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# Effect of duration of smartphone use on muscle fatigue and pain caused by forward head posture in adults

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## Abstract

[Purpose] The effect of duration of smartphone use on neck and shoulder muscle fatigue and pain was investigated in adults with forward head posture. [Subjects and Methods] Thirty-four adults with forward head posture were classified into groups by duration of smartphone use: 11 used a smartphone for 10 minutes each (group 1), 12 for 20 minutes each (group 2), and 11 for 30 minutes each (group 3). Fatigue cervical erector spinae and upper trapezius muscles was measured by electromyography, and pain before and after the experiment was evaluated using Visual Analog Scale (VAS) scores. [Results] There was a significant difference in the degree of fatigue in the left upper trapezius muscles in group 2 and left cervical erector spinae and bilateral upper trapeziuses group 3. There was a significant difference in fatigue in the left upper trapezius in groups 1 and 3. The VAS showed significant differences in all groups before and after the experiment and between groups 1 and 3. [Conclusion] Pain and fatigue worsened with longer smartphone use. This study provided data on the proper duration of smartphone use. Correct posture and breaks of at least 20 minutes are recommend when using smartphones.

**Key words:** Forward head posture, Muscle fatigue, Smart phone

## INTRODUCTION

Smartphones combine a variety of digital devices, unlike conventional telephones. Smartphones use has led to rapid changes in society by satisfying consumers needs, and their convenience has greatly expanded their availability. Working on computers and operating smartphones for long periods of time promote repetitive use of certain muscles, resulting in muscle fiber injury, cumulative damage from acute trauma, and myogenic tonus, which occur most often in the neck and shoulders[1].

Repetitive and cumulative trauma to the neck and shoulder causes forward head posture (FHP), a specific musculoskeletal abnormality[2]. FHP weakens the deep cervical flexor muscle, the midthoracic rhomboid muscle for scapular retraction, and the mid and lower trapezius muscles. FHP also shortens the pectoralis major and neck extension muscles. Upper trapezius muscle activity is increased more in FHP than in correct anatomic positions, and most patients complain of pain from muscle overuse[3].

According to Shim and Zhu[4], fatigue and stress in the neck and shoulders occur more easily with use of touch-screen computers than with desktops because small-monitor devices such as smart phones and tablet PCs cause people to look down and to slouch more than with desktops[5].

Smartphone use in a static position and with an unsupported arm could bring about abnormal alignment of the neck and shoulders. Because smartphones have small monitors that are typically held downward near the laps, users must bend their heads to see the screens, increasing activity in the neck extensor muscles overloading the neck and shoulders increases muscle fatigue, decreases work capacity and affects the musculoskeletal system[2, 3].

There are a number of studies on posture and motion with computer, laptop and smartphones use. However, studies are lacking on appropriate durations of use. This study aimed to investigated the effect of the duration of smartphone use in adults with FHP and the onset of fatigue and pain in neck and shoulder muscles.

Objective and quantitative data were obtained regarding appropriate duration of smartphone use in adults with FHP.

## SUBJECTS AND METHODS

A total of 34 patients in their 20s and 30s were enrolled whose tragus was located on the left side rather than at the lateral acromion angle on radiography in a lateral cervical view[6].

The procedure and purpose of the study were excluded to the subjects, who voluntarily consented to participate. This study excluded individuals with neck pain and those with congenital deformities, serious surgical or neurological diseases, limb injuries, or limb pain in the prior 6 months. The study received approval from the Korea Kyungnam University institutional review board (IRB 1040460-A-2014-022) before participant recruitment began.

The average age, height, and weight of subjects was 26.20 ± 5.45 years, 167.24 ± 7.73 cm, and 60.87 ± 8.03 kg, respectively. Mean VAS score was 1.15 ± 0.87 with no significant differences.

A goniometer was used on all subjects in order to quantify posture as they began to use a smartphones.

The subjects sat comfortably on a stool with their feet on the floor, knee and hip joints at right angles, and trunk upright. Upper arms were raised to clavicle level to prevent lumbar overflexion.

Subjects were allowed to use message services, KakaoTalk, games, and the Internet with no limitations during smartphone use[7, 8].

They were also instructed to focus only on phone use without paying attention to maintaining neck and lumbar posture. An electromyograms (EMG) was performed initially for one minute and then for another minute immediately after phone use began. Pain was assessed before and after smartphone use using the VAS.

A Galaxy S4 LTE-A smartphone (SHV-E330S, Samsung Electronics Co., Ltd., Seoul, Korea) was used in this experiment.

To collect the surface EMG signal from the cervical erector spinae and upper trapezius muscles, which support stability around the neck and shoulders, a Trigono™ Wireless EMG system (Delsys Inc., Boston, MA, USA) was used[9)].

The sampling rate was set at 2,000 Hz, and the bandwidth for the EMG signal noise rejection was set at 20–450 Hz.

The analog signals of each muscle were collected and analyzed by Delsys EMG Works Acquisition software for PC, based on digital signals that were wirelessly sent from the Trigono base station.

Before we attached the electrodes, we exfoliated the skin using sandpaper and then cleaned it with alcohol swabs in order to reduce the muscle resistance to the EMG signals.

The surface EMG electrodes were attached 1–2.5 cm apart in parallel with both the cervical erector spinae and upper trapezius muscle fibers.

The EMG sensors were attached around both C4 areas for the cervical erector spinae and slightly outward from the midline between C7 and the acromioclavicular joint for the upper trapezius muscle[10)].

Data from each muscle before and after the experiment were interpreted by mathematic FFT (Fast Fourier Transform) and spectrum analysis, and the median frequency was used as an index for muscle fatigue.

With high muscle fatigue, the frequency spectrum moves toward the lower end[11)].

The collected data were processed with SPSS Version 22.0 using a paired-t test to analyze muscle fatigue, changes in FHP, and severity of pain before and after the experiment in the three groups, and one-way analysis of variance (ANOVA) was used to compare the muscle fatigue, change in the FHP, and pain by elapsed phone use time. Least Significant Differince (LSD) was used for the post hoc test, and the level of significance was $\alpha$=0.05.

## RESULTS

In group 2, there was a significant difference in muscle fatigue before (72.73 ± 12.19) and after (70.08 ± 11.24) the experiment in the left upper trapezius muscle ($p<0.05$) in group 3, the significant difference was observed in the left cervical erector spinae (before: 68.61 ± 6.59; after: 61.93 ± 6.98) ($p<0.05$).

There were other significant differences in comparisons before and after the experiment: 71.62 ± 8.73 and 62.90 ± 7.07 in the left upper trapezius muscle and 75.44 ± 6.30 and 66.17 ± 8.26 in the right upper trapezius muscle ($p<0.05$) (Table 1).

Table 1.

**Fatigue measurements by group (N=34)**

| Group | | Pre | Post |
|---|---|---|---|
| | | Mean ± standard deviation | Mean ± standard deviation |
| Group 1 | LCES | 67.8 ± 4.5 | 65.4 ± 4.9 |
| | RCES | 62.2 ± 4.1 | 61.7 ± 4.6 |
| | LUT | 76.0 ± 9.3 | 75.1 ± 9.6 |
| | RUT | 69.0 ± 11.1 | 67.6 ± 11.3 |
| Group 2 | LCES | 66.1 ± 5.7 | 64.7 ± 5.0 |
| | RCES | 63.5 ± 9.8 | 66.3 ± 9.8 |
| | LUT | 72.7 ± 12.2 | 70.1 ± 11.2 |
| | RUT | 71.7 ± 8.8 | 70.8 ± 9.0 |
| Group 3 | LCES | 68.6 ± 6.6 | 61.9 ± 7.0 |
| | RCES | 64.2 ± 5.4 | 60.8 ± 8.4 |
| | LUT | 71.6 ± 8.7 | 62.9 ± 7.1 |
| | RUT | 75.4 ± 6.3 | 66.2 ± 8.3 |

$p<0.05$. LCES: left cervical erector spinae, RCES: right cervical erector spinae, LUT: left upper trapezius, RUT: right upper trapezius

There was a significant difference in muscle fatigue in the left upper trapezius between group 1 (75.12 ± 9.60) and group 3 (62.90 ± 7.07) (Table 2).

Table 2.

**Fatigue measurements within each group (N=34)**

| | | Group 1 (N=11) | Group 2 (N=12) | Group 3 (N=11) |
|---|---|---|---|---|
| | | Mean ± standard deviation | Mean ± standard deviation | Mean ± standard deviation |
| Pre | LCES | 67.8 ± 4.5 | 66.6 ± 5.7 | 68.6 ± 6.6 |
| | RCES | 62.2 ± 4.1 | 63.5 ± 10.0 | 64.2 ± 5.4 |
| | LUT | 76.4 ± 10.3 | 72.7 ± 12.2 | 71.6 ± 8.7 |
| | RUT | 69.0 ± 11.1 | 71.7 ± 8.8 | 75.4 ± 6.3 |
| Post | LCES | 65.4 ± 4.9 | 64.7 ± 5.0 | 61.9 ± 7.0 |
| | RCES | 61.6 ± 4.6 | 62.3 ± 9.8 | 60.8 ± 8.4 |
| | LUT | 75.1 ± 9.6 | 70.1 ± 11.2 | 62.9 ± 7.1 |
| | RUT | 67.6 ± 11.3 | 70.8 ± 9.0 | 66.2 ± 8.3 |

All VAS scores before and after the experiment increased, with significance show for all three groups ($p<0.05$).

## DISCUSSION

Smartphones are used frequently in daily life, and affect users both physically and psychologically.

A survey of adults over age 20 by Eom et al.[12] revealed that 18.8% had experienced symptoms related to a musculoskeletal disorder from smart phone use, and that pain had increased with duration of use.

In this study, we investigated muscle fatigue by measuring median frequency. The group that used the phone for 10 minutes showed decreased median frequency of fatigue in all of the muscles studied, but without significance ($p>0.05$). In the 20-minute group, there was a slight decrement in median frequency, and fatigue decreased significantly in the left upper trapezius ($p<0.05$).

There were no significant differences in muscle fatigue in the right cervical erector spinae ($p>0.05$), but significant differences were noted in the left cervical erector spinae and the left and right upper trapezius muscles ($p<0.05$) in the group that used the phone for 30 minutes.

A significant difference in muscle fatigue in the left upper trapezius was shown between the 10-minute and 30- minute groups.

In Park et al.[13], participants who used a smartphone for 20 minutes showed median fatigue frequency decrements both the upper trapezius and cervical erector spinae muscles, and also reported more load on the right shoulder than the left because the right shoulder was used more often . However, in our study, the 20-minute group presented significant differences in fatigue in the left upper trapezius ($p<0.05$), and the 30-minute group showed significant differences in fatigue in their left cervical erector spinae and left and right upper trapezius ($p<0.05$).

Previous studies revealed that smartphone overuse places the head in an unvarying posture and that continuous muscle contraction then brings about muscle weakness and fatigue that could easily develop into chronic cervical pain[14].

In addition, continuous static pressure on specific sites could also increase muscle fatigue and pain[15].

Kraemer et al.[16] reported that muscle fatigue is caused by work that requires repeated movement in static postures.

Park et al.[13] studied male subjects using a game that could be operated by both hands. In this study, we enrolled both male and female participants, and allowed them to use the phones freely for web surfing and messaging, rather than having them perform only one activity. The subjects held the phones in their left hands and used their right hands infrequently, which led to a greater load on the shoulder that performed the same motion.

All three groups showed significant differences in VAS scores after the experiment, and there was also a significant difference between the 10-minute and 30-minute groups ($p<0.05$).

Lee and Song[17] studied pain severity according to smartphone use duration, and they reported significant differences in reading, concentration, and headaches, although these could have been transient symptoms from the smartphone use.

The participants in this study mostly used their smartphones lowered toward their laps, so that they maintained fixed postures with their necks flexed. According to Kim et al.[18], looking downward promotes muscle fatigue more easily than does looking upward.

Most subjects were using the phones in the wrong position, which could have negatively affected muscles and joints. Combined with the wrong position, double and even triple myotonia and myalgia could be triggered[19]. Although we investigated only one session per subject, if adults with FHP continuously use smartphones, they could be exposed to cumulative pain.

There is a lack of studies regarding the physical effects of long-term smartphone use. Thus, we investigated muscle fatigue and VAS scores according to smartphone use time: 10 minutes, 20 minutes, or 30 minutes.

This study does have limitations. We observed differences with only short-term use but not long-term or continuous use. In addition, the subjects were limited to adults with FHP, so we did not have the opportunity to compare this group to those with normal posture, and also did not analyze differences based on different phone use postures.

Additional studies are needed regarding cumulative trauma, posture changes in the neck and shoulders, and treatment methods for related disorders.

## REFERENCES

1. Ming Z, Pietikainen S, Hänninen O: Excessive texting in pathophysiology of first carpometacarpal joint arthritis. Pathophysiology, 2006, 13: 269–270. [PubMed] [Google Scholar]

2. Mekhora K, Liston CB, Nanthavanij S, et al. : The effect of ergonomic intervention on discomfort in computer users with tension neck syndrome. Int J Ind Ergon, 2000, 26: 367–379. [Google Scholar]

3. Schüldt K, Ekholm J, Harms-Ringdahl K, et al. : Effects of changes in sitting work posture on static neck and shoulder muscle activity. Ergonomics, 1986, 29: 1525–1537. [PubMed] [Google Scholar]

4. Shin G, Zhu X: User discomfort, work posture and muscle activity while using a touchscreen in a desktop PC setting. Ergonomics, 2011, 54: 733–744. [PubMed] [Google Scholar]

5. Greig AM, Straker LM, Briggs AM: Cervical erector spinea and upper trapezius muscle activity in children using different information technologies. Physiotherapy, 2005, 91: 119–126. [Google Scholar]

6. Johnson GM: The correlation between surface measurement of head and neck posture and the anatomic position of the upper cervical vertebrae. Spine, 1998, 23: 921–927. [PubMed] [Google Scholar]

7. Lee S, Lee D, Park J: Effect of the cervical flexion angle during smart phone use on muscle fatigue of the cervical erector spinae and upper trapezius. J Phys Ther Sci, 2015, 27: 1847–1849. [PMC free article] [PubMed] [Google Scholar]

8. Kim GY, Ahn CS, Jeon HW, et al. : Effects of the use of smartphone on pain and muscle fatigue in the upper extremity. J Phys Ther Sci, 2012, 24: 1255–1258. [Google Scholar]

9. Zhang FR, He LH, Wu SS, et al. : Quantify work load and muscle functional activation patterns in neck-shoulder muscles of female sewing machine operators using surface electromyogram. Chin Med J (Engl), 2011, 124: 3731–3737. [PubMed] [Google Scholar]

10. Shin H, Kim K: Effect of cervical flexion on the flexion-relaxation ratio during smartphone use. J Phys Ther Sci, 2014, 26: 1899–1901. [PMC free article] [PubMed] [Google Scholar]

11. Murata A, Ishihara H: Evaluation of shoulder muscular fatigue indueced during mouse operation in a VDT task. IEICE Trans Inf Syst, 2005, 88: 223–229. [Google Scholar]

12. Eom SH, Choi SY, Park DH: An empirical study on relationship between symptoms of musculoskeletal disorders and amount of smartphone usage. J Korea Saf Manage Sci, 2013, 15: 113–120. [Google Scholar]

13. Park JH, Kang SY, Jeon HS: The effect of using smart-phone on neck and shoulder muscle activities and fatigue. Phys Ther Kor, 2013, 20: 9–26. [Google Scholar]

14. Viljanen M, Malmivaara A, Uitti J, et al. : Effectiveness of dynamic muscle training, relaxation training, or ordinary activity for chronic neck pain: randomised controlled trial. BMJ, 2003, 327: 475. [PMC free article] [PubMed] [Google Scholar]

15. Chung MK, Choi KI: Ergonomic analysis of musculoskeletal discomforts among conversational VDT operators. Comput Inderstrial Eng, 1997, 33: 521–524. [Google Scholar]

16. Kraemer WJ, Volek JS, Bush JA, et al. : Influence of compression hosiery on physiological responses to standing fatigue in women. Med Sci Sports Exerc, 2000, 32: 1849–1858. [PubMed] [Google Scholar]

17. Lee JI, Song HS: The correlation analysis between hours of smart phone use and neck pain in the Garchon university students. Acupunct, 2014, 31: 99–109. [Google Scholar]

18. Kim YG, Kang MH, Kim JW, et al. : Influence of the duration of smartphone usage on flexion angles of the cervical and lumbar spine and on reposition error in the cervical spine. Phys Ther Kor, 2013, 20: 10–17. [Google Scholar]

19. Lee J, Seo K: The comparison of cervical repositioning errors according to smartphone addiction grades. J Phys Ther Sci, 2014, 26: 595–598. [PMC free article] [PubMed] [Google Scholar]

Ergonomics. 2011 May;54(5):477-87. doi: 10.1080/00140139.2011.568634.

# Technique, muscle activity and kinematic differences in young adults texting on mobile phones.

Gustafsson E[1], Johnson PW, Lindegård A, Hagberg M.

