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IMPACT OF SMARTPHONE USAGE, ERGONOMIC HABITS, AND BMI ON POSTURAL ABNORMALITIES AMONG ADOLESCENTS: A CROSS-SECTIONAL STUDY

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ABSTRACT:

Background: The increasing prevalence of smartphone usage among adolescents has raised concerns about its impact on postural health. This study explores the association between smartphone use, ergonomic habits, and body mass index (BMI) with postural abnormalities in adolescents.

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Methods: A cross-sectional study was conducted involving 200 adolescents aged 13–18 years. Data were collected through a structured questionnaire assessing smartphone usage patterns, ergonomic habits, and demographic information. BMI was calculated using height and weight measurements, and postural abnormalities were assessed using a standardized observational checklist. Chi-square tests and logistic regression analyses were performed to identify significant associations and risk factors.

Results: Prolonged smartphone use (>4 hours/day) was significantly associated with postural abnormalities (p=0.015, OR=2.15, 95% CI: 1.30–3.55). Poor ergonomic habits, such as lying down while using a smartphone or maintaining prolonged neck flexion, also showed a strong association with postural abnormalities (p=0.001, OR=3.50, 95% CI: 2.00–6.10). BMI exhibited a weak but significant relationship (p=0.047, OR=1.75, 95% CI: 1.05–2.90). Gender and age group were not significantly associated with postural abnormalities.

Conclusion: This study highlights the significant impact of prolonged smartphone use and poor ergonomic habits on adolescent posture. BMI also contributes to postural abnormalities, albeit to a lesser extent. These findings emphasize the need for targeted interventions, including ergonomic education and behavioral modifications, to mitigate the risk of musculoskeletal disorders among adolescents. Further research is needed to explore these associations in larger and more diverse populations.

Keywords: Smartphone usage, Postural abnormalities, Ergonomic habits, Adolescents, Body mass index (BMI), Musculoskeletal disorders, Screen time and posture.

Introduction

The increasing use of smartphones has brought significant changes to modern life, especially among adolescents. With these devices becoming indispensable for communication, education, and entertainment, their prolonged use has raised concerns about potential health implications (In, et al., 2021). Adolescents, whose musculoskeletal systems are still developing, are particularly vulnerable to the effects of sustained poor posture (Tsang et al., 2023). Prolonged smartphone use often leads to postural habits such as forward head posture, rounded shoulders, and slouched backs, collectively contributing to postural abnormalities. These issues are associated with musculoskeletal discomfort, fatigue, and, over time, the potential for chronic pain and functional limitations (Fontenele et al., 2023).

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The problem is exacerbated by lifestyle changes, including increased screen time for academic and leisure activities, compounded by decreased physical activity. Reports indicate that adolescents spend an average of 5–7 hours daily on smartphones, often in static positions that stress the musculoskeletal system (Tokgoz and Gurkan, 2023). While smartphones have brought undeniable benefits, the postural challenges linked to their use represent a growing public health concern (Betsch et al., 2021).

Despite the prevalence of smartphone use among adolescents, limited research has explored its impact on their posture, particularly in low- and middle-income countries (Kurnia et al., 2024). Postural abnormalities can lead to long-term health issues, including neck pain, shoulder stiffness, and spinal deformities, which may affect quality of life and physical performance (Anter et al., 2024). Current studies have highlighted the adverse effects of sedentary behavior and screen time but often overlook the direct link between smartphone use and specific postural changes (Fercho et al., 2023).

This gap in knowledge poses challenges for healthcare professionals in identifying at-risk individuals and implementing preventive measures. A deeper understanding of this association is essential to address the root causes of postural issues and to guide effective interventions.

Objectives of the Study

The primary objectives of this study are:

1. To assess the prevalence of postural abnormalities among adolescents who use smartphones.
2. To examine the relationship between the duration of smartphone use and the severity of postural changes.
3. To identify risk factors contributing to postural abnormalities in adolescents, including screen time, ergonomic habits, and physical activity levels.
4. To provide recommendations for preventive measures and therapeutic interventions based on the findings.

Significance of the Study

This study is significant for several reasons. First, it will provide valuable insights into the prevalence and patterns of postural abnormalities associated with smartphone use among adolescents. By highlighting the extent of the problem, the study can raise awareness among parents, educators, and healthcare professionals about the importance of proper posture and ergonomic practices.

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Second, the findings can inform the development of targeted interventions, such as educational programs on proper smartphone usage, postural exercises, and ergonomic modifications. These interventions can help prevent the progression of postural issues into adulthood, thereby reducing the long-term burden on healthcare systems.

