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ORIGINAL ARTICLE

Effect of Smart Phone Addiction on Neck Muscles Endurance – A Cross-sectional Study

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Abstract

Introduction: Approximately 70% of the total population experience neck pain more than once a lifetime. The greater the amount of neck flexion that occurs during smart phone usage, the more stress is placed onto the spine, which causes neck pain. The Deep Neck Flexor (DNF) and the Deep Neck Extensors (DNE) muscles provide stability to the cervical spine during head and cervical spine movements. Deep Neck Flexor Endurance (DNFE) and Deep Neck Extensors Endurance (DNEE) are important component of cervical spine function. Aim of this study was to find out the effect of smart phone addiction on deep neck flexors and extensors endurance. **Method:** Neck Flexor Muscle Endurance Test (NFME test): The test was performed in supine and crook lying positions with the chin maximally tucked and maintained isometrically. The subject lifted the head and neck until the head was approximately 2.5 cm off the plinth while maintaining the chin retracted to the chest. Neck Extensor Muscle Endurance Test (NEME test): The subject was put in a prone position with the head protruding from the plinth and supported on a stool, arms at side. Then the subjects were asked to retract the chin and hold the head steady in a horizontal position while the stool was removed. **Result:** On analysis using Pearson Coefficient correlation between Mobile addiction and Neck Flexors endurance, r value was 0.1049 (p=0.3673) was not significant. On analysis using Pearson Coefficient correlation between Mobile addiction and Neck extensors endurance, r value was -0.1251(p=0.2816) was not significant. **Conclusion:** We conclude that there is no direct relationship between mobile addiction and neck flexors endurance. Also, it is concluded from above study that there is no direct relationship between mobile addiction and neck extensors endurance.

INTRODUCTION

According to Lee SC *et al.*, approximately 70% of the total population experience neck pain more than once a lifetime. Every year, the number of smart mobile users is increasing, and neck pain occurs mostly due to assuming an inappropriate posture while using their mobile devices. As stated by Lee SC *et al.,* the greater the amount of neck flexion that occurs during smartphone usage, the more stress is placed onto the spine, which causes neck pain. The Deep Neck Flexor (DNF) muscles provide stability to the cervical spine during head and cervical spine movements. Deep Neck Flexor Endurance (DNFE) is an important component of cervical spine function[1].

Smartphones have become an essential object in everyday life; people of all ages have started using smartphones for different daily tasks. Smartphones are not only a means of communication but also a key source of information and entertainment. The world is becoming increasingly dependent on smartphones. According to Alshahrani A *et al.,* the continuous checking and/or utilization of smartphone applications for prolonged periods is associated with stress, withdrawal, anxiety, sleep disturbance, decreased physical activity, poorer academic performance, and deterioration in wellbeing. Several studies have shown an association between time spent using smartphones and the severity of musculoskeletal complaints. Moreover, Alhassan A.A *et al.,* have reported the harmful impact of smartphones on neck and upper extremity function: the neck becomes more stressed due to the overuse of smartphones, leading to neck muscle weakness. It was reported that the prevalence of neck pain ranges between 17.3% and 67.8% among smartphone users, and the lifetime prevalence is 55.8 %[2].

Individuals with minor neck pain who often bend their neck considerably more than their healthy counterparts might have musculoskeletal symptoms due to the prolonged usage of smartphones. 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, which denotes a significant deficit in the DNF muscles of the neck that control the cervical spine. Forward head posture or poking chin posture is a poor posture commonly adopted during prolonged smartphone use in a seated position. Aberrant DNF activity with the addictive use of smartphones might cause constant tissue overloading, trauma, and neck pain. Moreover, DNF training has been recommended to optimize cervical spine function[2].