**Author information**

## Abstract

The aim of this study was to investigate whether there are differences in technique between young adults with and without musculoskeletal symptoms when using a mobile phone for texting and whether there are differences in muscle activity and kinematics between different texting techniques. A total of 56 young adults performed a standardised texting task on a mobile phone. Their texting techniques were registered using an observation protocol. The muscular activity in six muscles in the right forearm/hand and both shoulders were registered by surface electromyography and the thumb abduction/adduction and flexion/extension were registered using a biaxial electrogoniometer. Differences in texting techniques were found between the symptomatic and the asymptomatic group, with a higher proportion of sitting with back support and forearm support and with a neutral head position in the asymptomatic group. Differences in muscle activity and kinematics were also found between different texting techniques. The differences in texting technique between symptomatic and asymptomatic subjects cannot be explained by them having symptoms but may be a possible contribution to their symptoms. STATEMENT OF RELEVANCE: There has been a dramatically increased use of mobile phones for texting especially among young people during the last years. A better understanding of the physical exposure associated with the intensive use is important in order to prevent the development of musculoskeletal disorders and decreased work ability related to this use.

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PubMed ▼



**Format**: Abstract

Work. 2012;41 Suppl 1:1145-8. doi: 10.3233/WOR-2012-0294-1145.

# Risk factors and clinical features of text message injuries.

Sharan D[1], Ajeesh PS.

**Author information**

## Abstract

Use of mobile phone and sending text message is a very common in today's life. While sending a text message the users need to use their thumb and other palm muscles extensively. The thumb most of the time adducted on the key pad of the mobile and use high force to type the letters. Studies in literature showed that text messaging has an adverse effect on musculoskeletal system of hand. But the extensive study on the type of disorders set in among the users who extensively use mobile phone for texting. This study aims at to evaluate risk factor and clinical feature of the MSD due to hand held devices. Twenty seven subjects participated in this study. Predefined protocols were used to evaluate type of MSD occurred among the subjects. The study revealed that development of tendinitis in extensor pollicis longus, myofascial pain syndrome (70.37%) of adductor pollicis, 1st interossei and extensor digitorum communis . Other associated problems diagnosed were thoracic outlet syndrome (51.85%), fibromyalgia syndrome (25.93%), hypothyroidism (7.41%), wrist tendinitis (14.81%) and De Quervain's syndrome (7.41%). It has been observed that the pathology were tendinitis of extensor pollicis longus, myofascial pain syndrome of thenar muscles and 1st interossei, extensor digitorum communis.

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## MeSH terms

J Phys Ther Sci. 2017 May;29(5):921-923. doi: 10.1589/jpts.29.921. Epub 2017 May 16.

# Effects of the cervical flexion angle during smartphone use on muscle fatigue and pain in the cervical erector spinae and upper trapezius in normal adults in their 20s.

Lee S[1], Choi YH[2], Kim J[1].

Author information

## Abstract

[Purpose] The purpose of this study was to examine the effects of the cervical flexion angle on muscle fatigue and pain in the cervical erector spinae and upper trapezius in normal adults in their 20s. [Subjects and Methods] The study's subjects were 14 normal adults. After sitting on a chair with their back against the wall, they held a smartphone with both hands for 10 minutes and fatigue and pain in the neck and shoulder muscles were measured at different cervical flexion angles (0°, 30°, and 50°). Electromyography was performed to analyze the muscle fatigue of the right upper trapezius, left upper trapezius, right cervical erector spinae, and left cervical erector spinae, and a Commander$^{TM}$ Algometer was used to measure pain. The cervical range of motion was used as an instrument to compare and analyze the cervical flexion angles. [Results] The study's results showed statistically significant differences in the muscle fatigue and pain of the right upper trapezius and left upper trapezius depending on the cervical flexion angle and a post-hoc test showed statistically significant lower levels of muscle fatigue and pain at 50° than at 0° or 30°. No statistically significant differences were found between the right cervical erector spinae and left cervical erector spinae. [Conclusion] The cervical flexion angle during smartphone use may influence the muscle fatigue and pain of the upper trapezius.

**KEYWORDS:** Muscle fatigue; Pain; Smartphone

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Appl Ergon. 2017 Mar;59(Pt A):132-142. doi: 10.1016/j.apergo.2016.08.020. Epub 2016 Sep 11.

# Prevalence and risk factors associated with musculoskeletal complaints among users of mobile handheld devices: A systematic review.

Xie Y[1], Szeto G[2], Dai J[2].

**Author information**

## Abstract
This systematic review aimed at evaluating the prevalence and risk factors for musculoskeletal complaints associated with **mobile** handheld device use. Pubmed, Medline, Web of Science, CINAHL and Embase were searched. The methodological quality of included studies was assessed. Strength of evidence for risk factors was determined based on study designs, methodological quality and consistency of results. Five high-quality, eight acceptable-quality and two low-quality peer-reviewed articles were included. This review demonstrates that the prevalence of musculoskeletal complaints among **mobile** device users ranges from 1.0% to 67.8% and **neck** complaints have the highest prevalence rates ranging from 17.3% to 67.8%. This study also finds some evidence for **neck** flexion, frequency of **phone** calls, texting and gaming in relation to musculoskeletal complaints among **mobile** device users. Inconclusive evidence is shown for other risk factors such as duration of use and human-device interaction techniques due to inconsistent results or a limited number of studies.



**KEYWORDS: Mobile** handheld devices; Musculoskeletal complaints; Systematic review

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Hong Kong Physiother J. 2018 Dec;38(2):77-90. doi: 10.1142/S1013702518300010. Epub 2018 Aug 14.

# Musculoskeletal disorder and pain associated with smartphone use: A systematic review of biomechanical evidence.

Eitivipart AC[1,2], Viriyarojanakul S[3], Redhead L[4].

Author information

## Abstract

The number of smartphone users is growing dramatically. Using the smartphone frequently forces the users to adopt an awkward posture leading to an increased risk of musculoskeletal disorders and pain. The objective of this study is to conduct a systematic review of studies that assess the effect of smartphone use on musculoskeletal disorders and pain. A systematic literature search of AMED, CINAHL, PubMed, Proquest, ScienceDirect using specific keywords relating to smartphone, musculoskeletal disorders and pain was conducted. Reference lists of related papers were searched for additional studies. Methodological quality was assessed by two independent reviewers using the modified Downs and Black checklist. From 639 reports identified from electronic databases, 11 were eligible to include in the review. One paper was found from the list of references and added to the review. The quality scores were rated as moderate. The results show that muscle activity of upper trapezius, erector spinae and the neck extensor muscles are increased as well as head flexion angle, head tilt angle and forward head shifting which increased during the smartphone use. Also, smartphone use in a sitting position seems to cause more shift in head-neck angle than in a standing position. Smartphone usage may contribute to musculoskeletal disorders. The findings of the included papers should be interpreted carefully in light of the issues highlighted by the moderate-quality assessment scores.

**KEYWORDS:** Smartphone; musculoskeletal disorders; pain

PMID: 30930581 PMCID: PMC6405356 DOI: 10.1142/S1013702518300010

Ergonomics. 2015;58(2):220-6. doi: 10.1080/00140139.2014.967311. Epub 2014 Oct 17.

# Head flexion angle while using a smartphone.

Lee S[1], Kang H, Shin G.

Author information

## Abstract

Repetitive or prolonged head flexion posture while using a smartphone is known as one of risk factors for pain symptoms in the **neck**. To quantitatively assess the amount and range of head flexion of smartphone users, head forward flexion angle was measured from 18 participants when they were conducing three common smartphone tasks (**text messaging**, web browsing, video watching) while sitting and standing in a laboratory setting. It was found that participants maintained head flexion of 33-45° (50th percentile angle) from vertical when using the smartphone. The head flexion angle was significantly larger ($p < 0.05$) for **text messaging** than for the other tasks, and significantly larger while sitting than while standing. Study results suggest that **text messaging**, which is one of the most frequently used app categories of smartphone, could be a main contributing factor to the occurrence of **neck** pain of heavy smartphone users. Practitioner Summary: In this laboratory study, the severity of head flexion of smartphone users was quantitatively evaluated when conducting **text messaging**, web browsing and video watching while sitting and standing. Study results indicate that **text messaging** while sitting caused the largest head flexion than that of other task conditions.

**KEYWORDS:** head flexion; **neck** pain; smartphone; **text neck**

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Review article

# Prevalence and risk factors associated with musculoskeletal complaints among users of mobile handheld devices: A systematic review

Yanfei Xie, Grace Szeto, Jie Dai

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## Highlights

- The prevalence of musculoskeletal complaints reported by mobile device users ranges from 1.0% to 67.8%.
- Neck complaints have the highest prevalence rates ranging from 17.3% to 67.8% among mobile device users.
- There is some evidence that a neck flexion posture, as well as frequency of phone calls, texting and gaming are associated with musculoskeletal complaints reported by mobile device users.

## Abstract

This systematic review aimed at evaluating the prevalence and risk factors for musculoskeletal complaints associated with mobile handheld device use. Pubmed, Medline, Web of Science, CINAHL and Embase were searched. The methodological quality of included studies was assessed. Strength of evidence for risk factors was determined based on study designs, methodological quality and consistency of results. Five high-quality, eight acceptable-quality and two low-quality peer-reviewed articles were included. This review demonstrates that the prevalence of musculoskeletal complaints among mobile device users ranges from 1.0% to 67.8% and neck complaints have the highest prevalence rates ranging from 17.3% to 67.8%. This study also finds some evidence for neck flexion, frequency of phone calls, texting and gaming in relation to musculoskeletal complaints among mobile device users. Inconclusive evidence is shown for other risk factors such as duration of use and human-device interaction techniques due to inconsistent results or a limited number of studies.

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# Effect of prolonged smartphone use on cervical spine and hand grip strength in adolescence

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**Abstract**

**Background:** smartphones have become a necessity for most children as they are used for communication and entertainment purposes. They spend most of their time in using smartphones. This could have side effects on their health.

**Purpose:** to assess the effect of prolonged smartphones use on cervical spine, hand grip strength, median and ulnar nerves conduction velocities of the forearm in adolescent children who use it more than four hours per day.

**Methods:** 60 normal subjects with ages ranging from 14 to 18 years were divided randomly into two groups of equal number (group A, group B): group A represent the control group who use smartphones less than four hours per day. Group B represent the study group who uses smartphone more than four hours per day. Electromyography machine was used to investigate nerve conduction velocity of ulnar and median nerves. Universal goniometer was used to measure forward head angle. Visual Analogue Scale was used to assess the neck pain. Hand dynamometer was used to measure hand grip strength for subjects of both groups.

**Results:** showed significant differences in conduction velocity of ulnar nerve, forward head angle and visual analog scale for pain, indicating the effect on group B, while showed no significant difference in conduction velocity of median nerve and hand grip strength between the two groups.

**Conclusion:** Prolonged use of smartphones in adolescence decrease conduction velocity of ulnar nerve, leading to increased forward head position angle and neck pain, without effecting on handgrip strength and conduction velocity of median nerve.

**Keywords:** smartphone, cervical spine, hand grip Strength, adolescence

## Introduction

Smartphones have become a necessity for most children, they are used for both communication and entertainment purposes such as; messages, music, media, internet access, photos and games (Arslan, 2013) [1].

While using a smartphone, children usually flex their neck downwards to stare at the lowered object (smartphone) and maintain the head in a forward position for long periods of time, which may cause musculoskeletal disorders (Park *et al.*, 2015) [2].

Forward head posture (FHP) is the most common side effect of prolonged, sustained mobile or tablet use. 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 and encourages the gradual adaptation of FHP (Fernandez *et al.*, 2010) [3].

Extensive use of smartphones can be associated with physical health–related problems, such as pain in the wrists and neck, and it also exposes hands to intense stresses that may lead to pain and musculoskeletal disorders of the hand and thumb (Jonsson *et al.*, 2011) [4].

## Subjects, instrumentation and procedures

Sixty well developed adolescents of both genders participated in this study after signing institutionally approved consent form prior to data collection. They were recruited from Faculty of Physical Therapy students at Cairo University and secondary schools. Their ages ranged from 14 to 18 years. They were subdivided randomly into two groups of equal number 30 subjects each (A, B).

### Design of the study

Cross sectional design was applied in this study. 60 subjects were grouped into two groups A, B:

- **Control group A**: consisted of 21 females and 9 males who weren't exposed to prolonged use of smartphone (less than 4 hours per day).
- **Study group B**: consisted of 20 females and 10 males who are using smartphone for a prolonged time (more than 4 hours per day and starting using it at least 4 years ago to detect the real effect of smartphone use) (Brattberg, 2002) [5].

### Inclusion criteria

1. Subjects of late childhood (adolescence).
2. Age of participant ranged from 14 to 18 years.
3. Subjects with normal development.

### Exclusion criteria

1. Athletic one.
2. Genetic spinal deformity.

3. Injury to the neck or upper extremity.
4. History of inflammatory joint disease.
5. History of surgical intervention at the neck or upper extremity.
6. Patients with neuropediatric problems.

**Instrumentation for assessment**

1. **Hand Grip Dynamometer:** It was used for measuring the maximum isometric strength of the hand muscles in kilograms. It is a simple and commonly used test of general strength level (Levangie and Norkin, 2005) [6].
2. **Computerized Electromyography (EMG):** Computerized four channel EMG Tonnies neuroscreen plus 1.59 was used to test the median, ulnar nerves conduction velocity and to record the latency and amplitude of the median, ulnar nerves motor fibers in children using mobile phones more than 4 hours per day and non-users or using mobile less than 4 hours per day.
3. **Universal goniometer:** Goniometry refers to the measurement of angles, in particular the measurement of angles created at human joints by the bones of the body. The examiner obtains these measurements by placing the parts of the measuring instrument, called a goniometer, along the bones immediately proximal and distal to the joint being evaluated. Goniometry may be used to determine both a particular joint position and the total amount of motion available at a joint (Norkin and White, 2009) [7].
4. **Visual analogue scale (VAS):** It was used to measure the intensity of neck pain after prolonged use of smartphone and assess pain in non-users group. It was a vertical or horizontal 10 cm line graduated by different levels of pain, starting from 0 (no pain) till 10 (worst pain) (Swartzberg, 2002) [8].

**Results**

The main purpose of this study was to investigate the effect of prolonged smartphone use on cervical spine and handgrip strength.

It was intended to collect the measurements data of median and ulnar nerves conduction velocity by EMG machine, angle of forward head position by universal goniometer, handgrip strength by hand dynamometer device and pain assessment by VAS in both groups (A and B).

### 1. General characteristics of the patients

**Table 1:** General characteristics of the two studied groups

| | Group A (n= 30) | Group B (n= 30) | t value | P value |
|---|---|---|---|---|
| Age (yrs.) | 17.13 ± 1.01 | 17.47 ± 0.68 | -1.501 | 0.139 (NS) |
| Weight (kg.) | 72.73 ± 2.36 | 70.25 ± 13.58 | 0.741 | 0.462 (NS) |
| Height (cm) | 164.30 ± 8.84 | 167.17 ± 6.75 | -1.412 | 0.163 (NS) |
| Gender | | | | |
| Girl | 22 (73.3%) | 20 (66.7%) | $\chi^2$= 0.317 | 0.573 (NS) |
| Boy | 8 (26.7%) | 10 (33.3%) | | |
| Dominant hand | | | | |
| Left | 3 (10.0%) | 2 (6.7%) | $\chi^2$= 0.218 | 0.640 (NS) |
| Right | 27 (90.0%) | 28 (93.3%) | | |

Data are expressed as mean ± SD or number (%). $\chi^2$= Chi square test. NS= p> 0.05= not significant.

### 2. Duration of smartphone use

**Table 2:** Comparison between values of onset of smartphone use in the two studied groups

| | Group A (n= 30) | Group B (n= 30) | Z value | P value |
|---|---|---|---|---|
| Onset of smartphone use (yrs.) | 2.67 ± 1.40 | 8.68 ± 2.11 | -6.550 | 0.001 (S) |
| Duration of smartphone use/day (hrs.) | 2.07 ± 0.98 | 6.62 ± 2.26 | -6.413 | 0.001 (S) |

Data are expressed as mean ± SD. Z value= Mann-Whitney test. S= p< 0.05= significant.

### 3. Pain scale and FHPA

**Table 3:** Comparison between values of pain scale and FHPA in the two studied groups

| | Group A (n= 30) | Group B (n= 30) | Z value | P value |
|---|---|---|---|---|
| Pain scale | 1.70 ± 0.99 | 6.13 ± 1.66 | -6.318 | 0.001 (S) |
| FHPA | 61.17 ± 5.83 | 52.50 ± 2.54 | 5.274 | 0.001 (S) |

Data are expressed as mean ± SD. Z value= Mann-Whitney U S= p< 0.05= significant.

### 4. Hand dynamometer

**Table 4:** Comparison between values of hand dynamometer in the two studied groups measured in the right and left hands.

| | Group A (n= 30) | Group B (n= 30) | Z value | P value |
|---|---|---|---|---|
| Right hand | 56.07 ± 20.49 | 53.67 ± 13.89 | -0.022 | 0.982 (NS) |
| Left hand | 52.07 ± 19.62 | 45.83 ± 14.80 | -1.103 | 0.270 (NS) |

Data are expressed as mean ± SD. Z value= Mann-Whitney test. NS= p> 0.05= not significant.

