Original Article

The Relationship between Mobile Phone Addiction and Changes in Spinal Column Angles of Male High School Students with Endomorphic Body Type

Abstract

Background: This study aimed to determine the relationship between the duration of mobile phone usage and the changes in lordotic, kyphotic, and forward head angles in male students with endomorphic body types in high school boys. **Methods:** This descriptive–correlational study was conducted on male students aged 13 to 15 years in high school boys in Farooj City during the academic year 2022–2023. Using the Morgan table, 200 individuals were selected from the population through simple random sampling, with an average weight of 58.06 ± 9.26 kilograms and an average height of 163.94 ± 7.66 centimeters. Various tools and instruments such as an informed consent form, stadiometer, digital scale, caliper, tape measure, smartphone addiction scale questionnaire, kyphometer, flexible ruler, and craniovertebral angle measurement device were used for data collection. The data were analyzed using the Kolmogorov–Smirnov test to check for normality. Pearson and Spearman correlation coefficients were used to determine the relationship between variables, and the analyses were carried out at a 95% confidence level. Data analysis was performed using SPSS version 20. **Results:** The results of Spearman's correlation coefficient showed that there is a significant positive relationship between the level of addiction to smartphones and the kyphotic angle ($r = 0.416$, $P = 0.0001$), lordotic angle ($r = 0.185$, $P = 0.009$), and forward head angle ($r = 0.425$, $P = 0.0001$) among male students in high school boys with an endomorphic body type. **Conclusions:** The study found that male students with an endomorphic body type who have a higher addiction to smartphones tend to have increased kyphotic, lordotic, and forward head angles. This is concerning, considering adolescents are more sensitive to growth and typically spend much time on their phones. Educating this group on proper smartphone use is essential to avoid potential adverse effects like spinal column abnormalities. The suggested solutions include paying attention to proper posture while sleeping, sitting, walking, and standing and using educational media to study.

Keywords: *Endomorphic body type, forward head, kyphotic, lordotic, mobile phone addiction, spinal column, students*

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Introduction

In today's industrial world, occupational complications and diseases have also expanded with the advancement of technology and new sciences.[1] These advancements in our daily lives, including the use of mobile phones, have unintended consequences. Improper use of mobile phones and the lack of adherence to occupational health principles during use can lead to changes in spinal column angles and the onset of musculoskeletal abnormalities.[2] Furthermore, sedentary lifestyles have led to an increase in obesity and overweight individuals in society. Studies have also observed that obesity and overweight are essential factors in creating postural changes and abnormalities. Research conducted by Silva and colleagues in 2011 demonstrated that obesity is reported as the main factor in the onset of skeletal–muscular postural abnormalities.[3] In addition, Rossell and colleagues, in 2010, reported that being overweight also plays a vital role in creating postural abnormalities. These studies indicate that obesity and overweight are factors that must be considered.[4]

The vertebral column is one of the body's vital parts, crucial in maintaining body posture and supporting daily activities.[5] Changes in the angles and structures of the vertebral column result from the influence

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of various factors and directly correlate with the individual's body type, as well as the occurrence of deformities and changes in the vertebral column. Improper use of mobile phones, especially when they stabilize the body in incorrect positions, can negatively affect the vertebral column and overall health.

An individual's dynamic and static position during work can harm the structure and functionality of the joints and body. Injury to the joints and supporting structures may lead to reduced functionality, temporary disability, or permanent disability. Repetitive habits and conditions in the work environment can also lead to occupational musculoskeletal problems.[6] A study conducted by Bolghanabadi and colleagues (2014) demonstrated that work pressure, work history, overweight, hours of work, and fatigue are influential factors in upper body region disorders.[7] Furthermore, excessive use of smartphones can lead to musculoskeletal problems in the upper body region, as it may lead to long-term adoption of incorrect body positions.[8] Moreover, repetitive and prolonged use of mobile phones can exert excessive force on the shoulder and neck area and may be the primary cause of many upper body region abnormalities.[9]

