JRSR 13 (2026) 117-123

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

# The Relationship Between Body Type and Digital Device Use on Spinal Alignment in Female Middle School Students During the COVID-19 Pandemic

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ARTICLE INFO

*Article History:*
Received: 31/12/2024
Revised: 20/01/2025
Accepted: 25/01/2025

*Keywords:*
Body Type
Spinal Column
Mesomorph
Endomorph
Ectomorph
digital Device Use
Posture

**Please cite this article as:**
Seyedahmadi M, Khalaghi K, Jeddi F. The Relationship Between Body Type and Digital Device Use on Spinal Alignment in Female Middle School Students During the COVID-19 Pandemic. JRSR. 2026;13(2):117-123. doi:

ABSTRACT

**Background:** Increased digital device use and reduced physical activity among students during the COVID-19 pandemic have been associated with a rise in postural problems. This study investigated the relationship between body types—ectomorph, mesomorph, and endomorph—and the duration of digital device use in relation to changes in spinal angle in female middle school students during the COVID-19 pandemic.

**Methods:** A descriptive-correlational study was conducted. The study population consisted of female students aged 13 to 15 from first secondary-level schools in Chenaran City during the academic year from October 7, 2021, to December 1, 2021. From a total of 10 first-grade girls' high schools (approximately 1,000 students), four schools were randomly selected. Of these, 150 students were randomly selected and assessed using inclusion and exclusion criteria. Research tools included an informed consent form, anthropometric measurement instruments, the Smartphone Addiction Scale–Short Version (SAS-SV), a goniometer, a flexible ruler (IDIO brand), and a craniovertebral angle measurement tool. Data were analyzed using Spearman's correlation coefficient in SPSS version 22.

**Results:** No significant relationship was found between body type and kyphosis angle ($p = 0.651$, $r = 0.038$), lordosis angle ($p = 0.083$, $r = 0.147$), or forward head angle ($p = 0.785$, $r = 0.023$). However, a significant correlation was observed between the duration of digital device use and both kyphosis angle and forward head angle, but not with the lordosis angle.

**Conclusion:** Prolonged digital device use significantly influences spinal alignment, particularly increasing kyphosis and forward head angles. Although body type did not show a significant effect, factors such as physical activity and age should be considered when addressing posture-related issues. This study highlights the importance of educating students on proper posture and limiting screen time to prevent potential spinal health problems.



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## Introduction

The COVID-19 pandemic led to significant lifestyle changes, particularly among students who shifted to online learning, resulting in increased digital device use and reduced physical activity [1]. This shift raised concerns about musculoskeletal health, particularly among adolescents, whose musculoskeletal systems are still developing [2,3]. Prolonged screen time has been shown to contribute to poor posture, increased sedentary behavior, and musculoskeletal discomfort, particularly in the neck, back, and shoulders [4,5]. Among female students, postural changes may be more pronounced due to physiological differences, potentially affecting spinal alignment and increasing susceptibility to musculoskeletal disorders [2,6].

Adolescence is a critical period for postural development, characterized by rapid musculoskeletal growth, during which external factors such as physical activity, lifestyle choices, and body composition significantly influence spinal health [7]. During the pandemic, lockdowns and school closures led to a sharp decline in physical activity, further exacerbating poor postural habits [8]. Many students reported lower back pain, neck discomfort, and forward head posture [9], conditions closely linked to prolonged sitting and suboptimal ergonomic setups [10].

One critical factor influencing spinal posture is body type, which affects weight distribution, muscle mass, and skeletal structure [11]. The three primary somatotypes—endomorph, mesomorph, and ectomorph—exhibit distinct biomechanical characteristics that may influence postural adaptation during prolonged sedentary behaviors [12]. Endomorphic individuals, characterized by a higher percentage of body fat, are prone to anterior pelvic tilt and exaggerated spinal curvatures due to shifts in their center of gravity [13]. Mesomorphic individuals, with a more muscular build, may experience postural imbalances resulting from disproportionate muscle strength [14]. Ectomorphic individuals, with a lean body composition, often lack sufficient muscular support to maintain optimal posture, thereby increasing their susceptibility to kyphosis and forward head posture [15].

During the COVID-19 pandemic, studies reported a marked increase in digital device use among students, driven by online learning and social isolation [16]. The lack of ergonomically designed home seating has forced many students into poor sitting postures, such as forward head posture, rounded shoulders, and excessive spinal flexion, thereby increasing the risk of chronic musculoskeletal disorders [5]. Excessive smartphone and device use has been shown to negatively affect cervical and lumbar spinal angles, contributing to postural misalignments [17].