### 5. Nerve conduction velocity measured at right and left median nerves

**Table 5:** Comparison between mean values of nerve conduction velocity in the two studied groups measured at right and left median nerves.

| | Group A (n= 30) | Group B (n= 30) | t value | P value |
|---|---|---|---|---|
| Right | 66.63 ± 7.26 | 66.26 ± 8.06 | 0.185 | 0.854 (NS) |
| Left | 66.03 ± 6.27 | 68.93 ± 7.44 | -1.633 | 0.108 (NS) |

Data are expressed as mean ± SD. NS= p> 0.05= not significant.

## 6. Nerve conduction velocity measured at right and left ulnar nerve

**Table 6:** Comparison between mean values of nerve conduction velocity in the two studied groups measured at right and left ulnar nerves.

| | Group A (n= 30) | Group B (n= 30) | t value | P value |
|---|---|---|---|---|
| Right | 64.94 ± 5.08 | 55.98 ± 8.06 | 5.149 | 0.001 (S) |
| Left | 63.07 ± 5.67 | 57.75 ± 7.68 | 3.053 | 0.003 (S) |

Data are expressed as mean ± SD. S= p< 0.05= significant.

## 7. Right and left median nerves within each group

**Table 7:** Comparison between mean values of right and left median nerves in each of the two studied groups.

| | Group A (n= 30) | Group B (n= 30) |
|---|---|---|
| Right | 66.63 ± 7.26 | 66.26 ± 8.06 |
| Left | 66.03 ± 6.27 | 68.93 ± 7.44 |
| t value | 0.341 | -1.334 |
| P value | 0.735 (NS) | 0.187 (NS) |

Data are expressed as mean ± SD. NS= p> 0.05= not significant.

Right and left ulnar nerves within each group

**Table 8:** Comparison between mean values of right and left ulnar nerves in the two studied groups.

| | Group A (n= 30) | Group B (n= 30) |
|---|---|---|
| Right | 64.94 ± 5.08 | 55.98 ± 8.06 |
| Left | 63.07 ± 5.67 | 57.75 ± 7.68 |
| t value | 1.343 | -0.871 |
| P value | 0.184 (NS) | 0.387 (NS) |

Data are expressed as mean ± SD. NS= p> 0.05= not significant.

## Discussion

The aim of this study was to investigate the effect of prolonged smartphone use on cervical spine and handgrip strength in adolescence.

Sixty healthy subjects from both genders participated in this study and were subdivided into two groups of equal number, group (A) included 30 subjects that were non-users of smartphones and group (B) included 30 users of smartphones who are exposed to them more than four hours per day for more than 4 years. Ming *et al.*, (2006) [9] and Gyu *et al.*, (2012) [10] found that upper extremity musculoskeletal system symptoms appeared in adults who used smartphones for long periods of time exceeding three years.

The results of our study showed that there is no significant difference between group (A) and group (B) as regard to age, gender, weight, height and dominant hand. Both groups were comparable for age and sex distribution to ensure the complete randomization and reduce all factors that might bias the results as much as possible.

As regard to pain, neck pain was assessed by VAS that is which a reliable and valid scale for assessment of chronic pain (Langley and Sheppeard, 1985 and Mark *et al*, 1998). Our study showed that there was a highly significant difference between group (A) and group (B) which was higher in group (B). This result supports the fact that smartphone users suffer from chronic neck pain due to prolonged static position of neck in flexion angle during smartphone use. This is confirmed by many previous studies such as; Ackland *et al.*, (2011) [13], Alzarea and Patil (2015) [14], Sunil *et al.*, (2017) [15] and Ayushi and Mugdha (2018) [16] who concluded that flexed neck most commonly causes neck pain and soreness. Text neck syndrome is a modern age term that describes repeated stress injury and pain in the neck resulting from excessive watching or texting on smartphone over sustained periods of time (Neupane *et al.*, 2017) [17]. In addition, looking down at your smart phone too much can lead to upper back pain ranging from chronic, nagging pain to sharp and severe upper back muscles spasm.

Smartphone use encourages incorrect postures like neck bending or hunched postures (Hansraj, 2014) [18]. This causes an increase in the weight supported by the cervical spine as the head is flexed. Thus, habitual postures cause cervical extensors to weaken, resulting in atrophy due to chronic tightness and spasm which squeezes out oxygen and nutrient rich blood thus starving the muscle. This spasm and tightness of neck muscles invariably cause quite a lot of pain. (Ayushi and Mugdha, 2018) [16].

Continuous use of smartphones can cause repetitive microtrauma to the musculoskeletal structures giving rise to pain. This repetitive microtrauma is caused by alteration of length-tension relationship in the neck muscles. Also, in individuals performing repetitive tasks such as using smartphones may be associated with overload of low threshold motor units (Mork and Westgaard, 2006) [19].

Neck pain in turn can affect the cervical proprioception which is defined as a special type of sensation that informs the brain about sensations of deep organs and relationships between muscles, joints and generates afferent information that is crucial to effective and safe performance of motor tasks (Stillman, 2002) [20]. Due to the pain, there is change in the muscle fiber types, which reduces endurance of the cervical muscles specially the craniocervical flexors (O'Leary *et al.*, 2007) [21]. Furthermore, due to altered muscle function and altered length-tension relationship, there is compromise of cervical spine stability which increases the motion and mechanical load of the cervical segments (Falla *et al.*, 2004) [22]. Abnormal loading, decreased endurance, fatigue and pain contribute to a significant deficit in feed forward control of the cervical spine. These could be contributing factors which can make the cervical spine more prone to strain. Thus, reporting of significant pain by smartphone users is an alarming factor which could be a precursor to neuromotor dysfunction (Ayushi and Mugdha, 2018) [16].

In our study, the mean values of measurements of forward head angle (FHA) in groups (A) and (B) was found to be highly significant. That explained that smartphone users (group B) had forward head position due to looking downwards or to hold their arms out in front of them to read the screen, which makes the head move forward and causes an excessive anterior curve in the lower cervical vertebrae and an excessive posterior curve in the upper thoracic vertebrae to maintain balance. Thus, placing stress on the cervical spine and neck muscles which lead to forward head position.

This was also confirmed by Park *et al.* who said that forward-head posture is observed while using a smartphone for longer duration which may cause upper crossed syndrome and its related symptoms.

Forward head posture is defined as a posture that adopts upper cervical extension and lower cervical flexion. The center of gravity of the head in this posture is positioned at the front rather than the vertebral body weight. This increase in forward head posture has been demonstrated to correlate with respiratory muscle weakness in patients who have neck trouble, and accordingly led to muscle weakness and a decrease in the range of motion (Kapreli *et al.*, 2009; Yong-Soo *et al.*, 2017) [23, 24].

In addition, forward head posture usually leads to increased stress due to the muscle shortening of the neck extensors, especially at the back of the head. Thus, this problem can be addressed through an improvement of the forward head posture, for example, muscle strengthening for posture alignment or stretching for shortened muscles (Kendall *et al.*, 2005; Siao *et al.*, 2017) [25, 26].

Gravitational demands on the neck muscles are reported to be 3–5 times higher when holding a handheld device with a flexed head and neck posture than with a seated neutral posture (Vasavada *et al.*, 2015) [27].

Yan *et al.* revealed that smartphone use was correlated with a more static and more flexed spinal posture compared with desktop computer typing. He compared two methods of text entry on a smartphone: bilateral texting was associated with an increased cervical flexion while unilateral texting was associated with an asymmetric cervical posture. This indicates both text-entry methods on a smartphone are non-favorable as both of them were associated with a non-neutral posture of the cervical spine.

Young *et al.* and Deepika *et al.* have demonstrated that forward head posture causes spinal deformation, which increases scapula deformation, lordosis of the cervical vertebra, and kyphosis of the upper thoracic vertebra. They have also shown that such deformation causes neck pain and contracture of the muscles around the shoulders.

The current study found that there is a significant difference between the right and left ulnar nerve conduction velocity in groups (A) and (B). The users group were less than non-users in ulnar nerve conduction velocity but still within lower limit of normal level (55m/s) (Shan *et al.*, 2016) [31]. This demonstrated that prolonged use of smartphone affects the ulnar nerve conduction velocity due to sustained neck flexion due to looking downward at the smartphone screen. This effect on the ulnar nerve conduction velocity occurred because the ulnar nerve is derived from the medial cord of brachial plexus and contains fibers from spinal roots C8 and T1 which were compressed by prolonged static flexion during smartphone use.

Unfortunately, there were no previous studies till now about the effect of prolonged smartphone use on nerve conduction velocity of ulnar nerve.

The results of the statistical analysis in this study revealed that there were no significant differences between the two groups in the handgrip strength and the conduction velocity of the median nerve.

The effect on the ulnar nerve with the preservation of median nerve could be explained by the origin of both nerves. The origin of ulnar nerve comes from C8, T1 nerve roots which are completely compressed by neck flexion while the origin of median nerve comes from C5, C6, C8, and T1 which are not completely compressed by the neck flexion.

According to our study, the strength of handgrip was not affected by prolonged neck flexion at this age but we expect that muscles of handgrip especially innervated by ulnar nerve may be affected in old age after many years of smartphone use.

Unfortunately again, there were no previous studies -till now- about the effect of prolonged smartphone use on median nerve and handgrip strength.

**Summary**

1. There was significant difference in pain scale between the two groups, the group B (smartphone users) had higher pain than group A (non-users) in neck region due to neck muscles spasm because of prolonged use of smartphones.
2. There was significant difference in nerve conduction velocity study of ulnar nerve between the two groups. That group B had lower nerve conduction velocity than group A because of the compression on ulnar nerve due to prolonged neck flexion.
3. There was significant difference in forward head position angle between the two groups, group B had increased angle than group A which means prolonged users of smartphone had forward head position.
4. There was no significant difference in nerve conduction velocity study of median nerve between the two groups, thus the median nerve wasn't affected by prolonged use of smartphone till late childhood age.
5. There was no significant difference in handgrip strength between the two groups, which means that the prolonged use of smartphone didn't affect the handgrip strength in late childhood age.
6. There was no significant difference in nerve conduction velocity study of median and ulnar nerves between right and left side within each group, which means that the compression affection on nerves especially ulnar nerve came from prolonged cervical flexion -proximal- on nerve root not distally on nerve trunk in dominant hand only but affected both hands.

**Conclusion**

According to the results of this study it can be concluded that prolonged use of smartphone more than four hours per day can affect the cervical region causing forward head position, neck pain due to neck muscles spasm and reduced conduction velocity of ulnar nerve due to prolonged cervical flexion.

**References**


1. Arslan A. Examination of cell phone usage habits and purposes of education faculty students. International Journal of Human Sciences. 2013; 20(2):240-246.
2. Park J, Kim J, Jonggun K, *et al.* The effects of heavy smartphone use on the cervical angle, pain threshold of neck muscles and depression. Advanced Science and Technology Letters. 2015; 91:12-17.
3. Fernandez-de-las-penas C, Arendt-Nielsen L, Gerwin RC. Tension type and cervicogenic headache. 1sted, Jones and Bartlett, 2010, 91-94.
4. Jonsson P, Johnson W, Hagberg M. Accuracy and feasibility of using an electro goniometer for measuring

simple thumb movements. Ergonomics journal. 2007; 50:647-659.
5. Brattberg G. Do pain problems in young school children persist into early adulthood? A 13-year follow-up. European Journal of Pain. 2002; 8:187-199.
6. Levangie P, Norkin C. Joint structure and function. 4th ed., Davis Company. Elseavier, 2005, 156-164.
7. Norkin C, White DJ. Measurement of joinmotion. A guide to Goniometry. 4th ed., Davis Company, Philadelphia. 2009; 3-6:319-346.
8. Swartzberg R. A symptoms based approach for diagnosis and treatment of low back pain. WB Saunders, Philadelphia, 2002, 234.
9. Ming Z, Pietikainen S, Hanninen O. Excessive texting in pathophysiology of first carpometacarpal joint arthritis. Pathophysiology journal. 2006; 13(4):269-270.
10. Gyu Y, Chang S, Hye W, *et al.* Effects of the Use of Smartphones on Pain and Muscle Fatigue in the Upper Extremity. Journal of physical therapy science. 2012; 24:1255-1258.
11. Langley M, Sheppeard H. The visual analogue scale: Its use in pain measurement. Rheumatology international journal. 1985; 5:145-148.
12. Mark B, Helen W, Maureen P, *et al.* Pain Scores in Infants: A Modified Infant Pain Scale versus Visual Analogue. Journal of pain and Symptom Management. 1998; 15(2):117-123.
13. Ackland D, Merritt J, Pandy M. Moment arms of the human neck muscles in flexion, bending and rotation. Journal of Biomechanics. 2011; 4(3):475-486.
14. Alzarea BK, Patil SR. Mobile Phone Head and Neck Pain Syndrome: Proposal of a New Entity. OHDM. 2015; 14(5):313-317.
15. Sunil N, Ifthikar A, Mathew A. text neck syndrome – systematic review. Imperial journal of interdisciplinary research. 2017; 7(3):141-148.
16. Ayushi P, Mugdha O. Influence of Smartphone Addiction Grade on Cervical Pain in Young Adults. International Journal of Research in Engineering. 2018; 8(1):17-19.
17. Neupane S, Ifthikar A, Mathew A. text-Neck syndrome-Systemic review. Imperial Journal of Interdisciplinary Research. 2017; 3(7):141-148.
18. Hansraj K. Assessment of stress in the cervical spine caused by posture and position of the head. Neurospine surgery. Surgical technology international. 2014; 25:277-279.
19. Mork P, Westgaard R. Low-amplitude trapezius activity in work and leisure and the relation of shoulder and neck pain. Journal of applied physiotherapy. 2006; 100:1142-1149.
20. Stillman B. Making Sense of Proprioception: The meaning of proprioception, kinaesthesia and related terms. Journal of Physiotherapy. 2002; 88:667-676.
21. Leary S, Jull G, Kim M, *et al.* Craniocervical flexor muscle impairment at maximal, moderate and low loads is a feature of neck pain. Journal of man therapy. 2007; 12:34-39.
22. Falla D, Jull G, Hodges P. Feed forward activity of the cervical flexor muscles during voluntary arm movements is delayed in chronic neck pain. Expert brain research. 2004; 157:43-48.
23. Kapreli E, Vourazanis E, Billis E, *et al.* Respiratory dysfunction in chronic neck pain patients. A pilot study. Cephalalgia journal. 2009; 29:701-710.
24. Yong-Soo K, Yu-Mi K, Je-myung S. The effect of modified cervical exercise on smartphone users with forward head posture. Journal of physical therapy science. 2017; 29:328-331.
25. Kendall F, McCreary E, Provance P, *et al.* Muscles testing and function with posture and pain, 5th ed. Lippincott Williams & Winkins, 2005.
26. Siao H, Pieter C, Erin K, *et al.* The associations of mobile touch screen device use with musculoskeletal symptoms and exposures: A systematic review. PLOS ONE journal. Available from:|https://doi.org/10.1371/journal. Accessed at, 2018.
27. Vasavada A, Nevins D, Monda S, Hughes, E, *et al.* Gravitational demand on the neck musculature during tablet computer use. Ergonomics journal. 2015; 58:990-1004.
28. Yan F, Grace S, Pascal M, *et al.* Spinal kinematics during smartphone texting - A comparison between young adults with and without chronic neck-shoulder pain. Applied Ergonomics Journal. 2018; 68:160-168.
29. Young J, Won H, Seong G. Correlations among visual analogue scale, neck disability index, shoulder joint range of motion, and muscle strength in young women with forward head posture. Journal of exercise rehabilitation. 2017; 13(4):413-417.
30. Deepika S, Zubia V. Association between forward head, rounded shoulders, and increased thoracic kyphosis: A review of the literature. Journal of chairopractic medicine. 2017; 16(3):220-229.
31. Shan C, Michael A, Ralph B, *et al.* Electro diagnostic reference values for upper and lower limb nerve conduction studies in adult population. American Association of Neuromuscular and Electro diagnostic Medicine (AANEM), Nerve and muscle, 2016, 371-377.

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WILEY

SHORT REPORT

# Smartphone use addiction can cause neck disability

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## 1 | INTRODUCTION

A smartphone is one of the most popular devices among adolescents. Advancement in smartphone models, including portable media players, compact digital cameras, access to emails, GPS navigation units and high-resolution touch screens, contribute to the frequent use and addiction to smartphones (Kwon et al., 2013). Along with the rise in smartphone use, potential risks for musculoskeletal problems have been reported (Kang et al., 2012; Kwon et al., 2013).

Most smartphone tasks require users to stare sharply downwards or to hold their arms out in front of them to read the screen, which makes the head move forward and causes an excessive anterior curve in the lower cervical vertebrae and an excessive posterior curve in the upper thoracic vertebrae to maintain balance, placing stresses on the cervical spine and neck muscles (Berolo, Wells & Amick, 2011; Kang et al., 2012).