The cervical spine relies on the coordinated function of the Deep Neck Flexor (DNF) and Deep Neck Extensor (DNE) muscles to maintain postural stability, segmental control, and efficient movement during daily activities. The deep neck flexors, primarily the longus colli and longus capitis, act as local stabilizing muscles that maintain the physiological cervical lordosis, provide dynamic intersegmental stability, and control excessive cervical movements while minimizing mechanical stress on passive structures such as ligaments, intervertebral discs, and facet joints. Conversely, the deep neck extensors, including the cervical multifidus**,** semispinalis cervicis**,** semispinalis capitis**,** and suboccipital muscles, stabilize the posterior cervical spine, maintain an upright head posture against gravity, and eccentrically control cervical flexion during functional activities. These muscle groups work synergistically through coordinated co-contraction to optimize cervical alignment, enhance proprioception, and ensure efficient load distribution across the cervical vertebrae. During prolonged smartphone use, individuals commonly adopt a sustained forward head posture with excessive cervical flexion, which increases the moment arm of the head and substantially elevates the mechanical load on the cervical musculature. This prolonged static loading may result in muscle fatigue, reduced endurance, altered neuromuscular control, impaired proprioception, and cervical muscle imbalance, thereby increasing the risk of postural dysfunction and neck pain. Consequently, assessment of both deep neck flexor and deep neck extensor endurance is clinically important, as it provides valuable information regarding cervical muscle performance and may facilitate the early identification of musculoskeletal alterations associated with excessive smartphone use[3].

The widespread use of smartphones has become an integral part of modern life, particularly among young adults, leading to growing concerns regarding its impact on musculoskeletal health. Although previous studies have demonstrated an association between prolonged smartphone use and neck pain, forward head posture, reduced cervical range of motion, and functional disability, the effect of smartphone addiction on the endurance of the deep cervical musculature remains inadequately explored. Most existing research has focused on postural changes, pain intensity, or muscle activity, while limited studies have simultaneously evaluated both deep neck flexor and deep neck extensor muscle endurance in relation to smartphone addiction, especially among healthy Indian young adults. Furthermore, cervical muscle endurance is an important indicator of neuromuscular control and spinal stability, and early impairment may precede the development of clinical neck disorders. Identifying whether smartphone addiction is associated with reduced cervical muscle endurance may facilitate the early recognition of individuals at risk for future musculoskeletal dysfunction and support the implementation of preventive ergonomic and physiotherapy interventions. Therefore, the present study was undertaken to investigate the effect of smartphone addiction on deep neck flexor and deep neck extensor muscle endurance among healthy young adults[4].

MATERIAL AND METHODOLOGY

This cross-sectional observational study was conducted at a Physiotherapy College over a period of 6 months, involving 100 participants selected through purposive sampling. The study included young, healthy individuals aged 18-27 years with a smartphone addiction scale score >25. Participants with neck pain, recent fracture or injury of the cervical spine, and uncooperative subjects were excluded from the study. Quantitative data was collected as part of the research. The sample size was estimated using Fisher's arctanh transformation based on a presumed correlation coefficient of 0.52, with a confidence level of 95% and a power of 90 with no drop outs.

Statistical Analysis

Data collected was analyzed using "INSTAT" software and "Pearson coefficient correlation Test" was used to co-relate smart phone addiction to Neck flexors and extensors.

Procedure

Approval of the ethical committee was taken. People on the list were contacted personally for their consent of their voluntary participation to this project. Orientation regarding the purpose, procedure and benefits of this study was given to the patients. Participants were recruited according to the inclusion criteria and demographic data will be collected with written consent. Neck flexor and extensor endurance test was performed and endurance of the muscles was noted.

Smartphone Addiction Scale (SAS)

As stated by M Kwon *et al.*, SAS is a self-reporting scale to assess smartphone addiction which consisted of 10 items, with a five-point Likert scale (1: "strongly disagree" to 5" agree"). The ten items consisted of missing planed work, difficulty in concentration, pain in wrist, won't be able to stand long, feeling impatient & fretful, constant phone on mind, affecting daily life, constant checking, longer time, and people saying that I am smartphone addicted. The respondent circles the statement which most closely describes their smartphone use characteristics. Scores range from 10-50. The higher the score, the greater the degree of pathological use of the smartphone. The SAS is a reliable and valid measurement tool for the evaluation of smartphone addiction[24].

Neck Flexor Muscle Endurance Test (NFME test)

As stated by Parazza S *et al.,* the test was performed in supine and crook lying positions with the chin maximally tucked and maintained isometrically, the subject lifted the head and neck until the head was approximately 2.5 cm off the plinth while maintaining the chin retracted to the chest. During the test verbal

commands such as "tuck your chin in" or "hold your head up" were given. Whenever there was a loss of chin tuck or if the subject's head touched the investigator's hand for more than one second, if the skin folds began to separate due to a loss of chin tuck for the same amount of time, or if the subject wanted to stop because of fatigue or pain, the test was stopped[3].

