in this regard (Hazrati et al. 2022; Herrick & Ainsworth, 2003; Seyyedrezaei et al. 2021). Additionally, engaging in physical activities and sports during leisure time and harnessing their positive physiological effects on the skeletal-muscular system can serve as a convenient and affordable tool to prevent, treat, and improve these disorders. Some interventions, such as ergonomic modifications, rest, and exercise, are utilized to treat musculoskeletal disorders. Several studies have demonstrated the use of exercise in reducing pain and preventing muscle problems in computer users (Hosseini, et al. 2022; Khosravi, et al. 2023; Shafaei et al. 2024). Overall, physical activity and exercise are recognized as fundamental methods of primary care in managing chronic musculoskeletal pain. These methods not only have positive effects on the musculoskeletal system but also alleviate the sensation of pain. Therefore, the second objective of this study was to investigate the impact of participating in physical activity on skeletal-muscular disorders among adolescents. In conclusion, this study was designed to examine the effects of physical activity and the use of digital devices on skeletal-muscular disorders among adolescents.

## METHODS

The descriptive-correlational method was utilized in a cross-sectional study to investigate the relationship between physical activity, digital device usage, and skeletal-muscular disorders in adolescents. Written consent was obtained from the parents of the participants prior to their inclusion in the study. The research protocol followed the guidelines set forth in the Declaration of Helsinki.

The study's statistical population consisted of all first-year high school students in district 1 of district 22 in Tehran. With the help of G\*Power software (effect size, 0.2 error, 0.05, and power 0.95), the sample size was calculated to be 362 students (including 171 girls). Nevertheless, 400 students were chosen for the sample due to the potential for dropouts and measurement errors.

The Physical Activity Questionnaire for Adolescents (PAQ-A), developed by Kowalski et al. (1997), was used to evaluate participation in physical activity and exercise (Hazrati et al. 2022; Herrick & Ainsworth, 2003; Seyyedrezaei et al. 2021). This questionnaire consists of eight questions that participants rated on a 5-point Likert scale. The structural validity of the questionnaire was confirmed through confirmatory factor analysis, showing a

high loading rate of over 0.4. Additionally, the reliability of the questionnaire was demonstrated with a Cronbach's alpha coefficient of 0.88 (Kowalski et al., 1997). In our research, the reliability of PAQ-A was supported with a Cronbach's alpha value of 0.90.

The assessment tool known as the Mobile Phone Addiction Form was utilized to assess the level of dependency among users (Letvak et al. 2012; Masten, 2001). This form consists of 133 questions and 16 scales, with 11 numbers representing the lowest level of agreement and 6 numbers representing the highest level of agreement for each question. Individuals scoring 99 or below are classified as short-term users, while those scoring above 99 are categorized as long-term users. The reliability of this measure is verified through Cronbach's alpha, with a value of 0.96, and its validity is supported by content validity, indicating the robustness of this instrument.

To assess the prevalence of musculoskeletal disorders among the participants, the Nordic questionnaire was employed (Chris, et al. 2010; Conner & Davidson, 2003). This self-report questionnaire consists of two sections: the first part collects demographic data such as age, height, weight, gender, work history, marital status, and physical activity, while the second part identifies musculoskeletal symptoms in nine body regions, including the neck, shoulders, upper back, lower back (waist), elbows, hands and wrists, thighs, knees, ankles, and feet. These symptoms are reported as pain, discomfort, burning, or numbness experienced in the past 12 months, varying based on the individual's physical state. In this study, the questionnaire's reliability was confirmed through internal consistency analysis and calculation of Cronbach's alpha ( $\alpha = 0.89$ ), as well as test-retest method by determining the correlation coefficient ( $r = 0.89$ ).

The analysis of the data was conducted utilizing SPSS software version 26. Descriptive statistics, specifically the mean and standard deviation, were employed to summarize the data. To examine gender differences, an independent t-test was performed. Furthermore, the effects of physical activity and the use of digital devices on skeletal-muscular disorders among adolescents were assessed using the Pearson correlation test. The significance level was set at  $p < 0.05$ .

## RESULTS

The demographic data presented in Table 1 indicated that the average age of the participants was 16.57 years. Within the research group, 47% were female and 53% were male. Additionally, the average BMI of the participants was 22.49, suggesting that the students fell within the nearly normal range of BMI.

**Table 1.** Demographic data across gender

	Group	No.	mean±SD	P
age (year)	boys	191	16.22±1.15	0.93
	girls	171	16.47±1.26	
height (M)	boys	191	1.54±0.16	0.15
	girls	171	1.49±0.09	
weight (Kg)	boys	191	53.15±8.14	0.01
	girls	171	45.67±6.74	
body mass index (Kg/M <sup>2</sup> )	boys	191	22.69±1.61	0.34
	girls	171	22.47±1.92	

Table 2 presents the descriptive statistics (mean and standard deviation) for the research variables, which include physical activity, use of digital devices, and skeletal-muscle disorders. The results revealed that out of the total 362 individuals involved in the study, 264 children (27%) were actively involved in physical activity. This data suggests that the majority of the children examined, specifically 73% of them, did not participate in physical activity throughout the week. Notably, boys demonstrated a significantly higher engagement in physical activity compared to girls. Furthermore, the study findings indicated that the participants exhibited moderate to high levels of digital device usage. Additionally, the participants reported experiencing more discomfort in their neck, shoulder, and upper back.