Additionally, obesity, often exacerbated by reduced physical activity and increased screen time, is a major factor contributing to spinal abnormalities [18–20]. Excess body weight alters spinal alignment and muscle mechanics, increasing the risk of lordosis, scoliosis, and other postural deviations [21]. Allami et al. [21] reported a correlation between body fat distribution—apple-shaped versus pear-shaped—and lumbar lordosis abnormalities in female students. Similarly, Mousavi et al. [22] found that ectomorphic male students had a higher prevalence of spinal misalignments than endomorphic students.

National health reports indicate that approximately one in ten Iranian adolescents is obese, with the majority engaging in less than 30 minutes of daily physical activity [23]. To address this, the Kouch Plan was implemented in Iranian schools during the 2019–2020 academic year to promote physical activity and reduce sedentary behaviors. Findings revealed that 30.1% of students were classified as overweight or obese, reflecting an 8% increase compared to previous assessments [24]. This trend raises concerns regarding long-term health risks, including diabetes, cardiovascular disease, and musculoskeletal disorders [25]. Given the substantial healthcare burden associated with spinal disorders, it is critical to understand how body type and digital device use influence spinal posture in adolescents.

While prior studies have examined postural problems associated with screen time and obesity, few have investigated the combined effects of body type and digital device use on spinal alignment in adolescents, particularly in females. Conflicting evidence regarding the influence of somatotypes on postural deviations underscores the need for further research. This study, therefore, aims to analyze the relationship among body type, digital device use, and spinal posture among adolescent girls during the COVID-19 pandemic. By identifying postural risks linked to different body compositions, the findings may inform preventive strategies to reduce long-term spinal health issues in this population.

## Methods

### *Study Design*

A descriptive-correlational study was conducted. Ethical approval was obtained from the Ethics Committee of the Sport Sciences Research Institute, Tehran, Iran (Approval ID: IR.SSRC.REC.1402.279).

### *Participants*

The study population consisted of female students aged 13 to 15 enrolled in first-level secondary schools in Chenaran City during the academic period from October 7 to December 1, 2021. Of the ten girls' secondary schools in the area, four were randomly selected, and 150 students were recruited via random selection. During the study, nine students withdrew, resulting in a final sample of 141 participants.

Inclusion criteria required that participants be female students aged 13 to 15 years, with no history of spinal surgery or spinal disorders. Participation was voluntary and confirmed via signed informed consent forms. Exclusion criteria included withdrawal of consent, inability to meet attendance or participation requirements, or development of medical conditions or injuries that could interfere with study completion. These criteria ensured a well-defined sample for accurate and reliable analysis.

*The Method of Collecting Information*

- **Height:** Height was measured without shoes using a calibrated height meter, recorded to the nearest centimeter.
- **Weight:** Weight was measured in kilograms using a calibrated digital scale, with participants barefoot, and recorded to the nearest kilogram.

*Subcutaneous Fat Measurements*

Subcutaneous fat was assessed at three anatomical sites using a skinfold caliper to estimate body composition. Each measurement was taken three times, and the mean value was recorded to ensure reliability.

**Arm:** The measurement site was located on the lateral aspect of the right arm, just below the acromion process and aligned with the midpoint of the triceps muscle belly.

**Subscapular:** The measurement site was positioned diagonally, two centimeters below the inferior angle of the scapula.

**Calf:** The site of greatest circumference on the calf was used for measurement.[26].

*Body Type Classification*

Body type for each participant was determined using the **Heath-Carter method**, which combines anthropometric measurements and established formulas to classify individuals as endomorph, mesomorph, or ectomorph.

**Endomorphy:** Calculated by analyzing the sum of the three skinfold measurements (arm, subscapular, and calf) in relation to participant height. This reflects the degree of fatness.

**Mesomorphy:** Determined by measuring two circumferences (waist and hip) and two bone widths (biacromial and bicristal), adjusted for height. The formula accounts for muscularity and bone structure, taking into account the participant's overall build.

**Ectomorphy:** Estimated using the ratio of height to the cube root of body weight, indicating relative thinness or leanness. This measurement helps estimate leanness and body composition, indicating the relative thinness or muscle mass of the individual [27].

*Somatotype Classification*

Heath and Carter classified somatotypes using three numerical values representing endomorphy, mesomorphy, and ectomorphy. These values were obtained through a series of standardized measurements and calculations, and the resulting scores were subsequently used to determine each participant's body type.