Figure 1. Subject performing neck flexor muscle endurance test.

Neck Extensor Muscle Endurance Test (NEME test)

As stated by Parazza S *et al.,* the subjects were put in a prone position with the head protruding from the plinth and supported on a stool, arms at side and then the subjects were asked to retract the chin and hold the head steady in a horizontal position while the stool was removed. At this point the stopwatch was started and the endurance time was measured in seconds. The test was stopped if the subject could not maintain the head in a horizontal position or if the subject wanted to stop because of fatigue or pain. After the NEE test the subject was asked to stay prone with his/her head supported for 1 minute and then to sit up[3].

Figure 2. Subject performing neck extensor muscle endurance test.

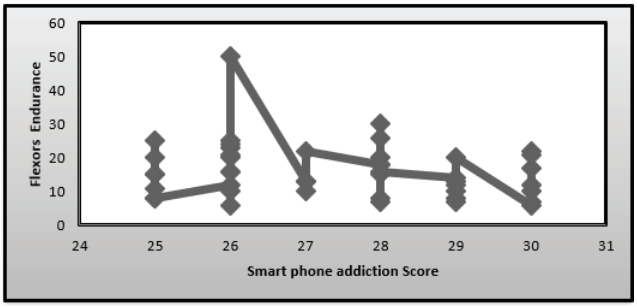
RESULT

On analysis using Pearson Coefficient correlation between Mobile addiction and Neck Flexors endurance, r value was 0.1049 (p = 0.3673) was not significant.

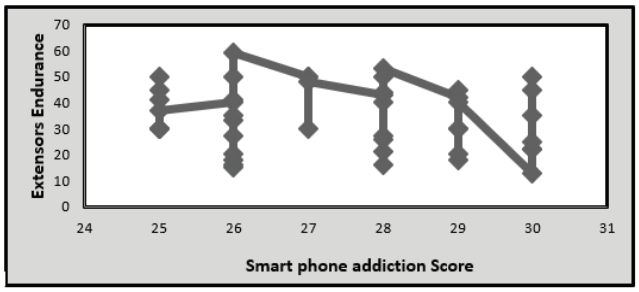
On analysis using Pearson Coefficient correlation between Mobile addiction and Neck extensors endurance, r value was -0.1251 (p = 0.2816) was not significant.

Table 1. Correlation between mobile addiction and neck muscles endurance (flexors and extensors)

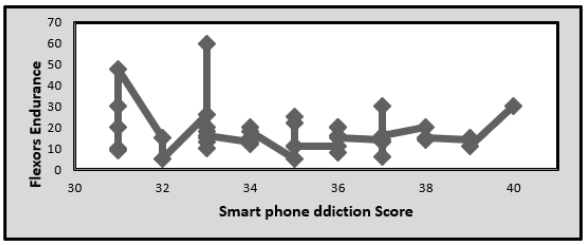
Group	Addiction Score	Mean Value	r value	p value	Result
Flexor endurance	25-30	16	-0.1957	0.1977	Not Significant
	30-40	17.56	-0.1571	0.3143	Not Significant
	40-50	17.92	-0.3738	0.2313	Not Significant
Extensor Endurance	25-30	34.49	-0.1382	0.3653	Not Significant
	30-40	36.56	-0.004045	0.9795	Not Significant
	40-50	26.25	-0.6056	0.0369	Significant



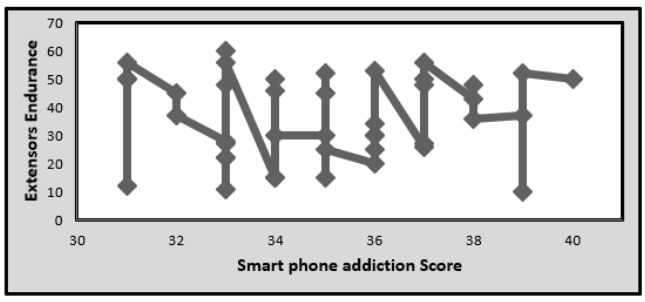
Graph 1. Smart phone addiction score (25-30) and neck flexors endurance.



