

Correlation of Smartphone Addiction with Cervical Muscle Strength and Joint Proprioception in Adolescents

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A B S T R A C T

Background: Smartphone have undeniably revolutionized our lives, there is growing concern regarding the addictive nature of these devices and the subsequent negative impacts on individuals and society.

Objective: To determine the correlation of smart phone addiction with cervical flexors strength and joint proprioception among adolescents, to determine the frequency of joint position error and to assess the influence of excessive Smartphone usage on the muscles responsible for cervical flexion among adolescents.

Methodology: A cross sectional survey was conducted on 377 students from various schools of Islamabad and Rawalpindi. Students of both genders with age ranged from 12-18 years having a history of Smartphone addiction for more than 4 hours were included in the study. Whereas exclusion criteria was children with special needs, history of cervical trauma within a year, motor problem in upper extremity and vestibular pathologies and dizziness. Smartphone addiction scale short version was used to determine the addiction among participants. Cervical joint position error (CJPE) was performed to assess the cervical joint proprioception and strength of the cervical flexors muscles was evaluated by manual muscle testing (MMT) procedure. Data was analyzed using SPSS version-23.

Results: Total 377 participants were included, out of which 184 (48.8%) were males and 193 (51.2%) were females. Mean value of Smart Phone Addiction Scale-Short version was 40.33 ± 7.95 . Correlation between Smart phone addiction and Joint position error was weak and non-significant. Correlation between Smart phone addiction and muscles of cervical region demonstrated that Sternocleidomastoid has a weak but significant (P-value 0.018) correlation (R-value 0.121) with smartphone usage, and remaining exhibited non-significant and very weak correlation.

Conclusion: This study concluded that majority of the students had smart phone addiction leading to highest cervical joint position error in Right rotation and right-side bending. Whereas, non-significant weak correlations were observed between smartphone usage on cervical muscle strength and joint proprioception.

Keywords: Adolescents, addiction, muscle strength, proprioception, smartphone

Introduction

Smartphone offer a range of mobile applications for communication, education, and entertainment. ¹ Everyone is now dependent on their Smartphone because it has become a necessity for the modern era. ² Smartphone provide customers additional benefits because they can access the internet, unlike ordinary mobile phones. ³ On the other hand, the Smartphone has a major impact on our lives because people are now more

inclined to use their phones for leisure than to take part in other activities. ⁴

A major cause of concern around the globe is smartphone addiction. ⁵ Excessive Smartphone use by students was found to have detrimental effects on their academic performance, mental well-being, and physical wellness. The number of smartphone users was predicted to almost triple by 2021, young urban populations experiencing this most intensely. In the recent survey, smartphone addiction was widespread

among young people in Pakistan by 60%.⁶ The majority of mobile users are typically between the age of 21 and 30 years. On average they use smartphone for 10 hours a day.⁷

The cervical structures play an important role in both mechanical flexibility, which results in a wide range of motion, and stability while supporting the weight of the head. (8) Recent studies have shown that people with cervical pain exhibit a decline in Deep Neck Flexors (DNF) activation when using their upper extremities for particular activities, which indicates a severe impairment in the neck's Deep Neck Muscles.⁹ According to several researches the extent of musculoskeletal complaints is correlated with the amount of time spent using smart phones.⁷ Additionally, studies have shown that using excessive smartphone has a negative impact on the neck and upper extremity function, which results in weak neck muscles. According to the data, prevalence of neck pain in smart phone users ranges from 17.3% to 67.8%.¹⁰

The cervical flexor muscles play a vital role in maintaining the head's neutral posture and controlling flexion in a stable manner within the cervical spine.¹¹ Insufficient control of segmental motions, a decline in activity, and a lack of neutral position control are all symptoms of dysfunction in the Deep Cervical Flexor muscles.¹² Abnormal Deep Neck Flexor activity coupled with compulsive Smartphone use may result in chronic tissue overload, damage, and neck pain.¹³

