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Neck Muscle Endurance, Pain, and Smartphone Use: A Cross-Sectional Study among College Students

[1] A.D.Kailashram, [2] K.R.N. Roshan, [3] Chrysolyte Mohanan*, [4] Antony Leo Aseer.P, [5] Subbiah Kanthanathan

[1, 2] Physiotherapist, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamilnadu, India.
[3] Lecturer, Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamilnadu, India
[4] Principal and Professor, Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamilnadu, India
[5] Associate Professor, Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamilnadu, India

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KEYWORDS

Neck Pain, Posture, Mobile Phone, Muscle Strength

ABSTRACT:

Background: Mobile technology has spread globally, with smartphones becoming an integral part of daily life. Continuous smartphone use among college students raises concerns about musculoskeletal health, particularly neck stress, leading to neck pain, muscle weakness, and impaired quality of life.

Objective: To analyse the effect of smart phone addiction on neck pain and associated changes in neck muscle endurance in college students.

Methods: A single-centre cross-sectional study was conducted among Sri Ramachandra Medical College students aged 18-27 with a history of neck pain. Baseline data and demographics were collected via Google Forms. Smartphone addiction was assessed using the Smartphone Addiction Scale-Short Version (SAS-SV), with cutoff values of 31/60 for males and 33/60 for females. Participants were divided into two groups based on their SAS-SV scores. Pain levels were evaluated using the Numerical Pain Rating Scale (0-10). Manual muscle testing assessed flexor and extensor neck muscle endurance, with normative values of 39s (male) and 29s (female) for flexors, and 20s for extensors (both genders).

Result: This study included 210 participants, classified into addicted and non-addicted groups. Among males, smartphone addiction strongly correlated with decreased flexor endurance (r=-0.89) and moderately with increased pain (r=0.28). Among females, addiction strongly correlated with decreased flexor endurance (r=-0.91) and weakly with increased pain (r=0.10). P-values (0.001) indicated significant correlations, but not differences, between variables.

Conclusion: Smartphone addiction has been found to have a significant impact on the flexor endurance of the neck muscles, as well as pain levels, in both male and female individuals.

1. Introduction

Smartphone usage has experienced rapid growth, driven by the devices' multifunctional nature encompassing communication and entertainment. Most studies have presented there is link between amount of time spent on smartphone usage and increasing neuromuscular issues [1]. India has been ranked as second in world for highest smartphone usage [2].

Extensive use of smartphones can become a risk factor for raise in physical health – related problems such as pain in the back and neck and prolonged use of smartphone can eventually cause the hand to adapt a position which can lead to musculoskeletal problems[3].It was highlighted in studies that the time spent in phone usage was associated with neck pain and college students was seen to be using for long time for reasons such as browsing social media, playing games and their academic work [4]. This can include both academic and non- academic purposes.

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Neck pain is most common complaint affecting individuals of all ages most particularly young adults due to their prolonged use of computer/phone which can lead to poor posture habits, stress and decreased physical activity with increasing physical health complaints [5].A study revealed there was a fixed posture of head flexion angle of 33 –45 degrees from vertical was maintained when using the smartphone and repetitive, prolonged head flexion posture which may contribute for neck pain [6]. There was a study which was conducted by using children as participants and found that they usually flex their neck downwards to stare at the lowered object (smartphone) and maintain the head in forward position for long periods of time, which may cause pain related disorders [7].

Research has indicated that deep flexor muscles of the cervical region are often delayed in their activation in cases of neck pain which can subsequently lead to the development of neck pain [8,9].Forward head posture (FHP) is the one of the most common side effect of prolonged and sustained use mobile phone in the same posture. This leads to extension at atlanto – occipital (C1 to C2) joints with flexion of lower cervical spine (C4 to C7) and flattening of mid cervical lordosis which causes joint dysfunction, abnormal afferent information affecting the tonic neck reflex weakens the muscle due to adaptation of the same posture and encourages gradual adaptation of forward head posture(FHP)[10]. During prolonged smartphone use in a seated position, individuals adopt an improper posture, referred to as forward head posture or chin poking.