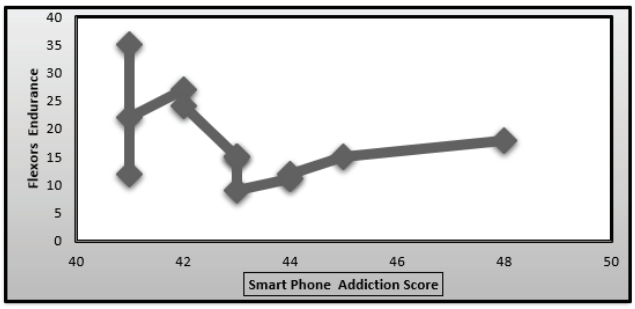
Graph 2. Smart phone addiction score (25-30) and neck extensors endurance.



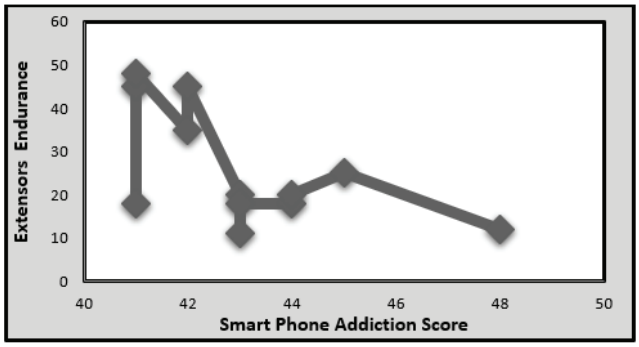
Graph 3. Smart phone addiction score (30-40) and neck flexors endurance.



Graph 4. Smart phone addiction score (30-40) and neck extensors endurance.



Graph 5. Smart phone addiction score (40-50) and neck flexors endurance.



Graph 6. Smart phone addiction score (40-50) and neck extensors endurance.

DISCUSSION

Smart phone is one of the fastest growing technological developments of all times and becoming an integral part of daily life among adolescents. Frequent use of smart phones forces the users to adopt an awkward posture to increased risk of musculoskeletal problems[9].In forward head and rounded shoulder posture the deep cervical extensors including longissimus capitis ,splenius capitis, cervical multifidus, upper trapezius becomes overactive and shortened. This leads to increased work of deep neck flexors as they are the antagonist muscles which balance the deep neck extensors. the deep neck flexors consist of rectus capitis anterior, rectus capitis lateralis and longus colli which play a vital role in supporting the cervical segment and the cervical curve.

This study investigated the effect of smartphone addiction on endurance of neck flexors and extensors among healthy college students. The findings of this research revealed no significant variation in neck extensor endurance for smartphone-addicted students. However, a substantial decrease in neck flexor endurance time in the smartphone addicted students was observed. Normal neck flexors endurance in female subjects is approximately 30 seconds, and that in males is nearly 40 seconds in age range of 18 to 28 years[22].

A. Alshrami *et al.,* results revealed that flexor endurance time (s) was significantly lower in the smartphone-addicted group in comparison with those in the non-addicted group ($p < 0.001$). Flexing the neck is the most usual and regular posture adopted by mobile phone users; they tend to adopt this posture when looking at their devices for long periods. The length of time devoted to smartphone usage and adopting flexed neck postures may cause pain and discomfort to the neck region in the long term. Furthermore, smaller smartphone screen sizes might indirectly influence the adoption of different neck positions to enhance looking at the screen. Smaller screens might cause more forward bending of the neck, reducing the distance between the screen and the user's eyes. A compensatory forward neck bending may be occasioned with increased neck muscle activity, which might have affected DNF endurance in the smartphone-addicted group[2].

Domenech *et al.,* concluded that the average DNF endurance test time was 39 s for males and 29 s for females between the ages of 20 and 80 years, and the Interrater reliability for DNF muscle endurance testing was 66%[23]. Our study also shows that the average DNF endurance test time was 19.58s for males and 14.22s for females between the ages of 18 and 27 years. The average DNE endurance test time was 35.22 for males and 33.56s for females of the above mentioned age group people.

The study of Shah *et al.,* examined the effect of smartphone addiction and relation to musculoskeletal disorder specially text neck by SAS questionnaire into English language and Neck Disability Index (NDI) by 100 physical therapy students in Ahmadabad College, SBB College and VS Hospital their age 20 – 25 years old found that positive correlation between the smartphone addiction and neck disability with predominance of female seen that may later effect on long term disability[4]. In our study, the highest rated component of SAS was "Missing planned work due to smartphone use", followed by "I will never give up using smartphone even my daily life is already greatly affected by it". The component rated least was "Feeling impatient and fretful when I am not having smartphone" followed by "The people around me tell that I use smartphone too much". Also, it was found in our study that smartphone addiction (Scoring on SAS 40-50/50) has a significant impact on neck extensors endurance.

