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Association of Neck and Back Angle with Muscle Endurance Among Asymptomatic Smartphone Users: A Correlation Study

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ABSTRACT

Background: Smartphones are becoming prevalent in daily life, but continuous use, especially among young adults, is frequently linked to poor posture, such as neck flexion, which can lead to musculoskeletal problems and muscular weakness. This correlational study investigated the relationship between neck and back angles and muscle endurance in asymptomatic smartphone users.

Methods: It is an observational study, with a total of 94 asymptomatic smartphone users aged 19-24 years, including 30 males and 64 females, who were assessed for neck and back endurance using a standardized neck and back endurance test, and their neck and back angles during smartphone use were measured from photographs using Kinovea software.

Results: The study found a significant negative correlation between increased neck and back flexion angles and reduced muscle endurance ($p < 0.05$). Posture during smartphone use was identified as the primary factor influencing endurance, whereas smartphone use duration showed no significant correlation with neck or back endurance ($p > 0.05$).

Conclusion: Maintaining good posture while using smartphones is important to mitigate the risk of reduced muscle endurance and potential musculoskeletal problems.

Keywords: Asymptomatic smartphone users, back Endurance test, Neck Angle, Back angle, Kinovea software, Neck Endurance test.

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INTRODUCTION

Smartphones are now an essential part of everyday life for people of all ages, serving as key sources of communication, information, and entertainment. This increasing dependency, however, has been indirectly linked to various musculoskeletal problems [1]. Globally, there are approximately 6.92 billion smartphone users, with university students in their 20s noted as the heaviest users [2]. Frequent smartphone use often leads to awkward postures, such as sustained neck flexion. A study in Thailand found that a significant majority (82.74%) of smartphone users experiencing musculoskeletal issues maintained a flexed neck posture while using their devices [3]. Excessive smartphone use can have harmful impacts on the neck and back. Sustained neck flexion, common during smartphone use, places substantial stress on the cervical spine, potentially altering its natural curve. Users often maintain a head flexion angle of 33° - 45°. Research indicates that the force on the spine dramatically increases with forward head tilt: an adult head weighing 10-12 pounds in a neutral position can exert forces of 27 pounds at a 15° tilt, 40 pounds at 30°, 49 pounds at 45°, and 60 pounds at 60°. Forward head posture, also known as poking chin posture, is a common issue associated with smartphone use, leading to continuous strain on neck and back muscles and a reduction in their endurance over time.

Back pain linked to smartphone use is also attributed to poor posture, which causes a forward tilt of the head that rapidly fatigues neck and back muscles. Increased cases of back pain, particularly in young adults, have been associated with smartphone overuse. Mechanical lower back pain is frequently reported among adults, with excessive electronic device use being a significant factor. Studies have shown a link between increased lumbar spine pain severity and smartphone overuse, suggesting a need to explore the relationships among smartphone use, core stability, and muscle endurance. Literature suggests a link between reduced neck muscle endurance and increased forward head posture, and that prolonged neck flexion may decrease neck flexor endurance [4]. While some studies explore the effects of smartphone use on posture, pain, and muscle activity, there is limited research specifically examining neck muscle endurance among individuals who use electronic devices such as smartphones. Some research indicates that relationships exist between cervical sagittal posture, muscle endurance, joint position sense, range of motion, and smartphone addiction levels. Another study examined how neck flexion angles affect neck muscle activity in smartphone users, noting variations in activity across angles. However, some studies have found no significant connection between smartphone usage habits, posture, and neck pain or disability in young adults, or no correlation between "text neck" posture and neck pain in young adults.

Given the widespread use of smartphones and the potential for musculoskeletal issues associated with poor posture, this study aims to specifically investigate the relationship between neck and back angles and muscle endurance in

asymptomatic smartphone users. Understanding this relationship can help individuals become more aware of their muscle strength and posture, potentially enabling them to prevent future complications.