Addictive smartphone use can cause repetitive strain on neck tissues, leading to micro-trauma, inflammation, and persistent neck pain [11]. Study by Lee et al. has shown that prolonged phone use is linked to increased discomfort, highlighting the importance of maintaining adequate muscle endurance, particularly in the deep neck flexor muscles [12]. Findings indicate that individuals with neck pain frequently exhibit delayed activation of the deep cervical flexor muscles, potentially leading to further development of neck pain [13, 14]. Furthermore it is proved that smartphone addiction can negatively affect neck flexor endurance, although this association was established in male population [15]. Recent research has established that patients with cervical pain show a delay in deep neck flexor (DNF) activation when performing certain tasks with their upper extremity [16].

While there is an association between using an smartphone usage and musculoskeletal symptoms including neck pain among college students there is limited evidence regarding the influence of the student,s demographics (sex and age), having an episode of previous neck pain, and various aspects of smartphone exposures including the smartphone time spent on using the phone, the head positions while using smartphone. The objective of this research is to analyse the mobile phone usasge data and understand how smartphone addiction influences the development of neck muscle weakness and also analyze both male and female participants.

The objective of this research:

1. To analyse the influence of smartphone addiction on neck muscle endurance and pain among male college students.
2. To analyse the influence of smartphone addiction on neck muscle endurance and pain among female college students

2. Methodology:

2.1. Study Design and Setting

A Cross-sectional study on students was conducted at Sri Ramachandra Institute of Higher Education and Research, India.

2.2. Ethical Approval

Ethical approval was obtained from the institutional ethical committee of XX Institution (ref. no: CSP-III/24 JUNE/06/197) and registration for this trial is XXX/2025/03/081698. An informed consent to participate is collected from the students.

2.3 Participants

This cross-sectional study is conducted on a sample of college students aged between 18 –27 years who were recruited from Sri Ramachandra institute of higher education and research, India. Participants using smartphone for more than 2 hours per day on an average of over past 6 months on a regular basis. Participants who regularly use their smartphone for activities such as texting, watching videos and playing games and self-reporting confirmation from the participants will be included. Participants with pre-existing neck injuries, chronic neck pain condition, chronic uncontrolled

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medical conditions, neuromuscular disorders affecting neck muscle endurance, participants who undergone neck surgeries were excluded from the study.

Sample Size: The sample required was calculated using G*POWER (version 3.1.9.7). Using an α value of 0.05 and a β value of 0.95 to find a large effect size relating to a change in the DNF endurance time between groups, 105 participants in each group were deemed sufficient.

The level of smartphone addiction among students was evaluated using the SAS-SV (14), a 10-item scale with a 6-point Likert response ranging from 1 to 6, with 1 representing 'strongly disagree, and 6 'strongly agree. Scores above 31and 33 indicated addiction for male and female respectively. Student participants were divided into two groups based on their SAS-SV scores for smartphone addiction.

2.4 Procedure

We obtained the demographic data including age, height, weight, pain associated with smartphone use, duration of smartphone use, and purpose of smartphone use by collecting the Google Forms from all the students and we were able to separate them into group A (smartphone-addicted) and group B (non-smartphone-addicted). Data were collected during September 2024 - November 2024 through a questionnaire to identify addicted and non-addicted participants and NPRS scale to identify participants' pain level due to smartphone usage. Muscle endurance was evaluated using two tests: the DNF endurance test for deep neck flexors and the CEET for cervical extensors.

Table 1: Demographic data Male and Female participants

Demographic variables	MALE n= 85	FEMALE n=125
Age in years (Mean±SD)	20.48±2.04	19.14±1.48
Height(cm) (Mean±SD)	174.4±8.26	159.4±6.37
Weight(kg) (Mean±SD)	74.08±15.18	58.25±10.84
SAS –SV in points (Mean±SD)	29.51±8.96	30.56±8.51
Pain score in points (Mean±SD)	2.01±1.71	2.18±2.18
Duration of usage		
1-2 hours n (%)	15(17)	9(7)
2-4 hours n (%)	36(42)	56(45)
4-6 hours n (%)	24(28)	52(42)
More than 6 hours n (%)	10(12)	8(6)
Purpose of mobile phone usage		
Social median (%)	62 (73)	84(67)
Watching videos n (%)	12 (14)	27(22)
Others n (%)	11 (13)	14(11)

SD –Standard deviation

2.5. Neck Flexor Endurance Assessment

To assess DNF endurance, students adopted a crook-lying position, maximally tucked their chin, and lifted their head 2.5 cm. The test measured the time they could maintain this position without compensatory movements, terminating when skin folds separated or the head touched the examiner's hand.