The cervical spine, the most movable section of the vertebral column, is controlled by a very sophisticated proprioceptive system.¹⁴ Proprioception is crucial for healthy motor development and control.¹⁵ Due to the decline of neck proprioception, which directly affects postural regulation and balance, the sensorimotor extent of the cervical spine is severely impaired.¹⁶

Smartphones allow users to maintain a static posture for extended periods of time, which reduces muscle excursion.¹⁷ For adequate reflexive and voluntary motions, the muscle receptors are crucial in sensing joint movement and position sense.¹⁸ The cervical muscles' significant role in proprioception is demonstrated by their high muscle-spindle intensity.¹⁹ The neck's proprioception, flexibility, and endurance have been proven as contributing factors to neck discomfort in numerous researches. Due to the significant frequency of neck pain among Smartphone users, examination of these parameters and an analysis of their interaction with the degree of addiction should offer new insight into the potential adverse effects for Smartphone users.²⁰ When cervical proprioception is compromised, individuals may experience difficulties in maintaining proper neck alignment and coordinating neck movements. This can contribute to symptoms such as neck

pain, stiffness, muscle tension, and decreased range of motion.²⁰

The increasing prevalence of smartphone usage among adolescents in Pakistan has raised concerns about its potential impact on musculoskeletal health, particularly regarding cervical muscle strength and joint proprioception. Adolescents are in a critical developmental stage, and excessive smartphone use may contribute to forward head posture, muscle fatigue, and weakened cervical muscles, potentially impairing joint proprioception. Understanding this correlation is essential to address early musculoskeletal issues, promote healthier smartphone usage habits, and guide interventions to prevent long-term health consequences. Therefore, the current study aimed to determine frequency of joint position error, to assess the influence of excessive Smartphone usage on the muscles responsible for cervical flexion and determine the association of smart phone addiction with cervical flexors strength and joint proprioception among adolescents.

Methodology

An analytical cross sectional survey was conducted for a period of 6 months from February 2023 to July 2023. The study title was approved from Institutional Review Board and Ethical Committee of Shifa International Hospital (IRB # 0364-22). Although our initial power analysis calculated by G-power software using effect size of 0.15, α error prob of 0.05 and power of 0.80, suggested a sample size of 343, we opted for a more conservative estimate of 377 to account for potential participant dropouts and ensure sufficient power for additional analyses. Data was collected after taking approval from different schools of Rawalpindi and Islamabad using a non-probability convenient sampling technique.

Students of both genders with age ranged from 12-18 years having a history of Smartphone addiction for more than 4 hours were included in the study. Whereas exclusion criteria was Children with special needs, history of cervical trauma within a year, motor problem in upper extremity and vestibular pathologies and dizziness.

Self-structured questionnaire along with standard questionnaires were filled by school going students with an attached informed consent. The study consisted of answering the Smart Phone Addiction Scale-Short Version for the assessment of Smartphone addiction. It consisted of six factors and 10 items, with a six-point Likert scale (1: "strongly disagree" to 6: "strongly agree"). This scale ranges from 10 to 60 points; with scores ≥ 34 indicating addiction.²¹

Cervical flexors assessment was done by Muscle Manual Testing. Muscles that were assessed during MMT are: Longus colli and Rectus Capitis that are deep flexors muscles and Sternocleidomastoid and Scalenus Anterior are the superficial muscles. It consists of six grades from 0 to 5 scales with grade 0 means no evidence of contractility and grade 5 means normal very strong muscle with full range of motion against resistance.²²

Cervical Joint Positioning Error Device was used to assess the joint proprioception. The individual was seated and equipped with modified headgear, while a laser was directed towards the center of a circular grid. The grid had a diameter of 40 cm and was divided into four equal quadrants through the intersection of two perpendicular lines positioned at its center. Additionally, a small circle with a radius of 4.5 cm was marked on the grid. (Figure 1) The individual's head was 90 centimeters away from the grid. In order to determine whether a subject has trouble repositioning with closed eyes, we gave the participants the instruction to make all cervical motions with their eyes open. We then asked them to relocate the laser beam in the middle of the grid. The participant was directed to close their eyes, flex their heads as much as possible, and then return them to what they thought to be their neutral position after a laser beam had been focused on the place on the wall grid chart.²³