In a study, Kang and colleagues (2011) demonstrated that individuals with musculoskeletal problems use smartphones.[10] These researchers also reported that the use of smartphones is significantly associated with other abnormalities in the upper limbs and functional disorders.[11] In other words, excessive use of smartphones has a detrimental effect on skeletal and muscular health. Smartphones have gradually become an integral part of everyday life for each individual and have played a significant role in changes to spinal column angles.[12] Excessive use of smartphones can lead to immobility, resulting in an increase in obesity and overweight in society, especially among children and adolescents.

Research indicates that obesity significantly affects body mechanics and spinal column status.[13] Biomechanical changes resulting from obesity can reduce the mechanical performance of muscles and impact proprioceptive function. These changes can play a significant role in musculoskeletal abnormalities.[13] To promote healthy lifestyles and combat obesity, a nationwide physical activity program has been implemented in all schools. In this study, 13 million students were evaluated, and preliminary results showed that 30.1% of students were overweight and obese. This ratio has increased by about 8% compared to a study conducted by Kaspin in 2016. These figures indicate a worrisome prevalence in society and warn of the likelihood of future noncommunicable diseases.[14] In developing countries, overweight and obesity in children and adolescents lead to an increase in blood fat levels and an increased likelihood of chronic diseases. These diseases include type 2 diabetes, metabolic syndrome, cardiovascular diseases, musculoskeletal problems, and social and psychological issues.[15] Statistics from the Ministry of Health indicate that out of every 10 Iranian teenagers, one is obese, another is overweight, and the remaining 8 have less than half an hour of physical activity during the day and are at risk of obesity.[16]

Furthermore, studies show that male students' anomalies vary among different body types. According to a study by Mousavi and colleagues, the endomorphic body type has the lowest percentage of anomalies (25.1% of total anomalies). The ectomorphic body type has the highest percentage of anomalies (37.7% of total anomalies).[17] This study appears to contradict research that has reported obesity as a cause of anomalies. Maintaining body health and preventing diseases and injuries are essential. The high costs of treating patients due to diseases and resulting complications, primarily caused by severe changes in the spinal column, demonstrate the necessity of having a healthy body and an appropriate level of health and well-being. This is especially crucial for children and teenagers during their growth period, as they are exposed to inappropriate pressures at home and school, including the use of mobile phones. Therefore, understanding the precise relationship between mobile phone usage and spinal column status and providing suitable solutions to prevent the adverse effects of these changes on an individual's health is very important and helpful.

The research indicates that in this area, sufficient investigations and research have yet to be conducted to compare the endomorphic body type for changes in the spinal column status in adolescence, especially in boys. Furthermore, the existing research results in this area need to be more consistent, and sufficient information exists. Therefore, it is necessary to provide solutions to prevent anomalies in the spinal column angles and the level of addiction to mobile phones in endomorphic individuals. In addition, studying the impact of the duration of mobile phone usage and the way it is used in creating anomalies in male middle school students with the endomorphic type and preventing the associated risks is very important. The health of this segment of society, especially in the conditions of modern life today, is of great importance. The identification, classification, prediction, education, and implementation of specialized corrective programs for these individuals is a significant priority of physical education programs in schools. This study can contribute to a better understanding of the impact of mobile phone addiction on the physical and mental health of students. It could play a significant role in preventing and intervening in mobile phone addiction. Therefore, this study aims to determine the relationship between the duration of mobile phone usage and changes in spinal column angles in middle school male students with the endomorphic body type. The main question is whether or not excessive use of mobile phones is significantly related to changes in spinal column angles in individuals with the endomorphic body type.