Forward head posture is one of the commonly recognized poor postures in the sagittal plane. It has been indicated that this posture might contribute to the onset and perpetuation of neck and back pain syndromes, with further loss of cervical spine extension (Burgess-Limerick, Plooy & Ankrum, 1998; McEvoy & Grimmer, 2005). Forward head posture is determined by a dynamic combination of daily life factors, such as computer use (Brink, Louw, Grimmer & Jordaan, 2014). Incorrect posture of the head and neck has been correlated with chronic musculoskeletal pain (Lau, Cheung, Chan, Lo & Chiu, 2010; Szeto, Straker & Raine, 2002).

The aim of the present study was to determine the level of smartphone addiction and its relationship with neck function in healthy young adult subjects.

## 2 | METHODS

A convenience sample of 78 healthy (based on university hospital general practitioners screening) student subjects (39 females and 39 males) from King Saud University were recruited for the study via an advertising poster. The sampling size was calculated with a confidence level of 95% and ±0.5 error. Their mean age was 21.3 ± 1.7 years, mean weight was 63.4 ± 15.9 kg and mean height was 1.66 ± 8.6 m. They reported no history of any physical or mental diseases. They all used a smartphone for several hours per day. The study was approved by the Ethical Review Board of the Faculty of Applied Medical Sciences at King Saud University (CAMS142–36/37) and written informed consent was obtained from each participant prior to their participation.

The study had a cross-sectional design, to measure self-reported addiction to smartphone use and any abnormal symptoms of neck function using the Smartphone Addiction Scale (SAS) and Neck Disability Index (NDI), respectively. The SAS and NDI questionnaires were distributed electronically through emails, with detailed clarification and explanation of the study's purpose and procedures.

### 2.1 | SAS

The SAS is a self-reporting scale to assess smartphone addiction (Kwon et al., 2013). It consists of six factors and 33 items, with a six-point Likert scale (1: "strongly disagree" to 6: "strongly agree"). The six factors were daily-life disturbance, positive anticipation, withdrawal, cyberspace-orientated relationship, overuse and tolerance. The respondent circles the statement which most closely describes their smartphone use characteristics. Scores range from 33 to 198. The higher the score, the greater the degree of pathological use of the smartphone (Ching et al., 2015). The SAS is a reliable and valid measurement tool for the evaluation of smartphone addiction (Kwon et al., 2013).

### 2.2 | NDI

The NDI assessment involves a 10-item, 50-point index questionnaire that assesses the effects of neck pain and symptoms during a range of functional activities (Vernon & Mior 1991). Of the 10 items, four relate to subjective symptoms (pain intensity, headache, concentration, sleeping), four to activities of daily living (lifting, work, driving, recreation) and two to discretionary activities of daily living (personal care, reading) (Stratford et al., 1999; Westaway, Stratford & Binkley, 1998). Each item is scored on a 0 to 5 rating scale, in which zero means 'No pain' and 5 means 'Worst imaginable pain. The test was interpretated as a raw score, with a maximum score of 50. A higher NDI score indicates greater neck disability. This index is the most widely used and most strongly validated instrument for assessing self-rated disability in patients with neck pain (Vernon, 2008).

### 2.3 | Data analysis

Data analyses were performed using SPSS 16.0 software for Windows (SPSS, Chicago, IL, USA). The numerical scores of SAS and NDI were presented as mean ± standard deviation. The Spearman correlation coefficient was used to assess the relationship between SAS and NDI scores. The significance level was set at $p \le 0.05$.

## 3 | RESULTS

The result of the study showed a clear association between addiction to smartphone use and various degrees of neck problems among the participants. The mean SAS and NDI scores were 119.4 ± 20.7 and 20.98 ± 5.1, respectively. The Spearman correlation coefficient showed a significant correlation ($p < 0.05$) between SAS and NDI scores (Table 1).

## 4 | DISCUSSION

The present study demonstrated that addiction to smartphone use is associated with neck problems and disability among healthy young adult subjects. This finding supports earlier work showing a high level of computer use-related musculoskeletal symptoms around the neck among young college students (Jenkins et al., 2007), and that smartphone addiction caused physical health-related problems (Kwon et al., 2013).

The neck disability among smartphone users might be related to frequent neck flexion posture (Bababekova, Rosenfield, Hue & Huang, 2011; Janwantanakul, Sitthipornvorakul & Paksaichol, 2012), which changes the natural curve of the cervical spine and increases the amount of stress on the cervical spine (Hansraj, 2014), leading to irritation and spasm in the surrounding skeletal structures and ligaments (Fredriksson et al., 2002), and proprioception deficits in the cervical vertebra (Kim, Kang, Kim, Jang & Oh, 2013).

Excessive use of smartphones can lead to habitual repetitive and continuous movements of the head and neck toward the screen throughout the day. Such movements are associated with a high risk of chronic neck pain (Veiersted & Westgaard, 1993) and may explain the strong association between SAS and NDI scores in the present study.

**TABLE 1** Mean, standard deviation and correlation of Smartphone Addiction Scale (SAS) and Neck Disability Index (NDI)

| Variable ($n$ = 78) | Mean ± standard deviation |
|---|---|
| SAS | 119.4 ± 20.7 |
| NDI | 20.98 ± 5.1 |
| Correlation coefficient | $p < 0.018$ |

The present study supports the need for public health educational programmes to inform people of the physical risks associated with excessive use of smartphones. In conclusion, smartphone addiction could cause significant neck disability because of the bad posture associated with their use. Bad posture associated with the use of smartphones may be the reason for neck function impairment. Individuals should make an effort to reduce the amount of time spent using a smartphone, and try to maintain an appropriate posture during its use.


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### REFERENCES


Bababekova, Y., Rosenfield, M., Hue, J. E., & Huang, R. R. (2011). Font size and viewing distance of handheld smart phones. *Optometry & Vision Science, 88*(7), 795–797. doi:10.1097/OPX.0b013e3182198792

Berolo, S., Wells, R. P., & Amick, B. C. (2011). Musculoskeletal symptoms among mobile hand-held device users and their relationship to device use: A preliminary study in a Canadian university population. *Applied Ergonomics, 42*(2), 371–378. doi:10.1016/j.apergo.2010.08.010

Brink, Y., Louw, Q., Grimmer, K., & Jordaan, E. (2014). The spinal posture of computing adolescents in a real-life setting. *BMC Musculoskeletal Disorders, 15*(1), 1. doi:10.1186/1471-2474-15-212

Burgess-Limerick, R., Plooy, A., & Ankrum, D. R. (1998). The effect of imposed and self-selected computer monitor height on posture and gaze angle. *Clinical biomechanics, 13*(8), 584–592.

Ching, S. M., Yee, A., Ramachandran, V., Lim, S. M. S., Sulaiman, W. A. W., Foo, Y. L., & Kee Hoo, F. (2015). Validation of a Malay version of the Smartphone Addiction Scale among medical students in Malaysia. *PloS One, 10*(10), e0139337. doi:10.1016/S0268-0033(98)00021-7

Fredriksson, K., Alfredsson, L., Ahlberg, G., Josephson, M., Kilbom, Å., Hjelm, E. W., & Vingård, E. (2002). Work environment and neck and shoulder pain: The influence of exposure time. Results from a population based case-control study. *Occupational and Environmental Medicine, 59*(3), 182–188. doi:10.1136/oem.59.3.182

Hansraj, K. K. (2014). Assessment of stresses in the cervical spine caused by posture and position of the head. *Surgical Technology International, 25*, 277–279.

Janwantanakul, P., Sitthipornvorakul, E., & Paksaichol, A. (2012). Risk factors for the onset of nonspecific low back pain in office workers: A systematic review of prospective cohort studies. *Journal of Manipulative and Physiological Therapeutics, 35*(7), 568–577. doi: 10.1016/j.jmpt.2012.07.008

Jenkins, M., Menéndez, C. C., Amick, B. C. III, Tullar, J., Hupert, N., Robertson, M. M., & Katz, J. N. (2007). Undergraduate college students' upper extremity symptoms and functional limitations related to computer use: A replication study. *Work, 28*(3), 231–238.

Kang, J. H., Park, R. Y., Lee, S. J., Kim, J. Y., Yoon, S. R., & Jung, K. I. (2012). The effect of the forward head posture on postural balance in long time computer based worker. *Annals of Rehabilitation Medicine, 36*(1), 98–104. doi:10.5535/arm.2012.36.1.98

Kim, Y. G., Kang, M. H., Kim, J. W., Jang, J. H., & Oh, J. S. (2013). Influence of the duration of smartphone usage on flexion angles of the cervical and lumbar spine and on reposition error in the cervical spine. *Physical Therapy Korea, 20*(1), 10–17. doi:10.12674/ptk.2013.20.1.010

Kwon, M., Lee, J. Y., Won, W. Y., Park, J. W., Min, J. A., Hahn, C., ... Kim, D. J. (2013). Development and validation of a smartphone addiction scale (SAS). *PloS One, 8*(2), e56936. doi:10.1371/journal.pone.0056936

Lau, K. T., Cheung, K. Y., Chan, M. H., Lo, K. Y., & Chiu, T. T. W. (2010). Relationships between sagittal postures of thoracic and cervical spine,

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RESEARCH REPORT

# Exercise training and postural correction improve upper extremity symptoms among touchscreen smartphone users

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**KEYWORDS**
exercise training;
hand grip;
smartphone;
upper extremity symptoms

**Abstract** *Background:* Repetitive movements and poor posture are associated with over-use of smartphones when texting or playing games and significantly contribute to the symptoms of pain and discomfort in the upper extremities.

*Objective:* This study investigated the effect of exercise training and postural correction on disabilities of the arm, shoulder, and hand (DASH), hand grip and key pinch strength among smartphone users.

*Methods:* One hundred university students were randomly divided into two groups; the experimental group participated in a 12-week programme of exercise training and postural corrections. The control group were instructed to follow their usual routine for smartphone utilization. Measurements of DASH scores, hand grip strength, and key pinch grip strength were conducted before and after 12 weeks for both groups.

*Results:* There were no significant differences between the start values of both groups for DASH scores, hand grip strength, and key pinch strength ($p > 0.05$). However, there was a significant improvement in all outcomes measured in the experimental group ($p < 0.05$), with significant changes in the outcomes of the control group.

*Conclusion:* Postural correction combined with a selected exercise training programme improved the hand grip, key pinch grip strength, and upper extremity disability and symptoms associated with smartphone use among university students.



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## Introduction

In the past few years, touchscreen smartphones have replaced most of the keypad phone products due to their versatility and abundance of applications. However, as many people maintain their neck flexed when using portable devices, there is a growing debate about the effect of touchscreen smartphones on the musculoskeletal system among prolonged users of these devices. Similar to desktop and laptop computers, prolonged use of touchscreen smartphones may also contribute to increased risk for the development of musculoskeletal symptoms such as chronic neck and shoulder pain [1,2].

With each new generation of mobile phone, there are more built-in functions which lead to increased exposure and use of mobile phone functions. In younger persons, these exposures may be of great importance due to their developing musculoskeletal structure, their tendency to use their mobile phone for messaging and gaming, and the likelihood of greater exposure as a result of repetitive messaging and gaming activities [3].

The combination of repetitive movements, poor posture, and over-use of mobile phones for texting or playing games, without taking rest breaks, can cause injury to the nerves, muscles, and tendons in the fingers, hands, wrists, arms, elbows, shoulders, and neck, which if ignored, may lead to long-term damage [4]. The frequency and duration of use of cellular phones is increasing, and the design characteristics of these phones give rise to concerns regarding their impact upon body mechanics [5].

Gustafsson [6] showed differences in physical load between the group of mobile phone users with musculoskeletal symptoms and the group without symptoms. He also found differences in muscle activity and kinematics between different texting techniques. Preliminary studies on the effect of mobile hand-held device use among university students revealed a significant association between upper extremity symptoms and frequent utilization of a mobile hand-held device [7]. Moreover, Gustafsson et al [8] found prospective associations were established between exposure to text messaging on mobile phone and musculoskeletal pain in neck, shoulder, and arm, and numbness/tingling in hand/fingers for both men and women.

Recently, a few epidemiological studies reported a high prevalence of neck–shoulder symptoms among mobile device users. A study in Canada indicated rates of 46–52% in shoulder symptoms among 140 individuals and 68% in neck symptoms [1]. Another study in China reported over 40% of neck–shoulder pain among 2575 young mobile phone users [9].

Touchscreen tablet users are exposed to extreme wrist postures that are less neutral than other computing technologies and may be at greater risk of developing musculoskeletal symptoms [10]. Moreover, head and neck flexion angles during tablet use were greater, in general, than angles previously reported for desktop and notebook computing [11]. Gold et al [12] reported that over 90% of university students adopted a flexed neck posture, with protracted shoulders and nonneutral wrist postures on the typing side when they used their mobile devices.

Despite the reported association between mobile use and upper extremity symptoms there is a gap in the knowledge on how exercise and proper hand grasp can improve these symptoms. Considering the increased use of touchscreen mobile phones among young people it is important to identify how physical therapy interventions can reduce these symptoms. The aim of this study was to examine the effect of a training programme and postural corrections on hand grip strength, key pinch strength, upper extremity disability, and symptoms associated with touchscreen smartphone use among university students.

## Methods

### Participants

In this study, 217 students from Cairo University, Giza, Egypt were identified as potential participants. A total of 100 students (age, 18–26 years) who reported mild to moderate symptoms in disabilities of the arm, shoulder, and hand (DASH) questionnaire (DASH score $\geq$ 25) [13], were invited to the study. They were recruited by convenience sampling. In order to be recruited, individuals had to have at least 6 months' experience in using smartphones for at least 3 hours daily. They had to be right hand dominant and prefer to use the right hand in one handed text entry. Other essential requirements were texting and typing speeds to make sure that all participants had similar skills in texting on a smartphone and typing on a desktop computer. Individuals were asked to perform a texting speed test on an iPhone 4s (Apple Inc., Cupertino, CA, USA) using both hands as well as perform a typing speed test on a desktop computer before entering the study. Only those who achieved a minimum texting speed of 15 words per minute on the smartphone and typing speed of 30 words per minute on the computer keyboard were recruited. The exclusion criteria were: (1) history of traumatic injuries or surgical interventions of the neck or upper limbs; (2) medical conditions which may have a negative effect on the spine and upper limbs; (3) chronic diseases such as rheumatoid arthritis, osteoarthritis, and other connective tissue disorders that affect the musculoskeletal system; and (4) neurological and orthopaedic disorders as well as sensory deficits [14].

Before the start of the study participants were allocated to two groups, the experimental group or the control group, using SPSS computer programme (version 16.0; SPSS Inc., Chicago, IL, USA) to conceal group allocation. Participants in the control group were advised to keep their regular routine and avoid any unusual activities that may increase the load on the arm and hand. Participants in the experimental group were engaged in a 12-week exercise programme. The CONSORT diagram showing the recruitment, assignment and progression of patients through the study is presented in Figure 1.

All procedures had been thoroughly explained and consent forms were obtained from all participants. The study was approved by the human research ethics committee of the Faculty of Physical Therapy at Cairo University and each participant signed written consent. The participants were recruited from Cairo University. The study was run in

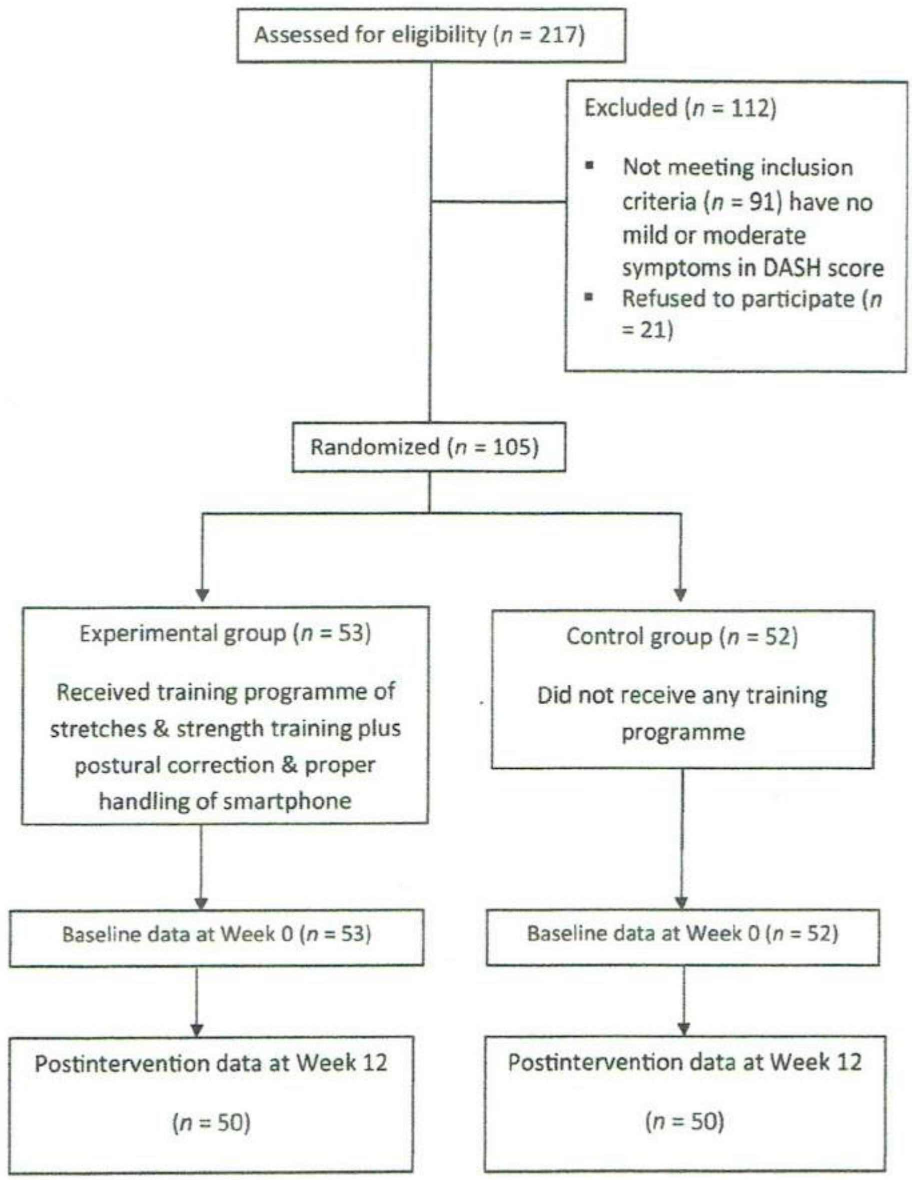


**Figure 1.** CONSORT diagram of the study. DASH = disabilities of the arm, shoulder, and hand.

accordance with the Helsinki Declaration of 1975, as revised in 1996 [15].