Parazza S *et al.,*[3] study showed significantly higher endurance of neck extensor muscles compared to flexor ones and studied relationships between pain and disability and between NFME and NEE tests. No significant relationship between each of the endurance tests, pain and disability in subjects with neck pain were found. This finding is consistent with the findings of the present study, as in this study it was observed that the neck extensor muscles had higher endurance as compared to flexor ones. This difference between the endurance in the neck extensor muscles and neck flexor muscles might be due to the reason that the neck extensor muscles are the postural or tonic muscles which are capable of maintaining a particular posture for longer duration as compared to neck flexor muscles which are phasic muscles and have a lower endurance.

The present study provides valuable clinical insight into the relationship between smartphone addiction and cervical muscle endurance among young adults. Although no significant overall association was found between smartphone addiction and neck flexor or extensor endurance, the findings emphasize the importance of monitoring smartphone usage habits as part of musculoskeletal health assessment. Excessive smartphone use is commonly associated with prolonged neck flexion, forward head posture, and increased mechanical stress on cervical structures, which may contribute to future neck dysfunction. Therefore, physiotherapists should educate individuals regarding proper ergonomics, posture correction, and regular physical activity to minimize potential musculoskeletal risks. Early screening and preventive

interventions may help maintain cervical spine health and reduce the likelihood of developing neck pain and postural abnormalities associated with prolonged smartphone use.

So according to the results of this study it can be concluded that no significant relationship was observed between smartphone addiction and neck flexor muscle endurance, and between smartphone addiction and neck extensor muscle endurance when overall data was analysed. However, it might also be related to the amount of addiction present in a particular individual. So, since the addiction ranging from 40-50 score had a least number of individuals the overall score of the addiction and its relationship with the muscle endurance had reduced. To the best of our knowledge, few studies have investigated the relationship between smartphone addiction and both deep neck flexor and extensor endurance among healthy Indian college students.

The present study has certain limitations that should be considered while interpreting the findings. Since the study employed a cross-sectional design, a causal relationship between smartphone addiction and neck muscle endurance could not be established. The participants were recruited using purposive sampling from a single institution, which may limit the generalizability of the results to the wider population. Smartphone addiction was assessed using a self-reported questionnaire, making the data susceptible to recall and response bias. Furthermore, only healthy young adults aged 18–27 years were included in the study; therefore, the findings may not be applicable to individuals from other age groups or those with existing cervical musculoskeletal disorders. In addition, objective measures of smartphone usage duration and posture were not evaluated, which may have influenced the relationship between smartphone addiction and neck muscle endurance.

CONCLUSION

The present study found no significant overall association between smartphone addiction and deep neck flexor or deep neck extensor muscle endurance among healthy young adults. However, a significant reduction in neck extensor endurance was observed in participants with higher smartphone addiction scores (40–50), suggesting that excessive smartphone use may adversely affect cervical muscle performance. Further studies with larger sample sizes are recommended to validate these findings.

FUTURE SCOPE OF THE STUDY

Based on the findings of the present study, future research should be conducted with larger sample sizes and participants recruited from multiple institutions to enhance the generalizability of the results. Longitudinal studies are recommended to investigate the long-term effects of smartphone addiction on cervical muscle function and to establish potential causal relationships. The inclusion of objective measures of smartphone usage, such as screen-time monitoring applications, may provide more accurate information regarding smartphone exposure. Furthermore, future studies should assess additional cervical parameters including posture, muscle strength, range of motion, and functional disability to obtain a more comprehensive understanding of the musculoskeletal consequences of excessive smartphone use. Awareness programs promoting proper ergonomics, posture correction, and healthy smartphone usage habits should also be encouraged among young adults to help prevent the development of cervical musculoskeletal disorders.

AUTHOR DECLARATION

The manuscript entitled 'Effect of Smartphone Addiction on Neck Muscles Endurance – A Cross Sectional Study' has not been published previously and is not under consideration for publication elsewhere. All authors have read and approved the manuscript.

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee of DVVPF's College of Physiotherapy, Ahilyanagar (Approval No. : IEC/2022/465/B). Written informed consent was obtained from all participants before enrolment.

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