Methods

This study has been reviewed by the Research Ethics Committee of the Sports Sciences Research Institute and has been approved and registered with the code SSRI.REC-2312-2567 (R2). The research method in this study has been considered descriptive and uses a correlational type. The statistical population of this study includes 1000 male high school students from Farooj City who are studying in the academic year 1401–1402. A simple random sampling method was used to select 200 male high school students from Farooj City based on the morgan table to determine the sample size. The inclusion criteria for the research included having male high school students aged 13 to 15 years and having no history of surgery or specific diseases. In addition, the exclusion criteria for the research included any withdrawal from continued cooperation and participant dissatisfaction during the research. Various tools and equipment such as an informed consent form, sphygmomanometer, digital scale, caliper and tape measure, smartphone addiction scale questionnaire, calipers, flexible ruler, and craniovertebral angle measuring device have been used in this research.

Execution process of the research

Initially, the nonprofit Hakim Nizami Institute of Higher Education and the Education Management of Farooj City permitted the research. This license ensures that the research is conducted legally and complies with regulations. For the sample selection, 200 male students from the first year of high school in Farooj City were chosen randomly. The height and weight of the students were measured. Subcutaneous fat in the arm, under the shoulder, and in the calf was measured using a caliper. The body type of the participants was determined using the Heath-Carter method and the relevant form. The Heath-Carter method is based on criteria such as height, weight, the product of the mean of these criteria, and fat thickness, which varies for each body type. The endomorphic body type was considered for further examination. A goniometer was used to measure the kyphosis angle, a flexible ruler for lumbar lordosis, and a device for measuring the craniovertebral angle. The level of addiction to the smartphone was evaluated using the Smartphone Addiction Scale Questionnaire (development and validation of a short version for adolescents) (SAS-SV). This questionnaire was developed based on previous research and can help us assess individuals' smartphone dependence.

Method of data collection

The height of each individual without shoes was measured directly using a stadiometer. The participant stood on a scale without shoes for weight measurements, and their weight was recorded in kilograms.

Subcutaneous fat measurements

1. Arm Measurements: To measure subcutaneous fat in the arm, the uppermost part of the lateral side of the arm, beneath the acromion process of the right shoulder, and in the mid-belly of the triceps muscle were used. These measurements were taken using a caliper and recorded
2. Subscapular Measurements: To measure subcutaneous fat in the subscapular area, a two-centimeter wide tape was placed diagonally below the inferior angle of the scapula and marked. Subsequently, the subcutaneous fat measurement was taken and recorded using a caliper
3. Calf Measurements: To measure subcutaneous fat in the calf area, the thickest part of the calf was measured and recorded using a caliper.

Determination of body type

In the Heath–Carter method, the participants' body type was determined by summing the three subcutaneous fat measurements relative to the individual's height. Heath and Carter classified the body type, and based on a higher numerical index, the endomorphic body type was identified as a single component.[18]

Measurement of smartphone addiction level

The Smartphone Addiction Scale Questionnaire (SAS-SV) was used to measure addiction to smartphones. This questionnaire comprises ten questions, and participants express their opinions on a 6-point scale from 1 (strongly disagree) to 6 (strongly agree) for each question. This scale differs between males and females. If males score more than 31 points, they have a strong inclination toward mobile phone addiction, while a score between 22 and 31 is considered high risk.[19]

Measurement of spinal column angles

Measurement of kyphosis angle

The thoracic kyphosis was assessed using a kyphometer. Initially, the midpoints of the spinous processes (T2-T1 at point 1) and (T12–T11 at point 2) were marked. During the measurement, the individual stood in a normal posture, with hands hanging by the side of the body. In this position, the kyphosis was measured and recorded by placing a block connected to the marker on point 1 and a block connected to the slider on point 2.[20]