## Assessment

The DASH outcome measure is a 30-item, self-reported questionnaire designed to measure physical function and symptoms in people with any of several musculoskeletal disorders of the upper limbs. This gives clinicians and researchers the advantage of having a single, reliable instrument that can be used to assess any or all joints in the upper extremity. Participants were instructed to read the questions and carefully choose the proper score from the 5 point scale. They received a clear description of the questionnaire and were asked to answer all questions as applicable. The score for each participant was calculated as:

$$[(\text{sum of } n \text{ responses}) - 1] \times 25, \quad (1)$$

where $n$ is equal to the number of completed responses. DASH score may not be calculated if there are more than three missing items [16]. The DASH questionnaire includes questions regarding pain, functional limitations, and tingling, weakness, and stiffness on shoulder, arm, and hand. It is a reliable, valid, and responsive tool for measuring the outcome in different regions of the upper extremities [17].

Grip strength was tested first, followed by key pinch. For each of the tests of hand strength, the participants were seated with their shoulder adducted and neutrally rotated, elbow flexed at 90°, forearm in neutral position, and wrist between 0° and 30° dorsiflexion and between 0° and 15° ulnar deviation [18,19]. For each strength test the scores of three successive trials were recorded [20]. The assessment was conducted with the dominant hand, as Sharan et al [21] reported that there is a correlation between hand dominance and musculoskeletal disorders.

## Equipment

We used the standard, adjustable-handle Jamar dynamometer (Asimov Engineering Co., Los Angeles, CA USA), which has been reported as the most accurate for measuring grip strength [22,23]. For standardization, it was set at the second handle position for all participants. The dynamometer was lightly held around the readout dial by the examiner to prevent inadvertent dropping.

The B&L pinch gauge (B&L Engineering, Tustin, CA, USA), used to measure key pinch, was held by the examiner at the distal end to prevent dropping. Scores were read on the needle side of the red readout marker. The calibration of both instruments was tested periodically during the study. The Jamar dynamometer and the B&L pinch gauge had the highest calibration accuracy of the instruments tested [23].

Data pertaining to upper extremity symptoms, hand grip strength, and tip pinch strength were collected from all participants on two different occasions; at the start of the study and 12 weeks later.

## Training programme

Stretching exercises: sideway arm stretch; participant folded his hands together and turn palms away from body as the arms were extended forward a gentle stretch should be felt all the way from shoulders to fingers. Forward arm stretch; participant folded his hands together and turn palms away from body, but this time arms should be extended over his head. Forearm and wrist stretch with elbow completely straight each participant should extend his arms in front of their chest and with their palm down, and bend the hand on the outstretched arm down toward the floor. Then turn the palm up and stretch the hand up toward the body. This stretches the forearm and wrist muscles. All stretches were held for 10 seconds and repeated eight times for each session [24].

Strength training: the intervention group were enrolled in a 12-week programme of strengthening exercises (dumbbell exercises) for muscles of the neck, shoulder, elbow, and wrist. These were performed for 20 minutes, three times a week. (1) Front raise: from a neutral starting position the participant lifts one arm at a time to 90° shoulder flexion, and 90° internal rotation. The elbows are slightly flexed ($\sim 5°$) during the entire range of motion. (2) Lateral raise: the participant is standing with arms in neutral starting position and the elbows are in a static slightly flexed position ($\sim 5°$). The participant lifts both arms to 90° shoulder abduction and 30° horizontal flexion. (3) Reverse flies: the participant is sitting bent over forward with the back straight and arms hanging. The arms are raised bilaterally, while keeping the elbows in a static slightly flexed position ($\sim 5°$), until the upper arms are horizontal. (4) Shrugs: the participant is standing erect with arms to the side and elevates the shoulders as high as possible in a maximal shrug. (5) Wrist extension: sitting with the forearm pronated on a support. From full palmar flexion the participant moves the wrist to full dorsal flexion.

Participants performed exercises in a rotating manner to optimally increase training load, and rested for 1–2 minutes in between sets [25]. The participants performed warm-up exercises at the beginning of each training session, with 10 repetitions of each exercise and 50% of 1 repetition maximum (RM). At the beginning and halfway through the intervention period, the participants were tested to optimize the training intensity and the loads were progressively increased according to the principle of periodization and progressive overload [26]. The intensity of the programme increased gradually from 20 RM at the beginning of the intervention period to 8 RM further along in the process.

Proper handling; clear and illustrated guidelines were given to all participants in the study groups including: adopt a neutral grip that keeps the wrist as straight as possible, as bending the wrist can add to the strain, adequate pausing and break times to avoid repetitive motion injuries due to performing the same task over and over, and switch activities between both hands frequently [13].

The participants were educated on the importance of correct postural alignment of the spine during sitting and standing activities. They were asked to adopt ideal head position, and were instructed to sit with the head in a "balanced position" considered by the participants to be ideal without any manual or verbal feedback regarding the position adopted. The posture was held for 10 seconds and repeated three times, and a 10-second rest period was allowed between repetitions [27].

## Data analysis

Data were analysed using SPSS for Windows version 16.0 (SPSS Inc., Chicago, IL, USA). An independent *t* test was used to compare demographic variables of the participants, and the Chi-square test was used for gender. Analysis of variance was used to compare DASH, the hand dynamometer, and the key pinch dynamometer of both groups, with time as the within participant factor (baseline measurement vs. postintervention measurement) and group as the between participant factor (experimental vs. control). Independent *t* tests were used to compare the change score between the two groups. Least significant difference test was used to locate the source of differences. The level of significance was set at 0.05 for all tests.

## Results

There were no significant differences between the two groups in age, weight, height, and body mass index ($p > 0.05$; Table 1). Descriptive statistics of the DASH, hand dynamometer, and key pinch dynamometer values of the two groups are illustrated in Table 2.

There were no significant differences between prevalues of both groups ($p > 0.05$) for DASH scores, hand grip, and key pinch grip dynamometer values. Moreover, there was no significant difference between pre- and postvalues of the DASH, hand grip, and key pinch grip of the control group ($p > 0.05$).

For DASH scores, the postvalue of the experimental group was significantly lower than that of the control group ($p = 0.048$). The postvalue of the experimental group was significantly lower than the prevalue ($p = 0.001$). For handgrip and key pinch grip dynamometer values, the

Table 1 Demographic characteristics of participants.

| | Control group, $n = 50$ | Experimental group, $n = 50$ | $p$ |
|---|---|---|---|
| Age (y) | 20.22 ± 1.97 | 20.30 ± 1.88 | 0.836[a] |
| Height (m) | 168.42 ± 9.77 | 169.04 ± 10.60 | 0.643[a] |
| Weight (kg) | 76.42 ± 16.31 | 65.90 ± 16.41 | 0.762[a] |
| Body mass index (kg/m$^2$) | 23.53 ± 3.89 | 22.79 ± 3.94 | 0.347[a] |
| Sex (male/female) | 36/14 | 39/11 | 0.488[b] |

Data are presented as mean ± standard deviation, unless otherwise indicated.
[a] Independent $t$ test.
[b] Chi-square test.

Table 2 Values of DASH, hand dynamometer, and key pinch dynamometer.

| | Control group, $n = 50$ | | $p$ | Experimental group, $n = 50$ | | $p$[a] |
|---|---|---|---|---|---|---|
| | Prevalue | Postvalue | | Prevalue | Postvalue | |
| DASH | 35.10 ± 8.11 | 35.66 ± 7.84 | 0.085 | 37.88 ± 8.51 | 32.62 ± 6.63 | 0.001 |
| Hand dynamometer (kg) | 30.46 ± 3.57 | 30.14 ± 3.31 | 0.692 | 30.94 ± 4.53 | 35.02 ± 4.56 | 0.001 |
| Key pinch dynamometer (kg) | 12.29 ± 1.96 | 12.10 ± 1.82 | 0.625 | 12.88 ± 1.91 | 14.49 ± 2.15 | 0.001 |

Data are presented as mean ± standard deviation.
$p > 0.05$ means no significant difference.
$p < 0.05$ means a significant difference.
[a] Least significant difference's analysis of variance.

postvalue of the experimental group was significantly higher than the postvalues of the control group ($p = 0.001$). The postvalue of the experimental group was significantly higher than the prevalue ($p = 0.001$), as shown in Table 2.

Analysis of the change scores revealed that the experimental group had significantly more changes in DASH scores, hand grip, and key pinch grip dynamometer ($p = 0.001$) compared with the control group, as shown in Table 3.

## Discussion

This study was conducted to examine the effect of an exercise training programme and postural correction on upper extremity disability and symptoms associated with touchscreen smartphone use among university students. The results of the current study showed a significant improvement in upper extremity disability and symptoms, hand grip strength, and key pinch strength of the experimental group, without significant changes in these outcome measures of the control group.

Previous studies [28,29] showed an association between upper limb disorders such as neck and shoulder pain and cellular phone over-use, which may explain why only 100 out of 217 eligible participants with mild to moderate symptoms of DASH score were selected. In addition, Storr et al [30] reported a female patient with de Quervain's tenosynovitis due to cell phone use. The patient sent 2500 texts per month, and stated that the specific thumb movement caused the tenosynovitis or other over-use trouble around the thumb.

Young et al [11] who reported that the head and neck flexion angles during tablet use were greater than angles previously reported for desktop and notebook computing, which could explain the neck pain symptoms of the participants. Moreover, there is a disturbance in electromyographic activities of neck and hand muscles; Xie et al [14] concluded that smartphone texting was associated with higher activity in neck extensor and thumb muscles but lower activity in upper and lower trapezius as well as wrist extensors, compared with computer typing.

The values of hand grip strength of the participants of this study were less than the normative values of a similar age group reported by Mathiowetz et al [20]. In their study, the

Table 3 Change score of DASH, hand dynamometer, and key pinch dynamometer.

| | Control group, $n = 50$ | Experimental group, $n = 50$ | $p$[a] |
|---|---|---|---|
| DASH | 0.55 ± 2.07 | −5.26 ± 2.07 | 0.001 |
| Hand dynamometer (kg) | −0.32 ± 1.22 | 4.08 ± 1.12 | 0.001 |
| Key pinch dynamometer (kg) | −0.19 ± 1.04 | 1.61 ± 1.02 | 0.001 |

Data are presented as mean ± standard deviation.
[a] Independent $t$ test.

average values of hand grip strength were 54.81 kg for males and 31.71 kg for females. However, the normal values of key pinch strength are 11.78 kg for males and 7.97 kg for females, which is similar to the results of our study.

The nonsignificant difference in the DASH, hand grip, and key pinch strength postvalues of the control group can be explained by the findings of Sengupta et al [31], who reported that due to the small keyboard, greater strain may be placed on the hand and arm muscles during mobile phone use compared to desktop or laptop use. This is in addition to the considerable increase in neck flexion angle during texting to look sharply downwards or to hold arms out in front to read the screen, leading to fatigue and pain in the neck and shoulders. Moreover, static loading caused by holding the hand-held device for long durations, often coupled with hazardous body postures and over-use of the hand muscles are likely contributors to the development of myofascial pain syndrome of the hand, forearm, neck, and upper back muscles [32].

The improvement of outcome measures of the experimental group is supported by the findings of Gram et al [33], who used the same exercise training programme to investigate the effect on neck/shoulder pain and headache among office workers. They found that neck/shoulder training at the workplace reduced neck pain and headache among office workers, and confirmed the positive effect of exercise training to reduce the upper extremity symptoms [25,34].

Key pinch strength was tested in the current study because the carpometacarpal joint represents the most important functional key in a human hand due to its circumduction and opposition abilities. These functions are very unique to humans and mean that its anatomy and functions are at risk of overloading due to excessive activity [35]. The saddle shape and reciprocal engagement of the carpometacarpal joint are stabilized by powerful ligamentous structures such as the intermetacarpal ligament, posterior oblique ligament, and dorsal radial ligament, which are involved in the movements described above [36]. The ability to reach keys in different areas of the mobile phone screen is regulated by changing the flexion angle of the carpometacarpal joint [37]. So, the key pinch strength was used to assess the strength of the thumb because it is the most affected part of the hand due to touchscreen phone use. The results of the current study proved its strength reduction due to touchscreen phone use and improvement due to proper handling and exercise training.

The reduction of the DASH score of the experimental group is supported by the findings of Pedersen et al [38], who reported that specific strength training at the workplace can lead to significant long-term reductions in spinal and upper extremity pain and DASH scores. It also supported by the findings of a few high quality studies showing the effectiveness of training on shoulder symptoms [39,40] and combined neck/shoulder symptoms [41,42]. Moreover, the improvement of the experimental group can be explained by the effect of postural correction training on assuming ideal head position, which is in accordance with the findings of previous studies [43–45] which reported that proper head position can minimize the stresses and strains acting on the upper body by creating a state of musculoskeletal balance. Proper and frequent postural correction to an upright neutral postural position serves two functions. Firstly, it minimizes the adverse loads on the cervical joints induced by poor spinal, cervical, and scapular postures. Secondly, it may train the deep postural-stabilizing muscles of the spine to better perform their functional postural-supporting role. Hence, assuming a proper head position is a common approach for the treatment of neck and shoulder pain syndromes.

The shoulder girdle attaches by muscles to the scapula and the back of the thoracic rib cage. These upper back muscles are prone to developing painful irritation. In clinical practice pain complaints from the neck, the shoulder girdle, and part of the shoulder are associated [46]. Neck, shoulder, and upper back muscles are all involved during repetitive movements/activity of the arms with a common effect on all three regions, which explains the importance of this study.

The significant improvement in DASH scores, hand grip, and key pinch strength of the experimental group may be due to a change in central pain perception, which is known to be altered in chronic pain conditions [47]. A change in pain level could result in beneficial changes in overall pain perception and a decreased pain sensitization. A previous study showed central adaptations of pain perception in response to neck/shoulder rehabilitation, i.e., pressure pain threshold also increased in other nontrained parts of the body [48]. The current study was unique in reporting the effect of strength training, postural correction, and proper handling on upper extremity pain among touchscreen users. To our knowledge this has not been reported in previous training intervention studies.

There are some limitations of this study. First, our participants were not selected randomly, because all were volunteers. This could cause a biased sample in favour of higher hand strength scores. There was an attempt to avoid a competitive atmosphere at the testing sites in order to decrease the chance of this happening. Second, the only outcome measure used to assess the thumb strength was key pinch. Other outcomes such as tip and palmar pinch were not considered. Third, the exercise training was semisupervised, so we were not sure if all participants performed the exercise with the same frequency, intensity, and duration. However, they were seen at least once per week to confirm that. Finally, the touchscreen phones used in this study had different screen sizes that would require different finger actions when operating the devices. Hence there is still a need to investigate the relationship between screen size and the effect of a training programme. Future research is needed to examine the effect of exercise intervention on the electromyographic activities of the thumb, forearm, shoulder, and neck extensor muscles.

## Conclusion

The present study demonstrated that exercise training, postural correction, and instruction on the proper handling of touchscreen smartphones reduced the upper extremity disability and symptoms and improved the hand grip strength and key pinch strength. Therefore, exercise training and ergonomic guidelines concerning the use of touchscreen smartphones will reduce the risk of developing upper extremity musculoskeletal disorders.

## Conflicts of interest

The authors have no conflict of interest to declare.

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## References

[1] Berolo S, Wells RP, Amick BC. Musculoskeletal symptoms among mobile hand-held device users and their relationship to device use: a preliminary study in a Canadian university population. Appl Ergon 2011;42:371–8.

[2] Kim GY, Ahn CS, Jeon HW, Lee CR. Effects of the use of smartphones on pain and muscle fatigue in the upper extremity. J Phys Ther Sci 2012;24:1255–8.