Figure 1. Head gear with integrated laser

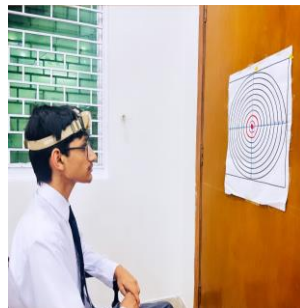


Figure 2: CJPE Testing.

Quantitative variables were expressed as mean and standard deviation whereas qualitative variables were expressed as frequency and percentages. The data analysis was done by using IBM SPSS 23.

Results

The mean age of the participants was 15.11 ± 1.89 (years). Out of total 377 participants 184 (48.8%) were males and 193 (51.2%) were female students.

Regarding the four muscles examined, 326 (90.2%) students were observed to have a grade 5 muscle strength for the rectus capitis muscle. However, 98 (26%) students achieved a grade 4 score for the sternocleidomastoid muscle.

The frequencies and percentages for the other muscles are presented in table I.

Table I: Manual Muscle Testing of Cervical Muscles (Average of left and right-side muscles)		
MUSCLES	GRADE 4	GRADE 5
Longus colli	51(13.5%)	326 (86.5%)
Sternocleidomastoid	98 (26%)	279 (74%)
Rectus capitis	37 (9.8%)	340 (90.2%)
Scalenus Anterior	50 (13.3%)	327 (86.7%)

Out of total 377 participants mean value of Smartphone addiction scale short version was 40.33 ± 7.95 , the score ≥ 34 indicates an addiction. The highest reported score was 59, while lowest recorded score reported at 15.

Mean of cervical joint position error was also calculated for each movement. Error was considered if the mean value of cervical joint position error angle was greater or equal to 4.5° . Right cervical rotation showed significant error (5.66 ± 2.61) which is more than 4.5 and the minimum error was found in Extension movement (5.03 ± 2.04) and the rest of the movements are shown in table II.

Table II: Mean and Standard Deviation of Cervical Joint Position Error/ (CJPE)		
	MEAN OF CJPE	ANGLE OF CJPE
MOVEMENTS	MEAN$\pm$ SD	MEAN$\pm$SD
Cervical Flexion	8.10 ± 3.72	5.14 ± 2.35
Cervical Extension	7.91 ± 3.23	5.03 ± 2.04
Cervical Right-side bending	8.17 ± 4.03	5.61 ± 2.53
Cervical Left side bending	8.84 ± 4.09	5.17 ± 2.52
Cervical Right Rotation	7.97 ± 4.01	5.66 ± 2.61
Cervical Left Rotation	8.61 ± 3.70	5.17 ± 2.41

A Pearson correlation test was conducted to examine the relationship between Smartphone addiction and flexors muscles of the cervical region. The results revealed that only the sternocleidomastoid muscle demonstrated a weak but significant correlation (p-value is 0.018 and R-value is 0.121) with Smartphone addiction. However, the remaining muscles exhibited non-significant and very weak correlation as shown in Table III.

Table III: Correlation between Smartphone Addiction and Cervical flexor muscles.		
VARIABLES	R VALUE	P VALUE
Longus colli	0.039	0.452
Sternocleidomastoid	0.121	0.018
Rectus capitis	0.033	0.525
Scalenus anterior	0.018	0.723

To examine the relationship between Smartphone addiction and joint position error, Pearson's correlation analysis was conducted. The results of this analysis indicated that all variables exhibited a very weak and non-significant correlation.

Cervical left side bending and left rotation showed very weak inverse correlation with the Smartphone addiction with values - 0.023 and -0.034 respectively (Table IV).