Measurement of lumbar lordosis angle

Lumbar lordosis was measured using a 30 cm flexible ruler with the Judas method. For measurement, two bony landmarks are necessary, with the twelfth thoracic vertebra (T12) serving as the starting point of the curve and the second sacral vertebra (S2) as the endpoint. After marking the bony landmarks, the individual was asked to stand still, and the examiner carefully aligned the flexible ruler precisely along the lower back curve. Points of contact between the ruler and bony landmarks were marked with a marker. Subsequently, the ruler was gently and accurately transferred onto a white paper, and the formed curve was drawn on it. The lordosis angle was then calculated using the equation for lumbar lordosis angle: 4Arc tan (2H.L¯1) = Ө. In this equation, L represents the straight line from vertebra T12 to S2 and H denotes the distance from the deepest point of the curve to line L drawn on paper.[21,22]

Measurement of forward head posture angle

A specialized device for measuring the forward head posture angle, using the craniovertebral angle method, was employed. The individual stands still and performs flexion and extension movements three times in the neck to return the head to its natural position. Then, point C7, the external occipital protuberance, and the tragus landmark are marked. By placing a fixed arm and a goniometer axis perpendicular to the ground and parallel to the C7 spinous process and positioning the mobile arm on the cartilage of the anterior part of the ear (tragus), the angle between the line from the seventh cervical vertebra to the tragus and the horizontal plane is measured.[23]

Data analysis

After gathering the data, it was analyzed in two sections, descriptive and inferential statistics, using SPSS version 20 and Excel 2010. The Kolmogorov–Smirnov test was employed to examine the normality of the data, and Pearson and Spearman correlation coefficients were used to determine the relationships between variables. The analyses were conducted at a confidence level of 95%.

Results

Two hundred male high school students participated in the study, with an average weight of 58.06 ± 9.26 kg and an average height of 163.94 ± 7.66 cm reported. Table 1 displays the frequency and percentage of smartphone addiction. 25% of the participants were nonaddicted, 38% were at risk, and 37% had smartphone addiction.

Table 1: Frequency and percentage abundance of smartphone addiction

	Frequency	Percentage abundance
Smartphone addiction		
No smartphone addiction	50	25%
At risk	76	38%
Smartphone addiction	74	37%

The mean and standard deviation of the spine angles, including kyphosis 35.08 ± 7.48, lordosis 46.78 ± 12.54, and forward head 31.98 ± 9.89, were obtained. We used the Kolmogorov–Smirnov test to assess normality and present the results in Table 2.

Table 2: Examination of the data's normality using the Kolmogorov–Smirnov test

Variable	Number	Statistics	The significance level
Smartphone addiction	200	0.087	0.001
Kyphosis	200	0.050	0.200
Lordosis	200	0.096	0.0001
Forward head	200	0.048	0.200

As shown in Table 2, the significance level for smartphone addiction and lordosis angle is less than 0.05, meaning that the variables do not have a normal distribution. In contrast, the significance level for kyphosis and forward head is greater than 0.05, indicating a normal distribution.

The Spearman's correlation coefficient test was used for data analysis. Table 3 displays the results of the correlation coefficient between the level of smartphone addiction and the kyphosis, lordosis, and forward head angles.

Table 3: Correlation coefficient between the level of smartphone addiction and the kyphosis, lordosis, and forward head angles

Variable	*r*	Sig
Smartphone addiction		
Kyphosis	0.416	0.0001
Lordosis	0.185	0.009
Forward head	0.425	0.0001

According to the Spearman correlation coefficient statistics, it is observed that among male middle school students with an endomorphic body type in Farooj City, there is a significant positive relationship between the level of smartphone addiction and the kyphosis angle (r = 0.416, P = 0.0001), lordosis angle (r = 0.185, P = 0.009), and forward head angle (r = 0.425, P = 0.0001). In other words, with an increase in smartphone addiction, the kyphosis, lordosis, and forward bending angles of male middle school students with an endomorphic body type have increased Figure 1.