2.6. Neck Extensor Endurance Assessment (CEET)

For the CEET (16), students lay prone with their neck and head off the table. They were instructed to hold their chin tucked for 20 seconds in a neutral neck position. Only one attempt was made to avoid muscle fatigue. A 5-10 degree change in position indicated weakness in the deep neck extensor as reported by Sebastian et al. (2015). The test was considered positive if there was an increase in chin-length or an inability to maintain the chin tuck owing to dominant superficial cervical extensor activity.

2.7 Data analysis

The Kolmogorov-Smirnov test was used to test the normal distribution of data and Levene's test was used to check whether the groups had equal variance. A between group comparison of student characteristics was conducted using an independent t-test for numerical data. The significant level for all statistical test was set at

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p<0.05. Pearson correlation was used to test the linear relationship between the variables. Statistical analysis was performed using the social science statistics.

3. Results

3.1 Participants characteristics:

The characteristics of the students (n=210) are summarized in Table 1. At baseline no significant difference between the groups was observed for mean age, weight, height for both male and female (p>0.05)

3.2 Comparison of variables between neck flexor endurance, pain score and Smartphone- addiction in male:

Among male participants in table I, smartphone addiction in comparison with flexor endurance showed strong negative correlation (r=-0.89) at p<0.001 and moderate negative correlation with pain score (r=-0.28) at p=0.009, indicating flexor endurance decreases as smartphone addiction increases and pain level increases along with the addiction of smartphone usage respectively.

3.3 Comparison of variables between neck flexor endurance, pain score and Smartphone- addiction in female:

Among female participants in table II, smartphone addiction in comparison with flexor endurance showed linear negative correlation (r=-0.91, p<0.001) and a weak positive correlation with pain score (r=0.10) at p=0.2, indicating flexor endurance decreases as smartphone addiction increases and pain level increases along with the addiction of smartphone usage.

From the collected data, social media was the most frequent use of smartphone among both male and female respondents (32.3 and 32.7% respectively). Female respondents had a longer usage of smartphone, with 45.68% using it for 4-6 hours a day compared to males, with the majority (50%) using it for 2-4 hours. (Refer Fig.1 and Fig. 2)

Table 1. Correlation between Smartphone addiction and flexion endurance, extension endurance, pain score for male

VARIABLES	Male	SMARTPHONE ADDICTION	FLEXOR ENDURANCE	EXTENSOR ENDURANCE	PAIN SCORE
SMARTPHONE ADDICTION	PEARSON'S COORELATION	1	-0.89	0.02	0.28
	SIG(2-TAILED)	0.001*	0.001*	0.85	0.009*
FLEXOR ENDURANCE	PEARSON'S COORELATION	-0.89	1	0.12	0.16
	SIG(2-TAILED)	0.001*	0.001*	0.27	0.14
EXTENSOR ENDURANCE	PEARSON'S COORELATION	0.02	0.12	1	-0.07
	SIG(2-TAILED)	0.85	0.27	0.001*	0.52
PAIN SCORE	PEARSON'S COORELATION	0.28	0.16	-0.07	1
	SIG(2-TAILED)	0.009*	0.14	0.52	0.001

Correlation of SAS, neck pain severity, cervical flexor endurance tests and cervical extensor endurance tests. *Pearson Correlation-coefficients significant at the 0.01 level (2-tailed).