MATERIALS AND METHODS

This correlational study examined whether there is an association between neck and back angles and neck and back endurance, and between the number of hours spent using a smartphone and endurance. 120 students, both male and female, aged 18 to 24, from Nitte Institute of Physiotherapy, Mangaluru. Duration of study from August 2024 to February 2025. Prior to the study, individuals who satisfied the inclusion criteria were young adults aged 19 to 24.

Young adults spend more than 2 hours/day on smartphones. Exclusion criteria were the Presence of neurological signs and persistent neck and back pain, a diagnosed psychiatric disorder, or severe cognitive impairment. Specific diseases (e.g., Malignancy, inflammatory joint and bone diseases). Each student had data collected on their gender, age, and the number of hours they use their smartphone each day. The craniovertebral (CV) angle and lumbar flexion angle, measured in Kinovea, were used to determine the neck and back angles. Markers were applied to the tragus of the ear and the C7 spinous process for the back, the spinal process of T12, and S1. Lateral photographs of the student have been taken while they are using a smartphone in a standing position, and the angle is measured to determine the endurance. The back and neck flexor endurance test was used. Participants lay in a supine hook-lying position. They performed a maximum isometric chin retraction followed by lifting the head and neck approximately 2.5 cm above the table while maintaining a chin tuck posture. The examiner's hand was placed below the occipital bone. Participants were verbally encouraged to keep their heads lifted. The time, in seconds, the subject held the position without touching the couch/hand was recorded with a stopwatch. Three trials were conducted with 5-minute intervals, and the average time was calculated [5]. For the Back Flexor Endurance Test, Participants were seated with hips and knees bent to 90 degrees, aligning hips, knees, and the second toe. Arms were folded across the chest, touching opposite shoulders. Participants were instructed to engage their abdominals to maintain a flat-to-neutral spine, ensuring the back did not arch. The duration the position was maintained was timed until a change in trunk position occurred, such as rounding of the back or needing to place hands down. Three trials were conducted with 5-minute intervals, and the average time was calculated [6].



Figure 1: Neck flexor endurance test **Figure 2: Back flexor endurance test**

RESULTS

The collected data were summarized using descriptive statistics: frequency, percentage, mean, and S.D. The independent-samples t-test was used to compare age, number of hours spent using a smartphone, endurance test results, neck angle, and back angle between males and females. To find the association between neck endurance and neck angle, endurance and back angle, number of hours using a smartphone and neck flexor endurance test (Seconds), and number of hours using a phone and back endurance, the Pearson correlation coefficient (“r”) was used. Also, to examine the relationships between the number of hours using a smartphone, endurance test, neck angle, and bank angle and age (Years), the Pearson correlation coefficient (“r”) was used. The p-value < 0.05 was considered significant. Data were analysed by using the SPSS software (SPSS Inc.; Chicago, IL) version 29.0.10.

Table 1: Descriptive Statistics for age, number of hours using smart smartphone, neck flexor endurance test, neck angle, back flexor endurance test, and back angle.

(n = 94)	Range	Mean	S.D.
Age (Years)	19 to 24	21.27	1.70
Number of hours using smart phone	3 to 14	5.44	2.13
Neck flexor endurance test (Seconds)	25 to 186	66.20	24.41
Back flexor endurance test (Seconds)	10 to 100	39.32	19.47

Neck angle (Degrees)	5 to 45	18.52	8.69
Back angle (Degrees)	10 to 100	31.28	12.83

Table 2: Association between neck endurance and neck angle.

		Neck angle (Degrees)
Neck flexor endurance test (Seconds)	“r”	-0.636
	p value	< 0.001*

Table 3: Association between back endurance and back angle.

		Back angle (Degrees)
Back flexor endurance test (Seconds)	“r”	-0.530
	p value	< 0.001*

Table 4: Association between number of hours using smart phone of neck and back endurance.

		Neck flexor endurance test (Seconds)
Number of hours using smart phone	“r”	-0.094
	p value	0.368

		Back flexor endurance test (Seconds)
Number of hours using smart phone	“r”	-0.102
	p value	0.328

DISCUSSION

The primary objective of this study was to explore the relationship between neck and back angles and their associated muscle endurance in asymptomatic smartphone users. Additionally, it aimed to examine whether the duration of smartphone usage influences muscle endurance in these regions. Given the increasing reliance on smartphones in daily life, understanding the musculoskeletal implications of prolonged usage is critical. The findings of this study provide important insights, particularly regarding postural alignment and muscular endurance.