Discussion

Improper posture while using a mobile phone for extended periods and lifestyle changes can lead to musculoskeletal abnormalities in the spinal region. Depending on an individual's body type, musculoskeletal abnormalities will appear differently. The main goal of this study was to examine the relationship between the level of smartphone addiction and changes in spinal curvature in endomorphic body type male students. The Heath–Carter method was employed in this research to determine the body type. The results indicate that 37% of individuals are severely addicted to smartphones, 38% are moderately addicted, and 25% are not addicted. The analysis of the results demonstrates a positive relationship between the level of smartphone addiction and the kyphosis, lordosis, and forward bending angles in male middle school students with an endomorphic body type in Farooj City. In other words, with an increase in smartphone addiction, the

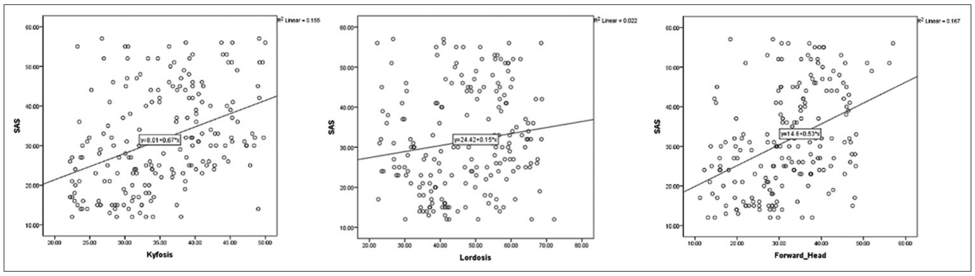

Figure 1: Correlation between smartphone addiction and forward head, lordosis, and kyphosis angles in male students with endomorphic body type

kyphosis, lordosis, and forward bending angles in male students with an endomorphic body type increase.

The results of this study showed a significant positive correlation (r = 0.416, P = 0.001) between the level of smartphone addiction and the kyphosis angle in male middle school students with an endomorphic body type. This means that as the level of smartphone addiction increases, the kyphosis angle also increases. In contrast to these results, a previous study conducted by Moghadam and colleagues demonstrated no significant relationship between the endomorphic, mesomorphic, and ectomorphic components with the lordosis and kyphosis angles.[24] A similar study by Shojaeddin in 2004 also indicated that there is no significant relationship between individual characteristics such as age, height, weight, and the investigated abnormalities, and the relationship between body type and the type of abnormality is also not significant.[17] The results of these studies are inconsistent with the results of the current study. This contradiction may be due to the difference in samples and the use of various tools to investigate abnormalities. So far, no research has addressed the significant relationship between lordosis, kyphosis, forward bending, and body type. In addition, some studies have yet to investigate the relationship between body type and the type of lordosis and kyphosis abnormalities. For example, Kargar and colleagues, in their research, despite calculating the values of body type and the angles of lordosis and kyphosis, did not mention any relationship between them.[5] Therefore, the body type alone does not significantly impact lordosis and spinal angles. Consequently, for a more precise and comprehensive investigation, further research is needed to examine other factors involved in this issue. More diverse and extensive research is needed to conclude. Nevertheless, these preliminary studies can shed light on ideas and pathways for future research.

In addition, the results showed that there is a significant and positive relationship (r = 0.185, P = 0.009) between the level of smartphone addiction and the lordosis angle in male middle school students with an endomorphic body type, meaning that with increasing smartphone addiction, the lordosis angle increased.[25] Dehghani and colleagues observed that the lordosis angle is associated with the endomorphic and mesomorphic components, which is consistent with the results of the present study.[25] In contrast, Seidi and Sanei demonstrated that the mesomorphic component has a positive and significant correlation with lordosis, and the ectomorphic component has a negative and significant correlation with lordosis, with no relationship between the endomorphic component and lordosis.[26] Furthermore, Pourbehzadi and their colleagues reported that there is a difference in the prevalence of lordosis among athletes with ectomorphic, mesomorphic, and endomorphic body types, with mesomorphic athletes having a higher prevalence of lordosis compared with ectomorphic and endomorphic athletes. In addition, the kyphosis angle was higher among athletes with an endomorphic body type than the other two groups.[27] In a review study, Hershkovich and their colleagues found that the endomorphic body type is associated with lumbar lordosis deficiency and that spinal deformities are more prevalent in underweight individuals compared to individuals with normal weight, overweight, and obesity.