[3] Gustafsson E, Johnson PW, Hagberg M. Thumb postures and physical loads during mobile phone use – a comparison of young adults with and without musculoskeletal symptoms. J Electromyogr Kinesiol 2010;20:127–35.

[4] Kleinert CM. Trapezio-metacarpal arthritis: the price of an opposable thumb. Indian J Plast Surg 2011;44:308–16.

[5] Chany M, Marras WS, Burr DL. The effect of phone design on upper extremity discomfort and muscle fatigue. Hum Factors 2007;49:602–18.

[6] Gustafsson E. Ergonomic recommendations when texting on mobile phones. Work 2012;41(Suppl. 1):5705–6.

[7] Abdelhameed AA. Upper extremities symptoms among mobile hand-held device users and their relationship to device use. In: Proceedings of the 5th Health and Environment Conference in the Middle East, 2014; March 2014. p. 71–7. Dubai, UAE, 3–4.

[8] Gustafsson E, Thomée S, Grimby-Ekman A, Hagberg M. Texting on mobile phone and musculoskeletal symptoms. A 5 years cohort study. In: Proceedings of the 19th Triennial Congress of the IEA, 9–14 August 2015, Melbourne.

[9] Shan Z, Deng G, Li J, Li Y, Zhang Y, Zhao Q. Correlation analysis of neck/shoulder pain and low back pain with the use of digital products, physical activity and psychological status among adolescents in shanghai. PLoS One 2013;8:78–109.

[10] Young JG, Trudeau MB, Odell D, Marinelli K, Dennerlein JT. Wrist and shoulder posture and muscle activity during touch-screen tablet use: effects of usage configuration, tablet type, and interacting hand. Work 2013;45:59–71.

[11] Young JG, Trudeau M, Odell D, Marinelli K, Dennerlein JT. Touch-screen tablet user configurations and case-supported tilt affect head and neck flexion angles. Work 2012;41:81–91.

[12] Gold J, Driban J, Thomas N, Chakravarty T, Channell V, Komaroff E. Postures, typing strategies, and gender differences in mobile device usage: An observational study. Appl Ergon 2012;43:408–12.

[13] Kietrys DM, Gerg MJ, Dropkin J, Gold JE. Mobile input device type, texting style and screen size influence upper extremity and trapezius muscle activity, and cervical posture while texting. Appl Ergon 2015;50:98–104.

[14] Xie Y, Szeto GP, Dai J, Madeleine P. A comparison of muscle activity in using touchscreen smartphone among young people with and without chronic neck-shoulder pain. Ergon 2015;28: 1–12.

[15] World Medical Association. Declaration of Helsinki, 4th (Somerset West) amendment. 1996. www.wma.net/en/30publications/10policies/b3/17c.pdf.

[16] Beaton D, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts: Validity, reliability, and responsiveness of the disabilities of the arm, shoulder and hand outcome measure in different regions of the upper extremity. J Hand Ther 2001;14:128–42.

[17] Kitis A, Celik E, Aslan UB, Zencir M. DASH questionnaire for the analysis of musculoskeletal symptoms in industry workers: a validity and reliability study. Appl Ergon 2008;40: 251–5.

[18] Kraft GH, Detels PE. Position of unction of wrist. Arch Phys Med Rehabil 1972;53:272–5.

[19] Pryce JC. Wrist position between neutral and ulnar deviation that facilitates maximum power grip strength. J Biomech 1980;13:505–11.

[20] Mathiowetz V, Kashman N, Volland G, Weber K, Dowe M, Rogers S. Grip and pinch strength: normative data for adults. Arch Phys Med Rehabil 1985;66:69–72.

[21] Sharan D, Mohandoss M, Ranganathan R, Jose J. Musculoskeletal disorders of the upper extremities due to extensive usage of hand held devices. Ann Occup Environ Med 2014;26: 22–5.

[22] Kirkpatrick JE. Evaluation of grip loss. Calif Med 1956;85: 314–20.

[23] Mathiowetz V, Weber K, Volland G, Kashman N. Reliability and validity of hand strength evaluation. J Hand Surg 1984;9: 222–6.

[24] Tom Valeo, How to Handle High-Tech Hand Injuries. http://www.webmd.com/arthritis/features/how-to-handle-high-tech-hand-injuries, (last accessed in October 2015).

[25] Andersen L, Zebis MK, Pedersen MT, Roessler KK, Andersen CH, Pedersen MM, et al. Protocol for work place adjusted intelligent physical exercise reducing musculoskeletal pain in shoulder and neck (VIMS): a cluster randomized controlled trial. BMC Musculoskelet Disord 2010;11:1471–4.

[26] Ratamees NA, Alvar BA, Evetoch TK, Housh TJ, Kibler B, Kraemer WJ, et al. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Med Sci Sports Exerc 2009;11:687–708.

[27] Kwon JW, Son SM, Lee NK. Changes in upper-extremity muscle activities due to head position in subjects with a forward head posture and rounded shoulders. J Phys Ther Sci 2015;27: 1739–42.

[28] Yoong JK. Mobile phones can be a pain–text messaging tenosynovitis. Hosp Med 2005;66:370.

[29] Ashurst JV, Turco DA, Lieb BE. Tenosynovitis caused by texting: an emerging disease. J Am Osteopath Assoc 2010;110: 294–6.

[30] Storr EF, de Vere Beavis FO, Stringer MD. Texting tenosynovitis. N Z Med J 2007;14:1267.

[31] Sengupta A, Grabiner S, Kothari P, Martinez G. Ergonomic aspects of personal digital assistant (PDA) and laptop use. In: Proceedings of the 6th International Scientific Conference on Prevention of Work-related Musculoskeletal Disorders, 2007; August 2007. p. 17. Boston, USA, 27–30.

[32] Eapen C, Bhat AK. Prevalence of cumulative trauma disorders in cell phone users. J Musculoskelet Res 2010;13:137–45.

[33] Gram B, Andersen C, Zebis MK, Bredahl T, Pedersen MT, Mortensen OS, et al. Effect of training supervision on effectiveness of strength training for reducing neck/shoulder pain

and headache in office workers: cluster randomized controlled trial. Biomed Res Int 2014;2014:693013.

[34] Sjögren T, Nissinen KJ, Järvenpää SK, Ojanen TM, Vanharanta H, Mälkiä EA. Effects of a workplace physical exercise intervention on the intensity of headache and neck and shoulder symptoms and upper extremity muscular strength of office workers: a cluster randomized controlled cross-over trial. Pain 2005;116:119–28.

[35] Turker T, Thirkannad S. Trapezio-metacarpal arthritis: the price of an opposable thumb! Indian J Plast Surg 2011;44: 308–16.

[36] Connell DA, Pike J, Koulouris G, van Wettering N, Hoy G. MR imaging of thumb carpometacarpal joint ligament injuries. J Hand Surg Br 2004;29:46–54.

[37] Sakai N, Shimawaki S. Motion analysis of thumb in cellular phone use. Appl Bionics Biomech 2010;7:119–22.

[38] Pedersen MT, Andersen CH, Zebis MK, Sjøgaard G, Andersen LL. Implementation of specific strength training among industrial laboratory technicians: long-term effects on back, neck and upper extremity pain. BMC Musculoskelet Disord 2013;9:287.

[39] Blangsted AK, Sogaard K, Hansen EA, Hannerz H, Sjogaard G. One-year randomized controlled trial with different physical-activity programs to reduce musculoskeletal symptoms in the neck and shoulders among office workers. Scand J Work Environ Health 2008;34:55–65.

[40] Ludewig PM, Borstad JD. Effects of a home exercise programme on shoulder pain and functional status in construction workers. Occup Environ Med 2003;60:841–9.

[41] Andersen LL, Saervoll CA, Mortensen OS, Poulsen OM, Hannerz H, Zebis MK. Effectiveness of small daily amounts of progressive resistance training for frequent neck/shoulder pain: randomised controlled trial. Pain 2011;152:440–6.

[42] Moher D, Hopewell S, Schulz KF, Montori V, Gotzsche PC, Devereaux PJ, et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. BMJ 2010;340:c869.

[43] Caneiro JP, O'Sullivan P, Burnett A, Barach A, O'Neil D, Tveit O, et al. The influence of different sitting postures on head/neck posture and muscle activity. Man Ther 2010;15:54–60.

[44] Falla D, Jull G, Russell T, Vicenzino B, Hodges P. Effect of neck exercise on sitting posture in patients with chronic neck pain. Phys Ther 2007;87:408–17.

[45] Thigpen CA, Padua DA, Michener LA, Guskiewicz K, Giuliani C, Keener JD, et al. Head and shoulder posture affect scapular mechanics and muscle activity in overhead tasks. J Electromyogr Kinesiol 2010;20:701–9.

[46] Andersen JH, Kaergaard A, Mikkelsen S, Jensen UF, Frost P, Bonde JP, et al. Risk factors in the onset of neck/shoulder pain in a prospective study of workers in industrial and service companies. Occup Environ Med 2003;60:649–54.

[47] Arendt-Nielsen L, Graven-Nielsen T. Muscle pain: sensory implications and interaction with motor control. Clin J Pain 2008;24:291–8.

[48] Andersen LL, Andersen CH, Sundstrup E, Jakobsen MD, Mortensen OS, Zebis MK. Central adaptation of pain perception in response to rehabilitation of musculoskeletal pain: randomized controlled trial. Pain Physician 2012;15:385–94.

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**Original Research Article**

# Correlation of smartphone use addiction with text neck syndrome and SMS thumb in physiotherapy students

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## ABSTRACT

**Background:** Young adults have grown up today with mobile phones as an evident part of their lives. Text neck syndrome and SMS thumb may occur due to repetitive use of hand held devices (HHDs) resulting in repetitive stress injury or an overuse syndrome while using their mobile phones or other electronic devices for prolonged periods of time. Our aim is to assess self reported addiction to smartphone use and correlate its use and musculoskeletal disorders (MSDs) in neck and hand in young healthy adults.

**Methods:** The study examined 100 healthy physiotherapy students of a college in Ahmedabad by random table sampling, in the age group of 20-25 years. Students were asked to fill a proforma with the questionnaires of Smartphone Addiction Scale (SAS), Neck Disability Index (NDI), and Cornell Hand Discomfort Questionnaire (CHDQ) attached. Level of significance was kept at 5%. Spearman correlation coefficient was used to correlate between the SAS and NDI, and SAS and CHDQ respectively.

**Results:** There was a predominance of females over males (females-76, males-24). Mean±SD of SAS, NDI and CHDQ was 102.49±22.15, 30±0.10 and 6.12±8.73 respectively. Spearman correlation coefficient showed a significant moderate positive correlation between both SAS and NDI ($r=0.671$, $p<0.001$) and between SAS and CHDQ ($r=0.465$, $p<0.001$).

**Conclusions:** The study showed that musculoskeletal problems in neck and hand(predominantly thumb) can be seen in smartphone addicted students which may be short term initially but may later lead to long term disability.

**Keywords:** Smartphone addiction, Text neck, SMS thumb, Musculoskeletal disorders

## INTRODUCTION

A smartphone is the most popular devices used among adolescents. In a study of university students of the United States, text messaging (SMS) was emerged as the most frequently used type of communicative medium.[1] A recent study shows that 79% of the population between the age 18-44 have their cell phones with them almost all the time, with only 2 hours of their walking day spend without their cell in hand.[2]

The term "Text neck" was coined by Dr. Dean L. Fishman, who is a US chiropractor. The term text neck is used to describe a repetitive stress injury or an overuse syndrome where a person has his/her head hung or flexed in a forward position and is bent down looking at his/her mobile or other electronic device for prolonged periods of time. In today's world, where the mobile technology has advanced so much, there are more and more people who are spending an increased amount of time on handheld devices , such as Smartphone, computer, tablets and e-readers. The end result is prolonged flexion of the neck when bent over these electronic devices resulting in the "text neck" or "turtle neck posture". This condition is a growing health concern and has the potential to affect millions of people all over the world.[2] Most smartphone tasks users require to stare sharply downwards or to hold their arms out in front of them to read the screen which makes their head move forward and cause an excessive anterior curve in the lower cervical vertebrae and an excessive posterior curve in the upper thoracic vertebrae to maintain balance, placing stresses on the cervical spine and the neck muscles. Forward head posture is one of the most commonly recognized poor postures in the sagittal plane.[3] Incorrect posture of the head and neck has been correlated with chronic musculoskeletal pain.[4]

The incidence of musculoskeletal disorders (MSD) of hand, wrist, forearm, arm and neck has been increasing all over the world due to prolonged, forceful, low amplitude, repetitive use of hand held devices(HHD). Continuous repetitive movements with the thumb and fingers have all been identified as risk factors which may lead to disorders of the thumb and its musculature like tendinosis of the extensor pollicis longus or myofacial pain syndrome in the hand. Studies have shown a relation between mobile design and anthropometry of the user in causing discomfort and fatigue in hand, elbow and shoulder while using the HHD.[5] Phrases have been coined to describe MSDs due to use of HHDs such as 'SMS thumb', 'iPod finger', 'blackberry thumb', 'wii injury' and 'nintenditis'; however, little evidence exists to support this association.[6,7]

Few studies have been reported about this substantial increase in the number of adolescent smartphone users, having various behavioural effects and its association with musculoskeletal discomfort, in recent years, which is becoming a growing problem and having a large impact globally.

Hence, the aim of the present study was to assess the level of self reported smartphone addiction and correlate its relationship with MSD's in neck as well as in hand in young healthy students.

## METHODS

Participants were recruited from SBB College of Physiotherapy, VS Hospital, Ahmedabad. To be included in the study their age group should be of 20-25 years with minimum Smartphone use of $\geq$1 hour per day, and able to understand and fill the questionnaire in English. Exclusion criteria were students with any other medical cause or a known condition which could lead to pain in the neck or upper limb. In addition, students with neck or upper extremity musculoskeletal trauma or spinal cord injury prior to the study were also excluded. Study design was observational analytical study with random sampling where total estimated sample included 100 subjects. Nature and purpose of the study was explained and informed oral consent was taken from the participants. The period for data collection in the study was from August to November 2017.

The questionnaire were distributed which consisted of 4 parts including, 1) Demographics (Name, age, gender, hand dominance) and hours of mobile usage per day which was classified according to Gustafsson et al, 2) Smartphone Addiction Scale (SAS) to measure self reported addiction to smartphone use, 3) Neck Disability Index (NDI) for any abnormal symptoms of neck functions, and 4) Cornell Hand Discomfort Questionnaire (CHDQ) for abnormal symptoms related to hand functions.[1]

### *Smartphone addiction scale (SAS)*

The SAS is a self-reporting scale to assess smartphone addiction (Kwon et al).[8] It consists of six factors and 33 items, with a six-point Likert scale (1: "strongly disagree" to 6: "strongly agree"). The six factors were daily-life disturbance, positive anticipation, withdrawal, cyberspace-orientated relationship, overuse and tolerance. The respondent circles the statement which most closely describes their smartphone use characteristics. Scores range from 33 to 198. The higher the score, the greater the degree of pathological use of the smartphone (Ching et al).[9] The SAS is a reliable and valid measurement tool for the evaluation of smartphone addiction.[8]

### *Neck disability index (NDI)*

The NDI assessment involves a 10-item, 50-point index questionnaire that assesses the effects of neck pain and symptoms during a range of functional activities.[10] Of the 10 items, four relate to subjective symptoms (pain intensity, headache, concentration, sleeping), four activities of daily living (lifting, work, driving, recreation) and two discretionary activities of daily living (personal care, reading) Each item is scored on a 0 to 5 rating scale, in which zero means 'No pain' and 5 means 'Worst imaginable pain. The test was interpreted as a raw score, with a maximum score of 50. A higher NDI score indicates greater neck disability. This index is the most widely used and most strongly validated instrument for assessing self-rated disability in patients with neck pain.[10]

### *Cornell hand discomfort questionnaire (CHDQ)*

It is a 6-item questionnaire containing a hand map diagram showing 6 shaded areas of the hand and questions about 1. Prevalence of musculoskeletal pain, 2. Discomfort and 3. Interference with work, during the previous week. Total discomfort score was calculated by using the following formula: frequency $\times$ discomfort $\times$ interference, where higher the scores indicated more discomfort. Maximum scoring for each area is 90, and the total scoring for 6 areas is 560, (Higher scores showing more discomfort). The validity of the CMDQ has been extensively tested by Dr. Oguzhan Erdinc in Turkey with good results.[11]

### *Statistical analysis*

Data analyses were performed using SPSS 16.0 software for Windows. The numerical scores of SAS, NDI and CHDQ were presented as Mean ± Standard deviation. As the data was not normally distributed, Spearman correlation coefficient was used to assess the relationship between SAS and NDI and SAS and CHDQ scores. The significance level was set at 5%.

## RESULTS

The sample composed of 100 participants (Age mean±SD =21.80±1.29), most of whom were females (76/100) with maximum people having usage hours of 2-4 hours per day (46/100). Participant characteristics and smartphone use behaviour are displayed in Table 1.