Neck and back angles were measured using Kinovea software, while standard endurance tests were employed to assess muscle endurance. The results revealed a significant negative correlation between flexion angles and muscle endurance in both the neck and back. Specifically, as the flexion angle increased, muscle endurance decreased, suggesting that poor posture during smartphone use can negatively impact muscular endurance even in asymptomatic individuals.

These findings are supported by Dr. Noel Samuel Macwan et al. (2023), who reported that limited research exists on the effects of muscle endurance among individuals who frequently use electronic devices such as smartphones, laptops, tablets, and computers. Their study demonstrated a strong link between altered posture and reduced muscle endurance, which can potentially lead to musculoskeletal disorders. Moreover, they emphasized that repetitive and prolonged muscle use associated with device usage

contributes to a decline in endurance over time [7,8]. This observation is consistent with the current study, which also found a postural basis for decreased muscle performance.

Further support comes from Suwalee Namwongsa et al. (2019), who observed significant differences in neck muscle activity across neck angles among smartphone users with and without pain. Their research highlighted that muscle activity and pain development varied with changes in neck flexion angle, reinforcing the concept that posture during device use plays a pivotal role in musculoskeletal health [9]. The current study aligns with these observations by identifying a decline in neck muscle endurance with increased flexion angles, even among users without symptoms.

In addition, Jeffrey C. Cowley et al. (2017) stated that muscle weakness affects joint angles, movement patterns, and overall joint stability. Their findings suggest that reduced muscle strength leads to altered movement behaviour and decreased endurance at specific joint positions [10,11]. This further substantiates the current study's findings that neck angle influences endurance levels, as muscle fatigue likely alters movement strategies during prolonged smartphone use.

The present study also identified a negative correlation between back angle and back muscle endurance, indicating that smartphone-induced postural changes are not limited to the neck region. This is consistent with the findings of Marcel Betsch et al. (2018), who investigated the impact of various smartphone-related tasks on spinal posture and muscle activity. Their study revealed that increased muscular loading during standing or walking while using a smartphone was associated with greater spinal flexion and reduced endurance [12,13]. These findings provide additional context for the observed decrease in back muscle endurance with increased flexion in the present study.

Interestingly, despite the physiological implications of poor posture, this study found no significant correlation between the number of hours spent using a smartphone and neck or back muscle endurance. This suggests that the duration of smartphone use may not be a primary factor influencing muscle fatigue. Instead, the posture or angle maintained during usage appears to be more critical. This finding emphasizes the importance of ergonomics and postural awareness rather than merely limiting screen time

CONCLUSION

This study demonstrated a significant correlation between neck and back angles and muscle endurance in asymptomatic smartphone users, concluding that greater flexion angles are associated with reduced muscle endurance. The study found that posture during smartphone use was the primary factor affecting endurance, whereas smartphone use duration did not have a direct impact on endurance. These findings emphasize the critical role of maintaining good posture while using smartphones to avoid muscle fatigue and potential musculoskeletal issues. As smartphone use continues to increase, adhering to ergonomic posture recommendations can help protect

long-term musculoskeletal health.

Strength: The study addresses a relevant issue in modern society by assessing the effects of smartphone use posture on angle and muscle endurance. It provides valuable information for improving posture and ergonomics by demonstrating a strong relationship between neck and back angles and muscle endurance.

Limitation: The study focuses primarily on angles and doesn't account for other factors that could influence muscle endurance, such as physical activity levels or individual differences. It also does not examine the long-term effects of smartphone use on muscle endurance and angle, which would require longitudinal studies.

Scope: Future research could directly compare neck and back angles and also investigate different age groups.

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Conflict of interest: The authors hereby declare there are no conflicts of interest to disclose.

Ethical approval: The trial was registered with the Clinical Trials Registry-India under CTRI number CTRI/2024/05/084732.

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