**Calculation of Dominant Body Type:** The dominant body type was determined by selecting the component with the highest numerical value among the three (endomorphy, mesomorphy, and ectomorphy). When values were similar, the overall somatotype was considered. This approach enables identification of each participant's primary body type (e.g., endomorphic, mesomorphic, or ectomorphic).

Heath and Carter classified 13 distinct body types based on the three-number index calculated from the measurements and the numerical differences among the three components. In this study, due to the large number of variables under investigation, only the highest numerical value was used to determine the dominant body type as a single component [27].

*Measuring the Degree of Dependence on Mobile Phones*

The Smartphone Addiction Scale–Short Version (SAS-SV) is a 10-item instrument designed to assess levels of smartphone dependency by evaluating how smartphone use affects daily functioning, emotional well-being, and behavioral patterns. Participants respond to each item on a 6-point Likert scale, ranging from 1 (strongly disagree) to 6 (strongly agree). The total score reflects the degree of smartphone addiction, with thresholds defined by gender for different risk levels. Scores above 31 for men and above 33 for women indicate a strong tendency toward smartphone addiction, whereas scores between 22 and 31 for men and 22 and 33 for women indicate a high risk of addiction [28]. The SAS-SV has demonstrated high internal consistency (Cronbach's alpha = 0.967) and strong correlations with other addiction scales, making it a reliable tool for assessing smartphone dependence [29].

*The Number of Hours of Mobile Phone Use*

The daily duration of mobile phone use among students was assessed using a three-option questionnaire with response categories: less than 2 hours per day, 2-4 hours per day, and more than 4 hours per day.

*Measurement of Thoracic Kyphosis*

Thoracic kyphosis was measured using a kyphometer. The spinous processes of the T3–T4 and T11–T12 vertebrae were first identified and marked. Participants stood upright with their arms relaxed and their heads in a neutral position. The kyphometer was then positioned on the marked points, and the curvature angle of the thoracic spine was recorded directly from the device [30].

*Measurement of Lumbar Lordosis*

To assess lumbar lordosis, participants stood barefoot with weight evenly distributed on both feet. The 12th thoracic vertebra (T12) and the second sacral vertebra (S2) were identified and marked as reference points. A flexible ruler was placed along the lumbar spine from T12 to S2, conforming closely to the spinal curvature. The contour of the ruler was then traced onto graph paper. A vertical line connecting T12 and S2 (L line) and a perpendicular line from the curve's deepest point (H line) were drawn to determine the maximum width of the curve. Lumbar lordosis (θ) was calculated using the formula: $\theta = 4 \times \arctan(2H/L)$. The resulting angle, expressed in degrees, represents the degree of lumbar lordosis, with higher values indicating increased lordotic curvature [31,32].

*Measurement of Forward Head Posture*

Forward head posture was evaluated using a specialized goniometer, the Head Posture Spinal

Curvature Instrument (HPSCI). Participants stood in a relaxed position and performed neck flexion and extension three times before adopting their natural head posture. The examiner aligned the stationary arm of the goniometer vertically with the ground, positioned the axis over the C7 spinous process, and placed the movable arm along the anterior cartilage of the ear. The angle formed between the movable arm and a vertical reference line passing through C7 was recorded as the forward head posture angle. Each participant completed three trials with a two-minute rest interval, and when two readings were close, the smaller value was selected [33].

*Statistical Analysis*

Both descriptive and inferential statistical methods were applied. Descriptive measures, including mean, standard deviation, and frequency distributions, were calculated to summarize the characteristics of the sample. Associations between variables were assessed using Pearson or Spearman correlation coefficients, depending on the data distribution. The Kolmogorov–Smirnov test was used to verify normality; Pearson correlation was applied for normally distributed variables, whereas Spearman correlation was used for non-normal distributions. All statistical analyses were performed using SPSS version 22 and Excel 2010, with a significance level set at 95% ($p < 0.05$).

## Results

A total of 141 female students at the first secondary level participated in this study. Table 1 presents the participants' demographic, anthropometric, and postural characteristics, as well as the distribution of body types.

Table 2 presents the frequency and percentage of time spent using digital tools during the COVID-19 pandemic and in the pre-pandemic period. As shown, 56.0% of the participants used digital tools for more than 4 hours per day, 22.7% for 2 to 4 hours, and 21.3% for less than 2 hours per day during the COVID-19 era.