**Table 2.** Descriptive results across gender

	Group	No.	mean±SD	P
physical activity	boys	191	2.84±0.74	0.001
	girls	171	1.63±0.52	
use of digital devices	boys	191	112.64±36.41	0.57
	girls	171	114.16±29.71	
Percent (%)				
neck	boys	191	50.1	0.82
	girls	171	49.3	
shoulders	boys	191	36.4	0.81
	girls	171	34.9	
upper back	boys	191	59.6	0.73
	girls	171	57.3	
elbows	boys	191	0.3	0.97
	girls	171	0.5	
low back	boys	191	12.2	0.80
	girls	171	13.3	
wrist/hands	boys	191	15.6	0.95
	girls	171	16.2	
hips/thighs	boys	191	14.1	0.13
	girls	171	12.6	
knees	boys	191	11.3	0.89
	girls	171	10.4	
ankles/feet	boys	191	2.6	0.45
	girls	171	3.1	

The Kolmogorov-Smirnov tests indicated that all research variables exhibited a normal distribution (all  $P>0.05$ ). Subsequently, the correlation analysis in Table 3 demonstrated a significant inverse relationship between physical activity and neck scores, indicating that neck scores decrease with higher levels of physical activity. Similarly, there was a significant inverse correlation between physical activity and shoulder scores, with shoulder scores decreasing as physical activity levels increase. Additionally, the results showed a significant inverse correlation between physical activity and upper back scores, suggesting that upper back scores decrease as physical activity levels rise. Notably, there were no significant correlations between physical activity and scores for elbows, low back, wrist/hands, hips/thighs, knees, and ankles/feet.

**Table 3.** The results of correlations between physical activity and musculoskeletal disorders

Neck	shoulders	upper back	elbows	low back	wrist/hands	hips/thighs	knees	ankles/feet
r=-.983	r=-.714	r=-.721	r=.021	r=.036	r=.010	r=.021	r=-.005	r=-.013
P<0.001	P<0.001	P<0.001	P=0.648	P=0.648	P=0.524	P=0.964	P=0.472	P=0.637

The findings from the correlation test, as shown in Table 4, indicate a clear and noteworthy relationship between the use of digital devices and musculoskeletal disorders. Specifically, the results demonstrate a direct and significant correlation between the use of digital devices and neck scores, implying that as the use of digital devices increases, so do the neck scores. Similarly, there is a direct and significant correlation between the use of digital devices and shoulder scores, indicating that shoulder scores also increase with increased use of digital devices. Additionally, the results reveal a direct and significant correlation between the use of digital devices and upper back scores, suggesting that upper back scores rise as the use of digital devices increases. However, it is worth noting that no significant correlations were observed between the use of digital devices and scores related to elbows, low back, wrist/hands, hips/thighs, knees, and ankles/feet.

**Table 4.** The results of correlations between use of digital devices and musculoskeletal disorders

Neck	shoulders	upper back	elbows	low back	wrist/hands	hips/thighs	knees	ankles/feet
r=.841	r=.697	r=.693	r=.006	r=.009	r=.027	r=.019	r=.014	r=.006
P<0.001	P<0.001	P<0.001	P=0.682	P=0.714	P=0.358	P=0.429	P=0.847	P=0.964

## DISCUSSION

This study was designed to examine the effects of physical activity and the use of digital devices on skeletal-muscular disorders among adolescents. The study found that out of the total 362 participants, 264 children (27%) were actively engaged in physical activity. This data indicates that the majority of the children, specifically 73% of them, did not take part in physical activity during the week. Notably, boys showed a significantly higher level of involvement in physical activity compared to girls. This result is consistent with previous research studies (Bandura, 1997; Baniyasi, et al. 2018; Chaharbaghi, et al. 2022; Chris, et al. 2010; Conner & Davidson, 2003; Zaborova et al. 2023), highlighting the low levels of physical activity among adolescents. The findings clearly demonstrate that adolescents are not engaging in sufficient physical activity to enhance their health. Given the crucial role of physical activity in maintaining overall well-being, including in the health system, it is highly recommended that children and youth participate in regular physical activity. Encouraging involvement in sports not only promotes vitality but also aligns their interests, behaviors, and needs with meaningful objectives. Therefore, thorough and strategic planning is essential to ensure physical activity, with more detailed and precise planning leading to sustainable progress and increased motivation for sports participation (Dana et al. 2021, 2023; Sadeghipor et al. 2021).