Table 2: Correlation between Smartphone addiction and flexion endurance, extension endurance, pain score for female:

VARIABLES	Male	SMARTPHONE ADDICTION	FLEXOR ENDURANCE	EXTENSOR ENDURANCE	PAIN SCORE
SMARTPHONE ADDICTION	PEARSON'S COOREALTION	1	-0.91	0.11	0.10
	SIG(2-TAILED)	0.001*	0.001*	0.22	0.26
FLEXOR ENDURANCE	PEARSON'S COOREALTION	-0.91	1	0.42	-0.13
	SIG(2-TAILED)	0.001*	0.001*	0.41	0.14
EXTENSOR ENDURANCE	PEARSON'S COOREALTION	0.11	0.42	1	-0.14
	SIG(2-TAILED)	0.22	0.41	0.001	0.11
PAIN SCORE	PEARSON'S COOREALTION	0.10	-0.13	-0.14	1
	SIG(2-TAILED)	0.26	0.14	0.11	0.001

Correlation of SAS, neck pain severity, cervical flexor endurance tests and cervical extensor endurance tests. *Pearson Correlation-coefficients significant at the 0.01 level (2-tailed).

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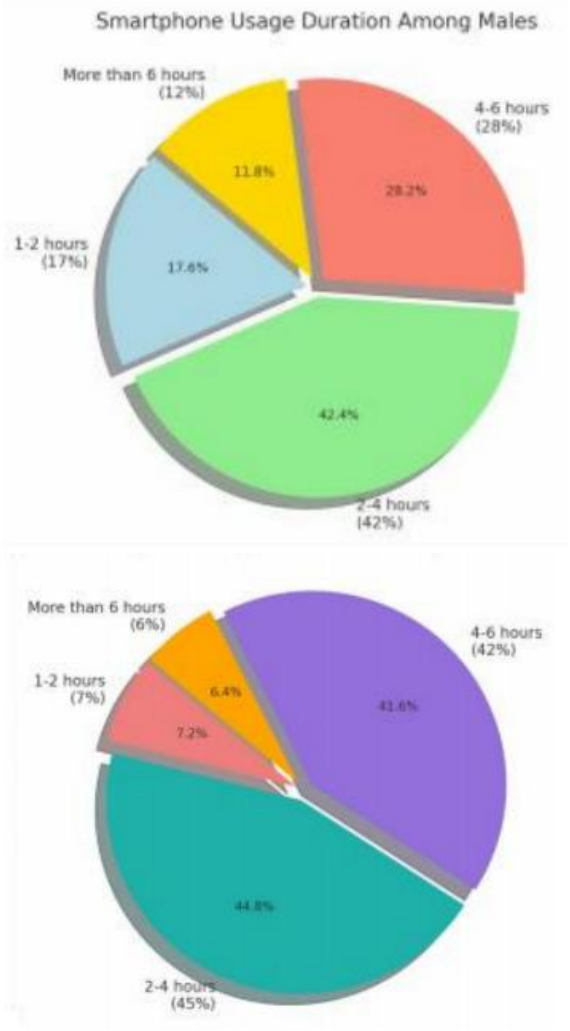
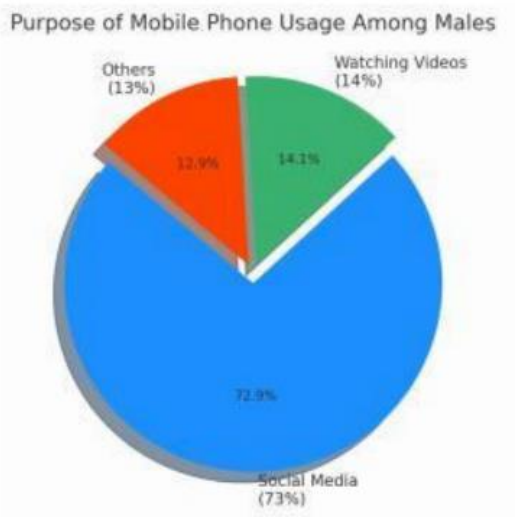


Fig 1: Male and female participants duration of smartphone usage:



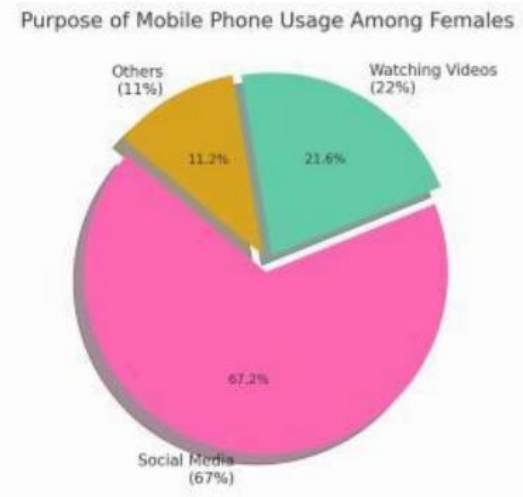


Fig 2: Male and female participant's purpose of smartphone usage respectively:

4. Discussion

This observational study investigated the correlation between smartphone addiction and neck muscle endurance in college students, revealing a significant association between prolonged smartphone use and decreased neck muscle endurance, as well as increased neck pain. [1,4]

The repeated flexion of the neck during smartphone use leads to muscle fatigue and pain [8, 9]. Extended mobile phone usage is commonly associated with FHP, a condition resulting in joint dysfunction, muscle atrophy, and the progressive development of FHP [10].

This study reveals a significant association between smartphone addiction and compromised neck muscle endurance, as well as increased pain, in both male and female college students, similar to previous research that linked excessive smartphone use to altered neck posture and muscle fatigue [1].

Unlike the observed impact on flexor endurance, extensor muscle endurance appeared to be unaffected by smartphone usage, with both groups of participants (addicted and non-addicted group) exhibiting normal levels and no significant differences [22].

Eitivipart et al (2018) found that frequent smartphone users had significantly higher VAS scores than the infrequent and non-user groups ($p < 0.05$) but found no

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difference between non-users and infrequent users. A study conducted by Maayah et al. utilized an online survey to inquire about smartphone usage and neck pain among university students whose findings indicated that the amount of time spent on the device was a significant factor associated with neck or shoulder pain. [23] Moreover, a history of neck or shoulder pain was a strong predictor of both the severity of neck pain and the length of time experiencing neck pain.

Notably, the study revealed a pronounced gender difference in the relationship between smartphone addiction and neck muscle endurance, with females exhibiting a stronger negative correlation (r=-0.91) compared to males (r=-0.89). Furthermore, while both genders experienced increased pain with smartphone addiction, the association was significantly weaker in females (r=0.10) than in males (r=0.28), suggesting potential differences in underlying mechanisms or contributing factors.

Our study indicated that social media was the most frequent use of smartphone among both male and female respondents (32.3 and 32.7% respectively). Female respondents had a longer usage of smartphone, with 45.68% using it for 4-6 hours a day compared to males, with the majority (50%) using it for 2-4 hours. This implies that females could be at increased risk for musculoskeletal problems as a result of long-term smartphone usage [21]. Although the participants in the smartphone-addicted group of our study showed decreased DNF Endurance and increased pain level they had not developed neck pain particularly only due to smartphone usage. However, a long-term study is required to monitor their musculoskeletal symptoms and causes for it.

This research demonstrated the effects of smartphone usage leading to reduction in endurance of neck muscles eventually causing postural problems, strain and long term complications.

The limitation that we conclude here is that of use of more than one geographical location, assessing and categorizing the students based on demographics. Since this is a cross- sectional study, a cause-effect relationship cannot be produced between smartphone addiction and DNF endurance. Since the data was collected by the method of google forms there can be recall bias.

5. Conclusion:

This research highlights a significant relationship between smartphone use and decreased neck muscle endurance, a major contributor to neck pain in college students, implying that prolonged smartphone use can lead to muscle fatigue, strain, and an increased risk of chronic neck pain. Notably, female participants exhibited a stronger negative correlation with endurance, suggesting possible gender-based differences in musculoskeletal adaptation and pain perception. Future research should focus on exploring alternative strategies to counteract the detrimental effects of prolonged smartphone use and improving muscle endurance through exercises.

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