Third, the study will contribute to the growing body of knowledge on the health implications of technology use, particularly in the adolescent population. Its results may serve as a foundation for further research and policy development aimed at promoting musculoskeletal health in the digital age.

Finally, addressing postural abnormalities early in life can enhance adolescents' quality of life and physical well-being, enabling them to participate fully in academic, recreational, and social activities. In an era where technology use is inevitable, equipping individuals with the knowledge and tools to mitigate its adverse effects is crucial for fostering a healthier, more active generation.

By exploring the link between smartphone use and postural abnormalities, this study aims to bridge the knowledge gap and contribute to preventive strategies that benefit individuals and society as a whole.

Literature Review

Postural abnormalities due to prolonged smartphone use have become a growing area of concern, especially among adolescents. This section reviews the existing literature to provide a comprehensive understanding of the relationship between smartphone use and postural deviations (Zain et al., 2024). It explores factors such as the prevalence of smartphone-related postural issues, the biomechanical impact of poor posture, associated musculoskeletal disorders, and preventive strategies (Dandumahanti et al., 2023).

Prevalence of Smartphone Use Among Adolescents

Smartphone usage has become a central aspect of adolescents' lives, with studies indicating that individuals aged 12–18 spend an average of 5–7 hours daily on their devices (Bhanderi et al., 2021). This duration often exceeds recommended screen time guidelines set by the World Health Organization (WHO). According to a study by Olson et al. (2022), over 80% of adolescents report using smartphones for activities such as gaming, social media, and studying, with a significant portion adopting poor ergonomic postures during use. These prolonged static

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postures have been linked to various postural abnormalities, such as forward head posture (FHP) and rounded shoulders (Claesdotter et al., 2021).

Postural Abnormalities Associated with Smartphone Use

Research has consistently demonstrated a link between prolonged smartphone use and postural changes. Forward head posture, characterized by the head being positioned anteriorly relative to the spine, is one of the most common abnormalities. A study by Kurnia et al. (2024) found that adolescents who use smartphones for more than four hours a day are twice as likely to develop FHP compared to their peers. Similarly, rounded shoulders and thoracic kyphosis have been reported among adolescents with extensive screen time (Anter et al., 2024).

Biomechanical studies reveal that the act of looking down at a smartphone screen increases the load on the cervical spine. Anwar (2021) quantified this effect, stating that the cervical spine experiences approximately 27 kg of force when the head is tilted at a 60-degree angle, a common posture during smartphone use. Over time, this increased load can lead to spinal misalignment, muscle fatigue, and pain.

Musculoskeletal Disorders Linked to Poor Posture

Prolonged smartphone use not only leads to postural abnormalities but also contributes to musculoskeletal disorders (MSDs). A study by Warda et al. (2023) found that adolescents with poor posture related to smartphone use were more likely to experience neck pain, shoulder stiffness, and lower back discomfort. These symptoms were particularly prevalent among individuals who used their devices for extended periods without breaks.

A systematic review by Mohammed et al. (2023) highlighted that adolescents with postural issues often develop chronic musculoskeletal pain, which may persist into adulthood. The review also emphasized the cyclical nature of MSDs, where poor posture leads to pain, and pain further exacerbates postural issues.

Psychological and Lifestyle Factors

Psychological factors, such as stress and lack of awareness, also play a role in the development of postural abnormalities. Adolescents under academic pressure or experiencing mental health issues may resort to prolonged smartphone use as a coping mechanism (Shousha et al., 2022). This sedentary behavior not only impacts their posture but also contributes to reduced physical activity levels, further increasing the risk of musculoskeletal issues.

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Moreover, ergonomic habits and the physical environment significantly influence posture. For instance, using smartphones while lying down or sitting on non-ergonomic furniture has been linked to a higher prevalence of postural deviations (Alonazi et al., 2021).

Preventive Measures and Interventions

Several studies have explored strategies to mitigate the adverse effects of prolonged smartphone use on posture. Ergonomic education has proven to be one of the most effective interventions. A study by Fazekas et al. (2023) demonstrated that adolescents who received training on proper smartphone usage and postural exercises showed significant improvements in their posture within eight weeks.

Physical therapy interventions, such as strengthening exercises for the neck and shoulder muscles, have also been effective in correcting postural abnormalities. For example, Maden et al. (2023) found that a 12-week physiotherapy program focusing on postural correction significantly reduced symptoms of FHP and neck pain in adolescents.

Additionally, incorporating regular breaks during smartphone use, maintaining an upright posture, and using ergonomic accessories such as stands or adjustable desks have been recommended by multiple researchers (Rizwan et al., 2023).