In addition, the research findings indicate a significant inverse relationship between physical activity and neck scores, indicating that neck scores decrease with higher levels of physical activity. Similarly, there was a significant inverse correlation between physical activity and shoulder scores, with shoulder scores decreasing as physical activity levels increase. Additionally, the results showed a significant inverse correlation between physical activity and upper back scores, suggesting that upper back scores decrease as physical activity levels rise. Notably, there were no significant correlations between physical activity and scores for elbows, low back, wrist/hands, hips/thighs, knees, and ankles/feet. This outcome aligns with previous research (Ghorbani et al. 2020a, 2020b) and demonstrates the positive impact of sports involvement on skeletal-muscular disorders among adolescents. Strength training has been found to have various effects on the body, including the lengthening of muscle tendons, the movement of different skeletal parts, and the stabilization and strengthening of ligaments. On the other hand, stretching exercises play a crucial role in coordinating the positive and negative muscles in the body. As a result, these exercises can increase the length of muscles on the concave side, enhance the strength and power of muscles on the convex side, and ultimately reduce deformities (Hazrati et al. 2022; Herrick & Ainsworth, 2003; Seyyedrezaei et al. 2021; Hosseini, et al. 2022; Khosravi, et al. 2023; Shafaei et al. 2024). Specifically, strengthening the muscles responsible for maintaining spinal alignment is essential for maintaining an upright posture, and such exercises can be beneficial for individuals with kyphosis. The reduction in the kyphosis angle observed in subjects after a training period can be attributed to the strengthening of the spinal straightening muscles, as well as the flexibility exercises that promote spinal movement and contribute to the relative restoration of shortened muscles. The strength and endurance of muscles are crucial factors in physical fitness, and their weakness can significantly impact the body's flexibility and performance. Imbalances in muscle strength and endurance can disrupt the body's alignment and create conditions that put undue stress on joints and other tissues (Sadeghipor & Aghdam, 2021a, 2021b; Taso et al. 2014).

In addition, the research findings indicate a clear and noteworthy relationship between the use of digital devices and musculoskeletal disorders. Specifically, the results demonstrate a direct and significant correlation between the use of digital devices and neck scores, implying that as the use of digital devices increases, so do the neck scores (Dana et al. 2021, 2023; Sadeghipor et al. 2021). Similarly, there is a direct and significant correlation between the use of digital devices and shoulder scores, indicating that shoulder scores also increase with increased use of digital devices. Additionally, the results reveal a direct and significant correlation between the use of digital devices and upper back scores, suggesting that upper back scores rise as the use of digital devices increases. However, it is worth noting that no significant correlations were observed between the use of digital devices and scores related to elbows, low back, wrist/hands, hips/thighs, knees, and ankles/feet (Hazrati et al. 2022). Research indicates that individuals who excessively use smartphones are at a higher risk for developing certain syndromes. This is due to the fact that they tend to adopt a bent neck posture while interacting with their mobile devices, which can have long-term effects. This posture, known as protraction, involves bending the head forward towards the screen of the phone. As a result, the cervical vertebrae from the first to the sixth move forward, increasing the flexion of the neck and causing the head to move downward. To correct this posture, the upper extensor muscles of the neck are activated, leading to extension of the neck vertebrae. Prolonged periods in this position can result in abnormalities in the upper limbs, including frontal head abnormalities (Sadeghipor et al. 2021; Vasconcelos et al. 2013). A thorough understanding of the impact of improper body posture on the spine and vertebrae is essential to grasp the severity of potential injuries. The weight of an average person's head is approximately 5 to 6 kg. As a simple guideline, for every centimeter the head is bent forward, an additional 2 kg of weight is placed on the neck, shoulders, back, and spine (Faircloth, 2017; Seyedi Asl et al. 2016, 2021). For instance, tilting your head forward

just the width of a knuckle to view your phone screen can subject your neck to the weight equivalent of a three to four-month-old baby. This condition, known as "texting neck," is a common issue resulting from prolonged use of electronic devices for communication and entertainment. "Text neck" can lead to discomfort and pain, as well as the development of a forward head posture that alters the body's natural alignment.

## CONCLUSION

The findings of this study indicate that the neck, shoulder, and back area are the most commonly affected regions by skeletal-muscular disorders in teenagers. Additionally, teenagers exhibit a high usage of smartphones and have low levels of physical activity. Furthermore, the study reveals that engaging in higher levels of physical activity can help prevent the occurrence of musculoskeletal disorders. Conversely, increased smartphone usage is associated with a higher likelihood of experiencing musculoskeletal abnormalities. Based on these results, it can be concluded that physical activity and smartphone usage are significant factors influencing the health of adolescents. One limitation of this study is the reluctance of some teenagers to participate in completing the questionnaires. To address this issue in future research, it is recommended to implement educational interventions that inform teenagers about the consequences of improper physical condition and to provide encouragement from both researchers and schools. These measures can help increase the participation rate of teenagers and yield more effective results. Additionally, utilizing different methods for assessing posture is also advised.

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