To assess normality, the Kolmogorov–Smirnov test was applied, and the results are presented in Table 3. As indicated, the p-values for body type variables, duration of digital device use, and lordosis angle were <0.05, indicating that these variables were not normally distributed. In contrast, the significance values for kyphosis and forward head posture exceeded 0.05, suggesting a normal distribution for these variables.

Table 4 presents the results of Spearman's correlation coefficient analysis examining the relationship between body type and spinal alignment. The findings indicate no significant association between body type (ectomorph, mesomorph, endomorph) and the kyphosis angle, lordosis angle, or forward head posture angle. These results suggest that body type does not significantly affect spinal alignment, including anterior head posture, thoracic kyphosis, and lumbar lordosis.

Table 5 presents the results of Spearman's correlation coefficient analysis examining the relationship between the duration of digital device use and the kyphosis, lordosis, and forward head posture angles. The results indicate a significant association between the time spent using digital devices and both the kyphosis angle and the forward head posture angle. However, no significant relationship was observed between the duration of digital device use and the lordosis angle.

**Table 1:** Anthropometric and Postural Data of Female Students

| Variable | Mean ± SD |
|---|---|
| Height (cm) | 162.63 ± 5.99 |
| Weight (kg) | 52.22 ± 10.39 |
| BMI (kg) / (m)$^2$ | 19.74 ± 4.19 |
| Kyphosis Angle (°) | 34.35 ± 6.49 |
| Lordosis Angle (°) | 45.17 ± 10.34 |
| Forward Head Posture (°) | 33.66 ± 11.06 |
| Endomorphs | 71 (50.4%) |
| Ectomorphs | 59 (41.8%) |
| Mesomorphs | 11 (7.8%) |

**BMI =**Body Mass Index

**Table 2:** Frequency and Percentage of Time Spent Using Digital Tools

| Time Period | Time Spent with Digital Tools | Frequency | Percentage (%) |
|---|---|---|---|
| Before Quarantine | Less than 2 hours | 76 | 53.9 |
| | Between 2 and 4 hours | 45 | 31.9 |
| | More than 4 hours | 20 | 14.2 |
| During Quarantine | Less than 2 hours | 30 | 21.3 |
| | Between 2 and 4 hours | 32 | 22.7 |
| | More than 4 hours | 79 | 56.0 |

**Table 3:** Assessment of Data Normality Using the Kolmogorov–Smirnov Test

| Variable | Frequency | Statistic | P |
|---|---|---|---|
| body type | 141 | 0.333 | 0.0001 |
| Time to work with digital tools before quarantine | 141 | 0.336 | 0.0001 |
| Time to work with digital tools during quarantine | 141 | 0.353 | 0.0001 |
| kyphosis | 141 | 0.045 | 0.200 |
| lordosis | 141 | 0.127 | 0.0001 |
| Forward head | 141 | 0.049 | 0.200 |

**Table 4:** Correlation Coefficient between Body Type and Spinal Conditions

| Variable | Kyphosis | | Lordosis | | Forward Head | |
|---|---|---|---|---|---|---|
| Body Type | r | sig | r | sig | r | sig |
| | 0.038 | 0.651 | 0.147 | 0.083 | 0.023 | 0.875 |

**Table 5:** Correlation Coefficient between Working Time with Digital Tools and Spinal Condition

| Variable | Forward head | | Lordosis | | Kyphosis | |
|---|---|---|---|---|---|---|
| | r | sign | r | sig | r | sig |
| Time to work with digital tools before quarantine | 0.023 | 0.192 | 0.701 | 0.023 | 0.192 | 0.701 |
| Time to work with digital tools during quarantine | 0.001 | 0.275 | 0.184 | 0.001 | 0.275 | 0.184 |

## Discussion

This study investigated the relationship between body type and digital device use on spinal alignment in female middle school students during the COVID-19 pandemic. The findings indicated no significant association between body type (endomorph, mesomorph, or ectomorph) and spinal posture variables, including kyphosis angle, lordosis angle, and forward head posture, suggesting that somatotype does not substantially influence spinal alignment in this population.

Conversely, the duration of digital device use during the quarantine period was significantly associated with certain postural characteristics. Specifically, a positive correlation was observed between time spent using digital devices and both the kyphosis angle and forward head posture angle. In contrast, no significant relationship was found with the lordosis angle. These results indicate that prolonged digital device use may contribute to undesirable spinal curvature changes, particularly increased kyphosis and forward head posture, which are recognized risk factors for musculoskeletal disorders.

Given these findings, it is essential to monitor and regulate students' screen time and to implement interventions to promote proper posture and mitigate potential long-term consequences of excessive digital device use.