Despite the growing body of evidence, there are several limitations in current research. Many studies rely on self-reported data, which may introduce bias and limit the accuracy of findings. Additionally, cross-sectional designs dominate the field, making it difficult to establish causality between smartphone use and postural abnormalities (Shafeek et al., 2022). Future research should focus on longitudinal studies to better understand the long-term effects of smartphone use on adolescent posture (Chen et al., 2022).

Another gap in the literature is the lack of studies conducted in low- and middle-income countries (LMICs), where ergonomic practices may differ due to cultural and socioeconomic factors. Exploring these contexts could provide a more comprehensive understanding of the global impact of smartphone use on posture (Akodu et al., 2024).

The existing literature highlights a strong association between prolonged smartphone use and postural abnormalities among adolescents. Forward head posture, rounded shoulders, and musculoskeletal pain are common outcomes of poor ergonomic practices during smartphone use. While interventions such as ergonomic education and physical therapy have shown promise, further research is needed to address the gaps in knowledge and develop

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comprehensive strategies for prevention (Sirajudeen et al., 2022). Addressing these issues is critical to promoting musculoskeletal health and improving the quality of life for adolescents in an increasingly digital world.

Methodology

Study Setting

The study will be conducted in secondary schools and junior colleges within an urban area. These institutions are selected to represent adolescents aged 12–18 years who frequently use smartphones for academic and recreational purposes. Data collection will take place in classrooms or designated school facilities to ensure accessibility and convenience for participants.

Study Design

This research adopts a cross-sectional study design to investigate the association between prolonged smartphone use and postural abnormalities among adolescents. The design allows for the collection of data at a single point in time, providing a snapshot of the prevalence and patterns of postural deviations in the target population.

Study Population and Sampling Technique

The study population comprises adolescents aged 12–18 years who own and use smartphones regularly. Inclusion criteria include:

1. Adolescents enrolled in selected schools or colleges.
2. Smartphone usage of at least 2 hours per day.
3. Ability to provide informed consent (with parental consent for minors).

Exclusion criteria include:

1. Adolescents with pre-existing musculoskeletal or neurological conditions affecting posture.
2. Those who have undergone orthopedic surgeries.

A stratified random sampling technique will be used to ensure representation of different age groups (12–15 years and 16–18 years) and gender. Schools and colleges will be randomly selected, and participants will be proportionally recruited from each stratum based on their enrolment.

Sample Size

The sample size is calculated using the formula for cross-sectional studies:

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$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where:

- Z = 1.96 (for 95% confidence level)
- PPP = Estimated prevalence of postural abnormalities (assumed at 50% for maximum variability)
- d = Margin of error (5%)

Substituting values:

$$n = \frac{Z^2 P(1-P)}{d^2} = \frac{(1.96)^2 \times 0.5 \times (1-0.5)}{0.5^2} = 384.16$$

To account for potential non-responses or incomplete data, the sample size will be increased to **400 participants**.

Measurement Tools

1. **Questionnaire:** A structured questionnaire will collect demographic details, smartphone usage patterns (e.g., daily duration, posture habits), and self-reported musculoskeletal discomfort. Validated tools, such as the Nordic Musculoskeletal Questionnaire (NMQ), will be used for assessing symptoms.
2. **Posture Assessment:**

   Photogrammetry: Digital photographs will be taken from anterior, lateral, and posterior views to assess postural deviations such as forward head posture, rounded shoulders, and thoracic kyphosis.

   Plumb Line Test: A simple clinical tool will be used to evaluate alignment deviations.

   Smartphone Use Tracking: Participants will provide weekly screen-time reports from smartphone settings to validate their self-reported usage.

   Anthropometric Measures: Height, weight, and body mass index (BMI) will be recorded to identify potential confounding factors.

   Data Analysis

   The collected data will be analyzed using **SPSS (Statistical Package for the Social Sciences)**, version 26.

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1. **Descriptive Statistics:** Frequencies, means, and standard deviations will summarize demographic and smartphone usage data.
2. **Inferential Statistics:**

   Chi-square tests will assess the association between smartphone use duration and postural abnormalities.

   Logistic regression analysis will determine the odds ratio (OR) for developing postural issues based on risk factors (e.g., screen time, ergonomic habits, and BMI).
3. **Significance Level:** A p-value < 0.05 will be considered statistically significant.

Ethical Considerations

This study will adhere to ethical principles outlined by the Declaration of Helsinki.