The results indicate that with an increase in the level of smartphone addiction, the forward bending angle in male middle school students with an endomorphic body type increases (r = 0.425, P = 0.001). It was also observed that there is a significant relationship between the kyphosis angle, forward bending, and the duration of smartphone usage, where an increase in smartphone addiction leads to an increase in the forward bending and kyphosis angles. These findings are consistent with the studies of Armo and colleagues in 2020[28] and Masoumi in 2019,[29] which addressed the effects of mobile phone and social media usage on the upper body in adolescents. Similarly, Kang and colleagues in 2012 demonstrated that smartphone users adopt inappropriate body positions, which can lead to musculoskeletal disorders in the upper body, such as upper cross syndrome.[10] Furthermore, Naqilou and colleagues in 2020[30] showed in their study on the impact of remote teaching on the musculoskeletal status and physical activity of university professors during the COVID-19 pandemic that there is a significant difference in the prevalence of musculoskeletal disorders before and during COVID-19 in the shoulder, back, neck, and waist areas, while no significant difference was found in the knee, elbow, wrist, hand, hip, and ankle areas.[30] Using a mobile phone and being in an inappropriate position for a long time exerts excessive force on the head and neck area, leading to muscular imbalance due to muscle weakness in this area. In the long term, this will lead to weakness in the trunk muscles and eventually cause curvature of the spine.[31]

One practical application of this study is the role of mobile phone addiction in the changes in spinal curvature angles. In addition, individuals involved in mobile phone addiction may have more significant changes in spinal curvature angles compared with those without mobile phone addiction. Moreover, recommendations for the prevention and treatment of spinal curvature angle changes due to mobile phone addiction should be provided to students, families, and healthcare professionals. It also emphasizes that long-term and improper mobile phone use can lead to spinal curvature changes and related problems. One limitation of this study was the investigation of the relationship between mobile phone addiction and spinal abnormalities in endomorphic boys, and future research should consider other body types, such as ectomorphic and endomorphic, to ensure generalizable and reliable results. Furthermore, this study should also consider other factors that may influence mobile phone addiction and spinal curvature changes. For example, the level of physical activity and personal computers can also be influential factors that need to be examined in data analysis.

Conclusions

The results showed that an increase in smartphone addiction leads to an increase in the angle of kyphosis, lordosis, and forward head posture in boys with an ectomorphic body type. The positive correlation between these variables indicates that as smartphone addiction increases, the angles of kyphosis, lordosis, and forward head posture also increase. Considering the sensitive period of adolescent growth and their extensive use of smartphones, educating this group of young people on proper and appropriate ways to use smartphones is important. Furthermore, considering that improper use of mobile phones can lead to consequences such as spinal column abnormalities, it is necessary to educate students about the consequences and preventive measures. Some suggested solutions include paying attention to proper sleeping, sitting, walking, standing posture and studying through educational media. In addition, to achieve reliable results, it is recommended to conduct further research with larger samples in different educational stages and to compare different gender groups (girls and boys) with each other. This will allow us to pay more attention to the relationship between the level of smartphone addiction and the degree of kyphosis, lordosis, and forward head posture in adolescents and to examine the exact influence of these two variables more precisely.

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Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request. The researchers interested in using the final dataset for scientific purposes may contact the corresponding author.

Informed consent

All procedures followed were under the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all the individual subjects for being included in the study.

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Conflicts of interest

“In the last five years, I have had the following potential conflicts of interest to disclose:

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- Employment: I am employed as a thesis advisor by the Hakim Nizami Institute of Higher Education, a university with a vested interest in the findings presented in this paper
- Personal Financial Interests: I have no particular financial interest related to this article
- Stocks or Shares in Companies: I have no stake in the university where the research discussed in this article took place
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