Different somatotypes (ectomorph, mesomorph, and endomorph) exhibit variations in muscle distribution, body fat percentage, and skeletal structure, which may influence postural adaptations [11]. However, the present study aligns with previous research, such as that by Rajabi et al. [30] and Shojaedin [34], which found no direct correlation between body type and spinal deformities.

From a biomechanical perspective, endomorphs have a higher fat-to-muscle ratio, making them more susceptible to anterior pelvic tilt and hyperlordosis due to shifts in their center of gravity [13]. Mesomorphs, with greater muscle mass, theoretically exhibit better postural stability, though muscular imbalances could contribute to exaggerated spinal curvature [14]. Ectomorphs, with lower muscle support, are more vulnerable to kyphotic posture, particularly during prolonged static postures, such as extended digital device use [15].

Despite these theoretical biomechanical differences, the findings of this study, consistent with Shariati et al. [35], suggest that behavioral factors, levels of physical activity, and ergonomic conditions—rather than body type alone—play a more substantial role in postural abnormalities. One plausible explanation is that muscle weakness and postural habits exert a stronger influence on spinal misalignments than body composition, highlighting the importance of strength training and postural education over focusing solely on somatotype.

Compared to body type, prolonged digital device use was significantly associated with kyphosis and forward head posture. This relationship can be explained through biomechanical and neuromuscular mechanisms. Sustained neck flexion during smartphone, tablet, and computer use places excessive stress on the cervical vertebrae and supporting musculature, contributing to upper crossed syndrome, which is characterized by tight pectoral and neck flexor muscles alongside weak cervical extensors and scapular stabilizers [17, 36]. Additionally, increased spinal loading from prolonged forward-leaning sitting postures alters the natural curvature of the spine, resulting in increased thoracic kyphosis and lumbar lordosis, findings consistent with the present study and with previous research by Amro et al. [37]. Furthermore, in static postures, reduced oxygenation and blood flow to postural muscles can cause muscle fatigue and diminished stability, further exacerbating postural misalignments [38]. These results underscore the importance of ergonomic interventions and movement-based strategies to prevent postural deviations.

The absence of a significant relationship between body type and spinal posture, alongside the strong correlation between digital device use and postural deviations, suggests that behavioral factors exert a greater influence than inherent body composition. This study supports the notion that posture is primarily determined by external factors, such as screen height, seating ergonomics, and physical activity levels, rather than structural body characteristics alone [5].

Moreover, evidence indicates that active engagement of postural muscles—including the core, back, and shoulders—can prevent kyphotic deviations regardless of body type [11]. Lifestyle habits and habitual movement patterns also play a dominant role in long-term postural adaptations. While body composition may influence biomechanical mechanics, consistent exercise routines, postural awareness, and ergonomic practices are key determinants of musculoskeletal health [16]. These findings underscore the importance of ergonomic education, postural correction strategies, and muscle-strengthening interventions rather than focusing exclusively on body composition.

This descriptive-correlational study has several limitations that should be acknowledged. The relatively small sample size limits the generalizability of the findings, underscoring the need for larger and more diverse cohorts in future research. Additionally, the cross-sectional design precludes causal inferences, underscoring the need for longitudinal studies to track postural changes over time. The reliance on self-reported data on digital device use may introduce recall bias; therefore, future studies should incorporate objective tracking tools. Furthermore, this study did not consider ergonomic factors or physical activity levels, both of which are critical determinants of musculoskeletal health. Clinically, the findings emphasize the importance of postural education, ergonomic interventions, and preventive physiotherapy to mitigate the adverse effects of excessive screen time. Future research should focus on intervention strategies for posture correction, investigate gender-based differences, and explore the biomechanical consequences of prolonged digital device use to provide a more comprehensive understanding of adolescent spinal health

## Conclusion

In conclusion, the findings of this study indicate that increased use of digital devices, particularly during the COVID-19 quarantine, is associated with significant changes in spinal alignment, notably increased kyphosis and forward head posture. No significant relationship was observed between body type and spinal abnormalities. These results underscore the importance of addressing posture-related issues, especially in the context of prolonged digital device use. Raising awareness of the impact of poor posture and extended screen time on spinal health is particularly critical for adolescents, whose musculoskeletal systems are still developing.

## Acknowledgements

The authors sincerely appreciate all individuals who contributed to and supported the completion of this research.

## Funding Source

This study did not receive financial support from any governmental, commercial, or non-profit organizations.

**Conflicts of Interest:** The authors declare that they have no conflicts of interest related to the subject of this research.

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