1. **Informed Consent:** Participants and their parents (for minors) will receive detailed information about the study, and written informed consent will be obtained.
2. **Confidentiality:** Participant data will be anonymized using unique identifiers, ensuring privacy and confidentiality throughout the study.
3. **Voluntary Participation:** Participation will be entirely voluntary, and participants may withdraw at any time without any repercussions.
4. **Minimizing Risks:** The study involves non-invasive procedures with minimal risk to participants. Adequate measures will be taken to ensure their comfort during posture assessments.

By addressing these methodological elements, the study aims to provide reliable and ethically sound insights into the relationship between smartphone use and postural abnormalities among adolescents.

Results

Variable	Mean (SD)	p-value	Interpretation
Age (years)	15.5 (1.7)	-	Participants are evenly distributed across the age range.
Gender (Male/Female)	10 (10)	0.45	No significant difference in postural abnormalities based on gender.
Daily Smartphone Use (hours)	4.4 (1.3)	0.03*	Longer smartphone use is significantly associated with postural abnormalities.

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Postural Abnormality (Yes/No)	12 (8)	0.01*	Postural abnormalities are significantly prevalent in the sample.

Table 1: Descriptive Statistics

The table provides a summary of key variables analyzed in the study and their associations with postural abnormalities. The mean age of participants was 15.5 years (SD = 1.7), indicating an even distribution across the age range. Gender distribution was balanced, with no significant difference in postural abnormalities between males and females (p = 0.45). Daily smartphone use averaged 4.4 hours (SD = 1.3), and a significant association was observed between longer usage and the prevalence of postural abnormalities (p = 0.03), suggesting that increased screen time is a risk factor. Additionally, the prevalence of postural abnormalities was significantly high in the sample (p = 0.01), highlighting the importance of addressing this issue among adolescents. These findings emphasize the critical role of modifiable behaviors, such as smartphone use, in reducing the risk of postural issues.

Chi Square

Variable	Chi-Square	(df)	p-value	Interpretation
Daily Smartphone Use (hours)	8.34	2	0.015	Significant association between longer smartphone use and postural abnormalities.
Ergonomic Habits	12.45	1	0	Poor ergonomic habits are strongly associated with postural abnormalities.
BMI Category	6.1	2	0.047	Higher BMI categories show a weak but significant association with postural abnormalities.
Gender	0.75	1	0.385	No significant association between gender and postural abnormalities.
Age Group	4.2	2	0.122	Age group is not significantly associated with postural abnormalities.

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Table 2: Chi Square

The chi-square analysis evaluates the relationship between various factors and postural abnormalities among adolescents. Daily smartphone use shows a significant association (X^2=8.34, P = 0.015), indicating that longer usage is linked to an increased prevalence of postural issues. Ergonomic habits exhibit the strongest relationship (X^2=12.45, p = 0.000), emphasizing the importance of maintaining proper posture during smartphone use. BMI also shows a weak but statistically significant association (X^2=6.1, p=0.047), suggesting that higher BMI categories may contribute to postural abnormalities. Gender (χ2=0.75, p=0.385) and age group (χ2=4.2, p=0.122) do not demonstrate significant associations, indicating that these variables are not major factors influencing postural abnormalities in this sample. These findings highlight the critical role of modifiable factors, such as smartphone use and ergonomic practices, in preventing postural issues.

Logistic Regression

Variable	Odds Ratio	95% CI	p-value	Interpretation
Daily Smartphone Use (hours)	2.15	1.30 - 3.55	0.005	Longer smartphone use significantly increases the odds of developing postural abnormalities.
Ergonomic Habits (Poor)	3.5	2.00 - 6.10	0.001	Poor ergonomic habits substantially increase the likelihood of postural abnormalities.
BMI Category (Overweight)	1.75	1.05 - 2.90	0.035	Overweight adolescents are at higher risk of postural abnormalities.
Gender (Male)	1.1	0.70 - 1.75	0.4	No significant effect of gender on postural abnormalities.
Age Group (16-18 years)	1.25	0.80 - 1.90	0.18	Age group is not a significant predictor of postural abnormalities.

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Table 3: Logistics Regression

The logistic regression analysis identifies key predictors of postural abnormalities among adolescents. Daily smartphone use shows a significant impact, with adolescents who use smartphones for extended hours being 2.15 times more likely to develop postural abnormalities (p=0.005). Poor ergonomic habits exhibit the strongest association, increasing the odds by 3.5 times (p=0.001), emphasizing the critical role of posture awareness during smartphone use. BMI also plays a role, as overweight adolescents have a 1.75 times higher likelihood of developing postural issues (p=0.035). Conversely, gender and age group do not significantly predict postural abnormalities, as indicated by their non-significant p-values (p=0.4 and p=0.18, respectively). These findings underscore the importance of addressing modifiable factors like smartphone usage patterns and ergonomic practices to prevent postural issues, while BMI also warrants attention as a contributing factor.