**Table 1: Demographic characteristics of 100 participants.**

| Hours of phone use/day | No. of participants |
|---|---|
| **1-2 hrs** | 13 |
| **2-4 hrs** | 46 |
| **>4 hrs** | 41 |

**Table 2: Mean ± Standard Deviation of outcome measures**

| Outcome measures | Mean±SD |
|---|---|
| **SAS**[a] | 102.49±22.15 |
| **NDI**[b] | 30±0.10 |
| **CHDQ**[c] | 6.12±8.73 |

[a]Smartphone addiction scale; [b]Neck disability index; [c]Cornell hand discomfort questionnaire

Mean±standard deviation of SAS, NDI and CHDQ are shown in Table 2.

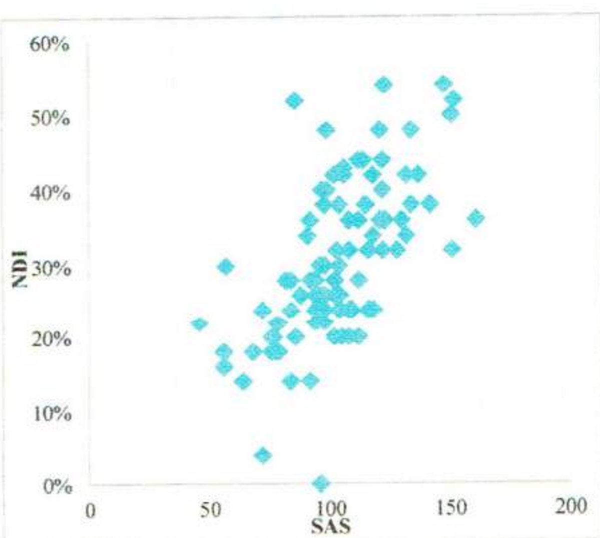


**Figure 1: Correlation between smartphone addiction scale and neck disability index (r=0.671*).**

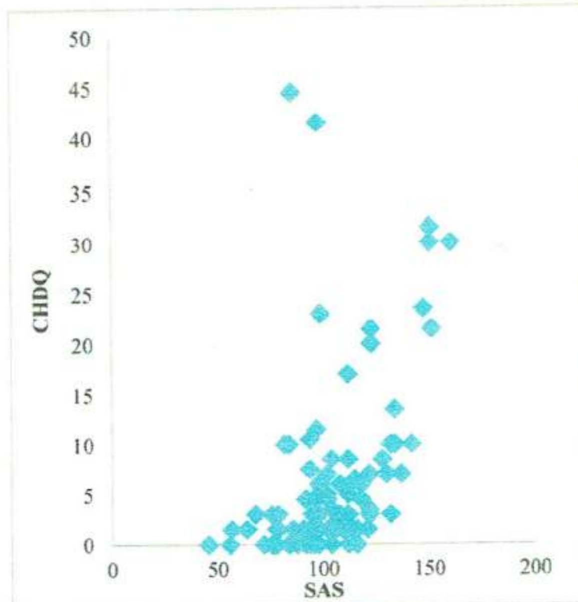


**Figure 2: Correlation between smartphone addiction scale and cornell hand discomfort questionnaire (r=0.465*).**

Spearman correlation coefficient showed significant positive moderate correlation between SAS and NDI (r=0.671, p<0.001), significant positive moderate correlation between SAS and CHDQ (r=0.465, p<0.001). The correlation between SAS and NDI is shown in Figure 1, and correlation between SAS and CHDQ is shown in Figure 2.

## DISCUSSION

Our results in the present study showed that that the degree of smartphone influence was significantly correlated with musculoskeletal discomfort in the participants. Significant moderate positive correlation between both SAS and NDI (p<0.001) and between SAS and CHDQ (p<0.001).

Moreover, SAS showed a higher score- indicating addiction to smartphone use, along with it the scores of NDI showing moderate disability (30-48%-moderate disability), and the CHDQ scores showed maximum scores of shaded areas Area C and E, showing more discomfort in the thumb.[12]

The neck disability among smartphone users might be related to frequent neck flexion posture, which changes the natural curve of the cervical spine and increases the amount of stress on the cervical spine, leading to irritation and spasm in the surrounding skeletal structures and ligaments.[3] Excessive use of smartphones can lead to habitual repetitive and continuous movements of the head and neck toward the screen throughout the day. Such movements are associated with a high risk of chronic neck pain and may explain the strong association between SAS and NDI scores in the present study.[3]

The physical exposure while text messaging on a mobile phone consists of low physical load, repetitive thumb movements and excessive neck flexion.[1] If text neck is left untreated, then it can lead to some serious permanent damage, such as flattening of the spinal curve, early arthritis; spinal misalignment, spinal degeneration or disc compression, disc herniation, or nerve damage.[2]

Text neck most commonly causes neck pain and soreness. In addition, looking down at smart phones too much can lead to upper back pain, also Shoulder pain and tightness ranging from chronic, nagging pain to sharp and severe muscles spasm.[2] Text neck directly affects the spine while flexing the head forward at varying degrees - when the head tilts forward at 15 degrees, the forces on the neck surge to 27 pounds, at 30 degrees 40 pounds, at 450 degrees 49 pounds and at 60 degrees 60 pounds. This issue is a major concern with children; since their heads are larger in relation to their body size than adults, and thus they are have an increased risk for text neck given their propensity to use mobile phones. Serious permanent damage of untreated text neck can be the result and be quite similar to occupational overuse syndrome or repeated stress/strain injury.[2]

Sustained gripping and repetitive movements (especially typing) with the thumb and fingers have all been identified as risk factors which may lead to disorders of the thumb and its musculature, leading to associated syndromes, such as wrist tendinitis or De Quervain's disease. Factors include small spacing in the keyboard, increased static loading and end range motion of the thumb during texting, but the range of movements of the thumb varies according to the mobile size, design and the anthropometry of the user.[7] Studies have revealed that while texting in mobile phone keypad, the thumb covered motions in planes of extension, flexion, abduction-adduction and opposition.[13] This posture of the thumb working near the extreme range of motion is perhaps the main triggering factor for the development of tendinosis of extensor pollicis longus.[7] Studies related to measurement of thumb postures during texting were shown to be affected by the size of the mobile phone and movement axis of the thumb.[14] This might have been a notable factor for developing maximum pain in the thumb areas, as seen in our study. Static loading by holding of the hand held device for long durations, often coupled with hazardous body postures and overuse of the hand muscles are likely contributors to the development of myofascial pain syndrome of hand, forearm, neck and upper back muscles.[15] Symptoms reported in earlier studies also included blistering, paraesthesia and swelling of the thumbs or fingers due to tendinosis and bursitis.[16]

Similar conclusions were given by Eva Gustaffson et al, who showed that the physical exposure while text messaging on a mobile phone consists of low physical load, repetitive thumb movements and excessive neck flexion, causing neck pain and soreness, also concluded prospective associations were found between text messaging on mobile phones and MSDs, implying mostly short term effects, and to lesser extent long term effects on MSDs in neck and upper extremities.[1]

Also, Sharan et al concluded text messaging has an adverse effect on musculoskeletal system of hand in persons who extensively use mobile phone, and different pathologies described were tendinitis of extensor pollicis longus, myofascial pain syndrome of thenar muscles and 1st interossei, De Quervain's syndrome.[19]

Hakala et al also reported that frequent use of mobile phones increases the risk of neck–shoulder and lower back pain in adolescents.[17] Lee et al stated that smartphone operation could cause upper extremity pain.[18] However, Karthikeyan et al concluded that smartphone addiction has no effect on craniovertebral angle but could negatively affect a person's depression status.[19]

The implications of the present study are such that students should make an effort to reduce the continuous amount of time of usage spent using a smartphone, and should also implement other preventive factors like maintenance of correct posture while usage, taking frequent short breaks, and usage of voice to text software could also be advised. Devices promote the predominantly usage of thumb, so users should be advised to habituate themselves by typing or with all the fingers. The study had limitations. Self-administered questionnaires does increase the risk of response bias, and also because data was collected from only one college, and by university students, further study needs to be done on a larger cohort for generalized results, representing the whole population.

So concluding, the present study showed that musculoskeletal problems in neck and hand (predominantly the thumb) can be seen in smartphone addicted students which may be short term initially but may later lead to long term disability. This supports the need for public health educational programmes to inform people especially the students about the physical risks associated with excessive use of smartphones.

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## REFERENCES

1. Gustaffson E, Thomee S, Grimby-Ekman A, Hagberg M. Texting on mobile phones and musculoskeletal disorders in young adults: a five year cohort study. Appl Ergon. 2017;58:208-14.
2. Neupane S, Ali U, Mathew A. Text Neck Syndrome - Systematic Review. Imperial J Interdiscipl Res. 2017;3(7):141-8.
3. AlAbdulwahab SS, Kachanathu SJ, AlMotairi MS. Smartphone use addiction can cause neck disability. Musculoskeletal Care. 2017;15(1):10-2.

4. Lau KT, Cheung KY, Chan KB, Chan MH, Lo KY, Chiu TTW. Relationships between sagittal postures of thoracic and cervical spine presence of neck pain, neck pain severity and disability. Manual Therapy. 2010;15(5):457–62.
5. Chany AM, William S, Marras D, Burr L. The effect of Phone Design on Upper Extremity Discomfort and Muscle Fatigue. Hum Factors. 2007;4:602-18
6. Sengupta A, Grabiner S, Kothari P, Martinez G. Ergonomic aspects of personal digital assistant (PDA) and laptop use. Book of abstracts, PREMUS 2007 conference, Sixth International Scientific Conference on Prevention of Work-Related Musculoskeletal Disorders, Boston, USA; 2007: 17.
7. Sharan D, Mohondass M, Rangnathan R, Jose J. Muskuloskeletal Disorders of Upper extremities due to extensive usage of hand held devices. Ann Occup Environ Med. 2014;26:22.
8. Kwon M, Lee J-Y, Won W-Y, Park J-W, Min J-A, Hahn C. Development and validation of a Smartphone Addiction Scale (SAS). PLoS One. 2013;8(2):e56936.
9. Ching SM, Yee A, Ramachandran V, Sazlly Lim SM, Wan Sulaiman WA, et al. Validation of a Malay version of the Smartphone Addiction Scale among medical students in Malaysia. PloS One. 2015;10(10):e0139337.
10. Vernon H, Mior S. The Neck Disability Index: A study of reliability and validity. J Manipulative Physiol Ther. 1991;14(7):409-15.
11. Erdinc O, Hot K, Ozkaya M. Cross-Cultural Adaptation and Validity and Reliability of Cornell Musculoskeletal Discomfort Questionnaires (CMDQ) In Turkish Language. Ergonomics. 2008;42(10):1333-49.
12. Lim C, Goh J (Eds.). Thumb motion and typing forces during text messaging on a mobile phone. ICBME, Proceedings 23; 2008: 2095–2098.
13. Ming Z, Pietikainen S, Hanninen O. Excessive texting in pathophysiology of first carpometacarpal joint arthritis. Pathophysiol. 2006;13:269-70.
14. Eapen C, Bhat AK. Prevalence of cumulative trauma disorders in cell phone users. J Musculoskelet Res. 2010;13:137-45.
15. Koh TH. Ulcerative "nintendinitis": A new kind of repetitive strain injury. Med J Aust 2000; 173:671
16. Sharan D, Ajeesh P. Risk factors and clinical features of text messaging injuries. Work. 2012;41:1145-8.
17. Hakala PT, Rimpela AH, Saarni LA, Salminen JJ. Frequent computer-related activities increase the risk of neck-shoulder and low back pain in adolescents. Eur J Public Health. 2006;16(5):536-41.
18. Lee M, Hong Y, Lee S, Won J, Yang J, Park S. The effects of smartphone use on upper extremity muscle activity and pain threshold. J Phys Ther Sci. 2015;27(6):1743–5.
19. Selvaganapathy K, Rajappan R, Dee TH. The effect of smartphone addiction on craniovertebral angle and depression status among university students. Int J Intg Med Sci. 2017;4(5):537-42.

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Stanford | Environmental Health & Safety

OHS 17-067a

# Is Your Tablet/Smart Phone a Pain in the Neck?

The cumulative effect of smartphone and tablet use both on campus and at home may increase the risk of chronic neck injuries and repetitive stress injuries in the fingers.

DID YOU KNOW?

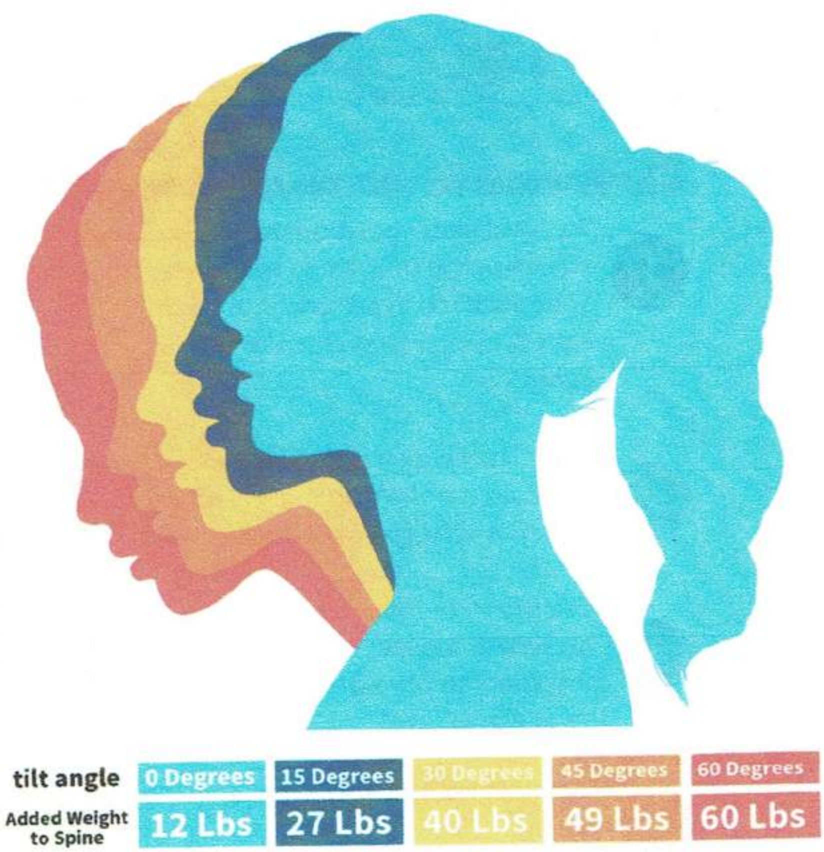
The effects of long term forward neck posture leads to "long term muscle strain, disc herniations and pinched nerves." **Mayo Clinic Health Letter Vol. 18, #3 March 2000**[1]

Forward head posture results in loss of vital capacity of the lungs by as much as 30%. This shortness of breath can lead to heart and blood vascular disease. The entire gastrointestinal system is affected; particularly the large intestine. Loss of good bowel peristaltic function and evacuation is a common effect of FHP. **-Rene Cailliet, M.D., Director of the Department of Physical Medicine and Rehabilitation at the University of Southern California**[1]

1. http://text-neck.com/anatomy-and-effects-of-texting.html

**BEST PRACTICES:**

- **Hold your mobile device at eye level**
- **Alternate hands you use to hold your mobile device**
- **Use voice dictation (Siri, Cortera, etc.)**
- **Consider use of a tablet holder if using it for an extended period of time**
- **Consider use of a stylus pen**
- **Use your desktop computer to reply to e-mails and browse the internet**

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**Original Research Article**

# Awareness of text neck syndrome in young-adult population

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## ABSTRACT

**Background:** Text neck is a repeated stress injury and pain sustained from excessive watching or texting on handheld devices for long periods of time. Dependence of mobile phone is increasing rapidly and people spend long hours on mobile phone that lead to various musculoskeletal problems. This study will help us find the awareness of text neck syndrome and awareness of hazards which are caused by excess usage of phone. This study also aimed at finding the knowledge regarding the preventive measures of text neck syndrome.
**Methods:** The study design was an observational study with a sample size of 311. A self-administered questionnaire was distributed to all subjects. Results were calculated in percentile format.
**Results:** This study stated that 35% population has heard of text neck syndrome out of which only 8% population has knowledge of this syndrome. The results also stated that 21% population have knowledge regarding the preventive measures of this syndrome.
**Conclusions:** This study has demonstrated a low level of awareness of text neck syndrome amongst young adult population. Also it mentioned about lack of knowledge of preventive measures in this population.