Table IV: Correlation between Smartphone Addiction and Cervical joint proprioception.		
Variables	R-Value	P-Value
Cervical flexion	0.013	0.795
Cervical extension	0.041	0.427
Cervical right-side bending	0.012	0.688
Cervical left side bending	-0.023	0.654
Cervical right rotation	0.004	0.939
Cervical left rotation	-0.034	0.516

Discussion

The present study aimed to investigate the correlation of smartphone addiction and cervical flexors strength, as well as joint proprioception, in adolescents. However, the results of the study did not reveal any significant correlation. The majority of the cervical flexor muscles did not exhibit significant correlation with smartphone addiction, indicating that excessive smartphone use may not have a direct impact on the strength or functioning of these muscles. However, it is worth noting that a weak but significant correlation was observed specifically with the sternocleidomastoid (SCM) muscle.

In a study conducted by Alshahrani et al. in 2018, the researchers investigated the impact of smartphone use on cervical proprioception and balance. The study assessed neck proprioception and found that in the heavy-use group, the distances in joint position error (JPE) during right and left rotation were higher compared to the light-use group. Based on these findings, the authors concluded that long-term smartphone use has a negative effect on cervical proprioception.²⁴ In contrary to the previous findings the current study revealed non-significant correlation between smart phone addiction and proprioception. The discrepancy in findings could be due to variations in population demographics, or measurement techniques. Differences in smartphone usage patterns, physical activity levels, and ergonomic practices among the adolescents studied could also play a role.

In a study conducted by Portelli et al. in 2018. The study's results demonstrated that participants who spent four or more hours per day using electronic devices exhibited greater distances of joint position error (JPE) specifically during neck flexion, in comparison to those who used electronic devices less frequently. However, no significant differences were observed in JPE distances during neck extension, right rotation, and left rotation between the two groups.²⁵ These results are in favor to the present study results which also revealed no correlation between these variables.

Aishwarya et al. conducted a study in 2023 on Does Smartphone Use Really Impact Cervical Rotation and Cervical Proprioception in Asymptomatic Individuals. The results indicated that among the various movements, right lateral flexion had the greatest influence on the average distance of head repositioning error in cervical proprioception, followed by flexion, left lateral flexion, left rotation, extension, and finally right rotation.²⁶ Conversely, current study revealed significant errors in joint position (JPE) during right rotation, followed by right-side bending, left-side bending, left rotation, flexion, and extension. The differences in findings might be due to variations in measurement techniques used and different population demographics.

In order to assess the proprioception and repositioning errors in cervical spondylosis with subject's age and gender, Ravi et al. did a study in 2012. The study revealed that individuals with cervical spondylosis experienced more significant proprioceptive errors in all planes during the Head-to-Neutral repositioning tests when compared to healthy adults of similar age and gender.²⁷ It's worth noting that in current study, which involved healthy students, movements were performed in all cardinal planes regardless of gender. The most substantial errors were observed in side bending and rotations, which were conducted in different cardinal planes.

In 2014, Lee et al. conducted a study on the comparison of cervical repositioning errors according to Smartphone addiction grades. The study revealed a significant difference in joint position sense (JPS) among individuals with varying levels of Smartphone addiction, categorized as normal, moderate, and severe. This indicated that group with severe smartphone addiction displayed the largest errors in repositioning the cervical vertebrae.²⁸ It is important to note that current study did not assess position sense errors over time, therefore making direct comparisons with these studies is difficult. Nevertheless, current study findings suggest that prolonged bending postures, commonly associated with smartphone use, may increase the risk of reduced JPS, potentially due to micro-injuries or trauma in the surrounding soft tissues of the joints.

Conclusion

The current study concluded that majority of the students had smart phone addiction leading to highest cervical joint position error in right rotation and side bending whereas non-significant weak correlations were observed between smartphone usage on cervical muscle strength and joint proprioception. Specifically, sternocleidomastoid showed a significant correlation with smartphone addiction.

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