Discussion

This study aimed to investigate the association between smartphone usage, postural abnormalities, ergonomic habits, and BMI among adolescents. The findings revealed significant associations between daily smartphone use, poor ergonomic habits, and postural abnormalities. These results are consistent with several previous studies but also highlight areas where the current study adds new insights.

Smartphone Use and Postural Abnormalities

A significant association was found between increased smartphone use and the presence of postural abnormalities, corroborating findings from other studies (Eletreby et al., 2020; Banadaki et al., 2024). Studies have consistently shown that prolonged smartphone usage contributes to poor posture, particularly in the cervical spine, leading to conditions such as forward head posture, rounded shoulders, and increased thoracic kyphosis (Kamel et al., 2023). Our study's findings also align with those of Beliche et al. (2021), who found that longer screen time was a risk factor for musculoskeletal disorders in adolescents, particularly affecting the neck and shoulders. This reinforces the idea that excessive screen time may be a primary contributor to the rising prevalence of musculoskeletal complaints among younger populations. Interestingly, while past studies like those by Metin et al. (2023) have shown a strong link between digital device use and postural deviations, the current study found that the duration of smartphone use (specifically, those using smartphones for over 4 hours a day) had the most

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significant impact on posture. This could be due to the nature of the study, which specifically focused on smartphone use, as opposed to other screen-based devices like laptops or tablets, which may promote different postural behaviors.

Ergonomic Habits and Postural Abnormalities

Poor ergonomic habits were another key finding associated with postural abnormalities. This result echoes previous studies such as those by Priya et al. (2022), who suggested that improper sitting posture during device usage can lead to musculoskeletal issues. In the present study, adolescents who reported using their smartphones while lying down, sitting with poor back support, or maintaining prolonged neck flexion were more likely to exhibit postural abnormalities. These findings are in line with research by Hussain et al. (2023), which found that poor ergonomic habits, such as incorrect screen positioning and inadequate support, contribute significantly to the development of posture-related issues.

This highlights an important factor: while technology itself is a contributing factor to postural deviations, the lack of awareness and intervention regarding ergonomic practices could be exacerbating the problem (Hasan et al., 2024). Improving ergonomic awareness among adolescents is crucial to preventing the development of postural abnormalities associated with excessive smartphone use.

BMI and Postural Abnormalities

Our study also explored the role of BMI in relation to postural health, revealing a weak but significant association between higher BMI and postural abnormalities. This finding is consistent with previous research such as that by Mohamed et al. (2022), who found that higher BMI can contribute to musculoskeletal discomfort due to altered body mechanics and increased strain on the spine. Adolescents with higher BMI often exhibit poor posture due to increased body weight, which can alter spinal alignment and increase the risk of musculoskeletal disorders. Although the association in our study was not as strong as the one for smartphone use or ergonomic habits, it still emphasizes the importance of addressing weight management and posture in adolescent health initiatives.

Gender and Age Group

Gender did not show a significant effect on postural abnormalities in this study, which contrasts with some studies that suggest females may be at higher risk due to anatomical and hormonal factors (Saraiva et al., 2022). However, the lack of a significant finding in this study may be

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attributed to the relatively balanced gender distribution among the participants, suggesting that other factors, such as smartphone use and ergonomics, might have a stronger influence on postural health than gender alone.

Similarly, while some studies indicate that older adolescents might be at greater risk due to longer exposure to technology, this study did not find age group to be a significant factor. This may reflect the increasing prevalence of smartphone use across all age groups within the adolescent population, regardless of age, as highlighted in previous work by Acet et al. (2025).

Conclusion

In conclusion, this study provides valuable insights into the relationship between smartphone use, postural abnormalities, ergonomic habits, and BMI among adolescents. The findings suggest that prolonged smartphone use and poor ergonomic habits are significantly associated with postural issues, which aligns with previous research. The study also reinforces the idea that addressing ergonomic education and promoting better posture among adolescents is essential to mitigating the risks posed by modern technology use.

However, the study also highlights the need for further research to explore the role of BMI and its influence on posture, particularly in larger, more diverse populations. Additionally, interventions targeting smartphone usage and ergonomics could be incorporated into school health programs to prevent the development of musculoskeletal issues. By addressing these key risk factors, we can ensure that adolescents maintain better posture, reduce discomfort, and avoid long-term musculoskeletal problems as they grow into adulthood.

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