**Keywords:** Text neck syndrome, Neck pain, Neck posture

## INTRODUCTION

A mobile phone is a device which is used for voice and data communication. Along with the basic voice function of a phone, current mobile phones may support many additional services such as text messaging, email, gaming, camera, Whatsapp, Facebook, GPS etc.[1]

The cervical spine is a continuous and coordinated network of muscles, nerves and joints, the pathway ranging from the brain to the spinal cord. Irritation along this pathway leads to pain.[2] A recent systematic review done in Honk Kong suggests that prevalence of musculoskeletal problems with mobile phone usage are high ranging from17.3% to 67.8% for neck complaints.[3]

The term "Text neck" was coined by Dr. Dean L. Fishman, a US chiropractor. The term of 'Text neck or another phrase turtle neck posture can be described as a repeated stress injury and pain sustained from excessive watching or texting on handheld devices for long periods of time'.[2] Text neck leads to harmful symptoms such as neck pain, upper back pain, shoulder pain, chronic headaches and increased curvature of the spine.[2,4] On using the mobile phone over long periods of time, users usually adopt prolonged forward head posture.[4-7] A recent study done in Thailand shows that Text Neck syndrome has become a global epidemic affecting a large number of population of almost all ages who use mobile phones. Text neck syndrome is a growing health concern and can affect large number of population all over the world.[4]

If text neck is not treated or corrected in right time it can lead to serious permanent damage and can result into overuse syndrome or repeated stress injury. Long term untreated text neck can result into inflammation of the neck ligaments, muscles and nerves leading to permanent arthritic changes.[2,4,8,9]

It may also lead to some serious damage, such as Flattening of the spinal curve, onset of early arthritis, spinal misalignment, spinal degeneration, disc compression, disc herniation, etc.[2,10,11]

As the dependence of mobile phone is increasing rapidly[1] and people spend long hours on mobile phone which lead to various musculoskeletal problems [6,7,12] This study will help us find the awareness of text neck syndrome as neck pain is an already prevalent significant health problem.

Presently less research is been done on Text Neck Syndrome so there is lack of literature. Thus this study will help us gain knowledge regarding this condition and its awareness amongst the population.

The objectives of this study are as follows 1) To check awareness of text neck syndrome in young-adult population. 2) To check the knowledge about text neck syndrome in young-adult population. 3) To check the knowledge of preventive measures for text neck syndrome.

## METHODS

This is an "observational study" with a sample size of 311. Method of sampling used was "Purposive Sampling'. This study was performed on the population living in Mumbai and Pune cities of Maharashtra. It was performed during the period of August 2017 to February 2018.

### *Subjects*

311 subjects from various nonmedical institutions who use mobile phones participated in this study. The inclusion criteria was- Subjects using phone since past 1 year and their age should be between 18-24 years and the Exclusion Criteria was subjects having any congenital cervical problem and subjects with traumatic and pathological cervical problem.

Ethical approval was obtained from the institutional ethical committee and each subject signed an informed consent approved by the committee.

### *Questionnaire*

A self-administered questionnaire was prepared in Google docs. The questionnaire included questions pertaining to 1) personal and information related to phone usage 2) awareness and knowledge related to text neck syndrome 3) hazards of excess phone usage.

The questionnaire was pilot tested for its validity by panel of expertise and it was modified based upon feedback received from the final version of the questionnaire was then distributed to all subjects via email.

### *Data analysis*

Descriptive statistics was conducted to evaluate the responses obtained from the subjects. The percentage of responses for each question was calculated.

## RESULTS

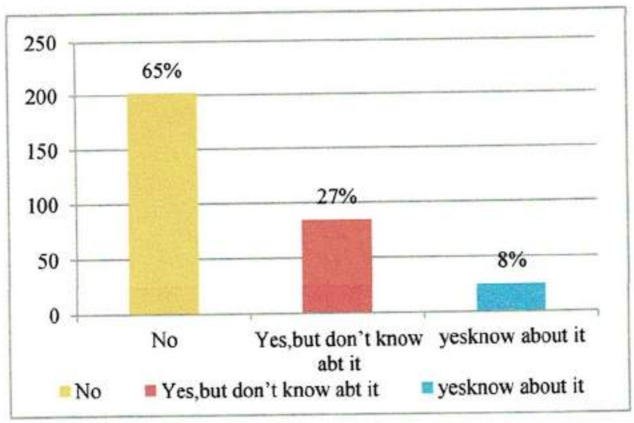



**Figure 1: Showing the results for question, have you heard about text neck syndrome?**

This graph shows us that 65% population is not aware of text neck syndrome, 27% have heard about it but don't know what it is and 8% know about it.

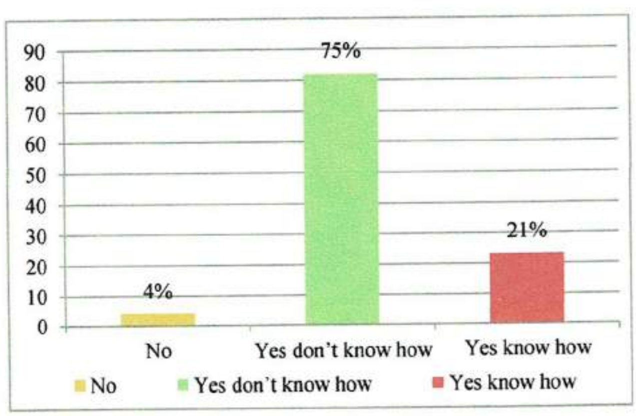



**Figure 2: Showing results on question, do you think you can prevent text neck syndrome?**

This graph shows that 4% population think we cannot prevent text neck syndrome, 75% think we can prevent it but the method is not known to them and 21% think we can prevent it and know how it is to be prevented.

Figure 3 shows the causes of text neck syndrome.13% population thinks it is because of talking on phone, 6%

think it's because of reading of text books and 81% population thinks it is because of texting.

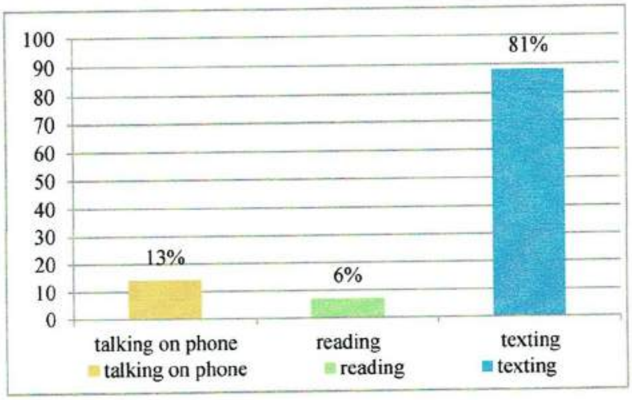
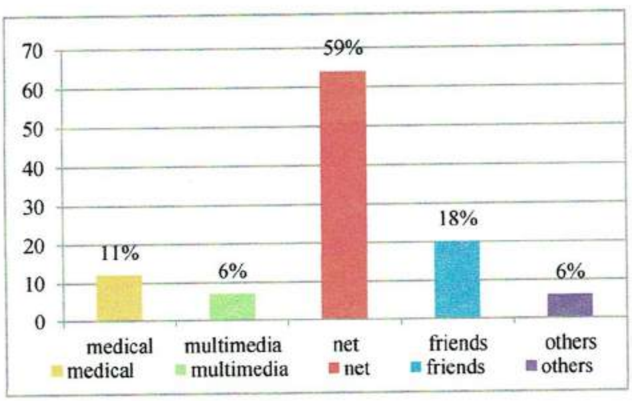



**Figure 3: Showing results on question, what do you think can cause text neck syndrome?**




This graph shows results of from where has the population heard about text neck syndrome.

11% have heard from medical professional, 6% from multimedia, 59% from the internet, 18% from friends and 6% from other sources.

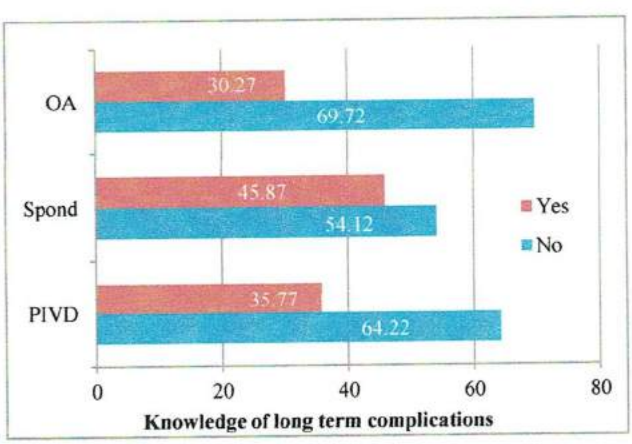



**Figure 5: Showing results on, are you aware of any long term complications of text neck syndrome?**

This graph shows us the results of awareness of long term complications of text neck syndrome.

The awareness of osteoarthritis of cervical spine is the maximum with a population of 69.72%. The awareness of PIVD is 64.22% and awareness of spondylosis is 54.12%.

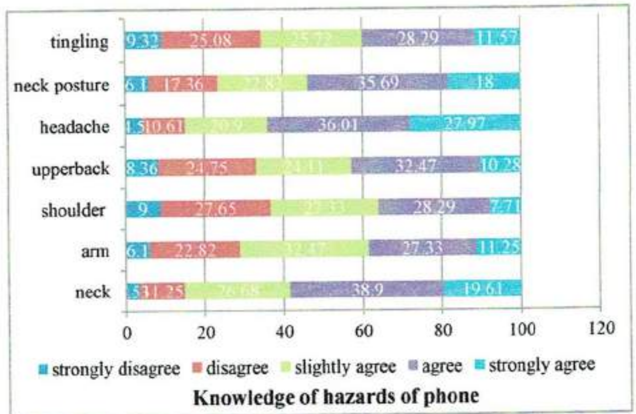



**Figure 6: Showing results of question, do you think your phone can cause following health hazards?**

This graph shows us the results of knowledge of hazards of long term usage of mobile phone.

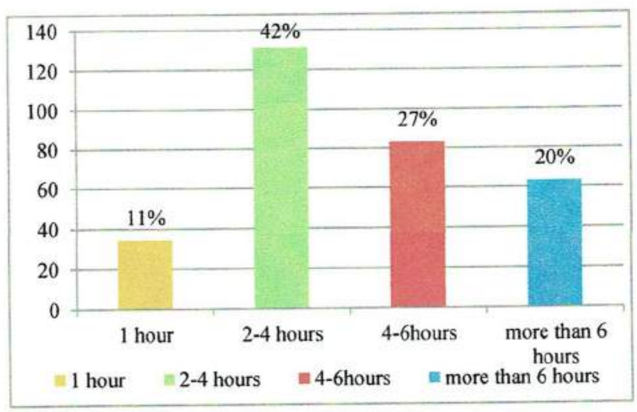



**Figure 7: Showing results on question, in a day, how many hours do you spend on mobile phones other than calls?**

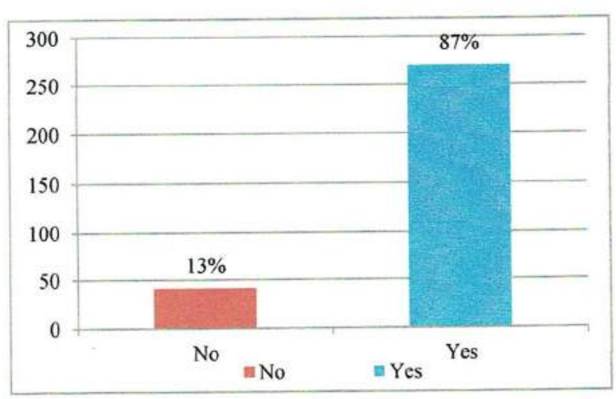



**Figure 8: Showing results on question, do you think you should minimize phone usage from health perspective?**

Figure 7 shows us the number of hours of mobile phone usage. 11% population uses phone for 1hour, 42% population uses phone for 2-4hours in a day, 27% population uses phone for 4-6 hours and 20% population uses phone for more than 6 hours in a day.

Figure 8 tells us that 13% population doesn't think that they should minimize phone usage and 87% think that they should minimize phone usage.

## DISCUSSION

In present study we tried to gain in knowledge regarding awareness of text neck syndrome and knowledge of its preventive measures. Texting on mobile phones is an activity which involves looking into mobile screens in a flexed position of the neck with a forward head posture and with rounding of shoulders and movement of the thumb and arms in a continues pattern. If this posture is maintained over long time, the centre of weight for the head is pushed forward. This imbalance, causes constant contraction of musculature to compensate giving rise to text neck syndrome with symptoms such as neck pain, shoulder pain, upper back pain, forward head posture, muscle spasm etc.[2,4,9,11,13] A 5 years cohort study on texting on mobile phones and musculoskeletal disorders in young population suggested that neck pain is the most prevalent short term as well as the long term effect of excess usage of mobile phones.[14]

A study by Hansraj states that normally our head weighs between 10-20 lb. While texting as the cervical flexion increases the effective weight on our neck increases the maximum being 60lb at 60 degrees.[13] A total of 311 subjects participated in this study. The average age of the subjects was 21 out of which 27% have heard about TNS but don't know about it where as 8% have heard about TNS and know about it. 65% haven't heard about TNS. These results could be attributed to level education and level of ignorance regarding this syndrome. Out of 311 subjects, 109 answered the question on causes of TNS out of which 81% population answered that TNS is caused due to excess Texting on phone whereas 13% think it's because of talking on phone and 6% think it's because of reading of textbooks.

Most of the subjects use their mobile phone for 2-4 hours in a day (42%) and 27% population use their phone for 4-6 hours in a day. A study done in Korea mentions a positive relationship between hours of mobile phone use and subjective musculoskeletal problems.[7]When smart phones are constantly used without any rest, and a poor posture is maintained over a long period of time, musculoskeletal pain can occur.[7] From the graph we see that most of the subjects agreed that mobile phone usage can cause neck pain, headache and upper back pain and most of them disagree that mobile phone usage can cause shoulder pain and arm pain. From the graph we see that 38.9% population agrees that neck pain could be a health hazard of excess usage of phone. A study done in Lahore, on prevalence of neck pain amongst under graduate students found out that 56.7% subjects from their study suffered from neck pain.[15]

Out of 109 subjects 75% subjects answered that preventing TNS is possible but the ways of preventing are not known to them. The possible reason for this could be lack of knowledge and ignorance towards this syndrome. Only 21% are aware of the preventive measures of TNS. The forward head position causes weight to be shifted anteriorly which puts stress on the lower cervical segments leading to various degenerative conditions of the neck. Out of 109 subjects, 45.87% are aware of spondylosis as a long term complication, 35.77% are aware of PIVD and 30.27% are aware of OA of cervical spine.

Thus we conclude that the awareness regarding TNS is not adequate and knowledge regarding this syndrome is important as it is a cumulative stress injury and can be prevented.

## CONCLUSION

This study has demonstrated a low level of awareness of text neck syndrome amongst young adult population. According to this study only 35% population has heard of Text neck syndrome. Also it mentioned about lack of knowledge of Text neck syndrome in this population. Out of the people who have heard of text neck syndrome, only 21% know about the preventive measures.

### *Limitation of study*

- The study is restricted only to young-adult population.
- Also due to time constrain has been done on a lesser population.

### *Future scope of study*

- The scope of this study will be to see prevalence of TNS in young adult population.
- Also the scope will be to study associated risk factors and their prevention in details.

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## REFERENCES


1. Kumar LR, Chii KD, Way LC, Jetly Y, Rajendaran V. Awareness of mobile phone hazards among university students in a Malaysian medical school. Health. 2011;3(07):406.
2. Neupane S, Ali UI, Mathew A. Text Neck Syndrome-Systematic Review. Imperial J Interdisciplinary Res. 2017;3(7):141-8.
3. Xie Y, Szeto G, Dai J. Prevalence and risk factors associated with musculoskeletal complaints among users of mobile handheld devices: A systematic review. Applied ergonomics. 2017;59:132-42.
4. Vate-U-Lan P. Text Neck Epidemic: a Growing Problem for Smart Phone Users in Thailand. Int J Comput Internet Manag. IJCIM. 2015;23(3):55.1-55.6.
5. Lee JI, Song HS. The correlation analysis between hours of smartphone use and neck pain in the Gachon university students. The Acupuncture. 2014;31(2):99-109.
6. Kim MS. Influence of neck pain on cervical movement in the sagittal plane during smartphone use. J Physical Therapy Sci. 2015;27(1):15-7.
7. Kim HJ, Kim JS. The relationship between smartphone use and subjective musculoskeletal symptoms and university students. J Physical Therapy Sci. 2015;27(3):575-9
8. AlZarea BK, Patil SR. Mobile Phone Head and Neck Pain Syndrome: Proposal of a New Entity. OHDM Headache. 2015;14(5):313-7.
9. Al-Gharabawi B. Text Neck Syndrome: A New Concern for Physical Therapists Worldwide". EC Orthopaedics. 2017;8(3):89-91.
10. Dr Dean Fishman. www.textneck.com
11. Walsh A. A Modern Spine Ailment: Text Neck. Spine-health. Available at: http://www.spinehealth.com/blog/modern-spine-ailmenttext-neck. Accessed on 5 November 2015.
12. Kim MS. Influence of neck pain on cervical movement in the sagittal plane during smartphone use. J Physical Therap Sci. 2015;27(1):15-7.
13. Hansraj KK. Assessment of stresses in the cervical spine caused by posture and position of the head. Surg Technol Int. 2014.
14. Gustafsson E, Thomée S, Grimby-Ekman A, Hagberg M. Texting on mobile phones and musculoskeletal disorders in young adults: a five-year cohort study. Applied ergonomics. 2017;58:208-14.
15. Malik A, Pasha MU, Khalid S, Ahmad A, Gilani SA. Prevalence of neck pain among Undergraduate students of Lahore. Int J Scientific Engineering Res. 2017;8(10):569-76.


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**Reference 10, 13: Incomplete reference.**